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Short Notes

Preliminary Checklist of Orchids in the Sungai Kangkawat, Imbak Canyon Conservation Area (ICCA), Sabah, Malaysia

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Abstract

A study on orchids diversity was carried out in the Sungai Kangkawat, Imbak Canyon Conservation Area (ICCA), Sabah, Malaysia. The study aimed to record species composition and distribution of orchids in the furtherance of orchid conservation objective in the gazetted conservation area. A total of 95 species and 30 genera were collected from South Rim, Kawang, and Nepenthes trails. The collection consists of 91 epiphytes, two terrestrials, and two mycoheterotrophs. More orchids were found in the riverine than inland areas. Our study on the species composition based on the vegetation types shows that the presence of inconspicuous and achlorophyllous, either mycoheterotrophic or leafless epiphytic orchids, are indicators of the undisturbed vegetation types. Though the finding was preliminary and brief, our encounter of endemic and rare species underlines the importance of Sungai Kangkawat forest area as an orchid biodiversity hotspot.

Keywords: Borneo, endangered, ICCA, lowland forest, Orchidaceae, riverine forest.

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Introduction

Imbak Canyon Conservation Area (ICCA) comprises 30,000 hectares of undisturbed rainforest located deep in the heart of Sabah, approximately 300 km from Kota Kinabalu. The conservation area consists of a 25 km long valley surrounded on three sides by steep sandstone cliffs up to 1,000 m. Its stunning wilderness area essentially forms a self-contained ecosystem. This forest area is also an important wildlife corridor linking two protected areas in Sabah -- Danum Valley and Maliau Basin, and is enriched with plant biodiversity and acclaimed as a genetic seed bank. Recognising the significance of this heritage site for conservation, the Sabah State Government gazetted Imbak Canyon as a Class I (Protection) Forest Reserve in 2009, providing legal status as a protected area (Latif & Sinun, 2012). The ICCA comprises primary lowland mixed dipterocarp and upper montane forests, including at around 800 m of the dipterocarp forest that starts with patches of montane heath or *kerangas* forest (Pesiu et al., 2019). Upper elevations of the canyon home to a high diversity of carnivorous pitcher plants and orchids.

Thus far, a number of botanical studies carried out by local institutions within the ICCA have provided insights on species composition and ecology of the vascular plants. The most recent study aimed to document the diversity of the interesting, endemic, rare, and threatened plant species in Batu Timbang by Pesiu et al. (2019). A total of 413 species from 82 families were recorded from the study area of which 93 species were endemic to Borneo, including 10 endemic species to Sabah (Pesiu et al., 2019). Meanwhile, previous expeditions in Mount Kuli by Suratman et al. (2011) recorded 153 tree species from 46 families, and Sugau et al. (2011) on the study of Dipterocarpaceae recorded a total 42 species. A few studies on other vascular plants, such as by Chong et al. (2011) on the study of *Begonia* recorded eight species, and Shim et al. (2011) on the study of ferns recorded a total of 104 species from 21 families. Noteworthy is a study on Orchidaceae by Go et al. (2011) that reported a total of 109 species in ICCA. With approximately 25,000 species, orchids are the most speciose and widespread flowering plants (Swarts & Dixon, 2009). It is estimated that as abundant as 3,000 species of wild orchids occur in Borneo (Lamb, 1991; Beaman et al., 2001).

Sadly, the abundance and distribution ranges of plant species in and around the ICCA have largely declined due to selective logging, development of human settlements, and large-scale agriculture (Bernard et al., 2013). Therefore, as part of a conservation effort, a scientific expedition was conducted with an objective to record the diversity, composition, and distribution of orchids in

selected sites in the Sungai Kangkawat area of ICCA. There is still a lack of knowledge concerning the orchid flora of different vegetation types in ICCA. The expedition was also intended to collect principal information to support the development of a biodiversity conservation management plan in the ICCA. Here in this paper, we report our preliminary findings.

Materials and Methods

Study site

A botanical sampling through a geographic expedition was held from 28th September 2018 to 4th October 2018 in a lowland mixed dipterocarp forest, which includes a riverine forest, in the Sungai Kangkawat Research Station, ICCA (Figure 1). Three selected trails were studied; South Rim, Kawang and Nepenthes trails.

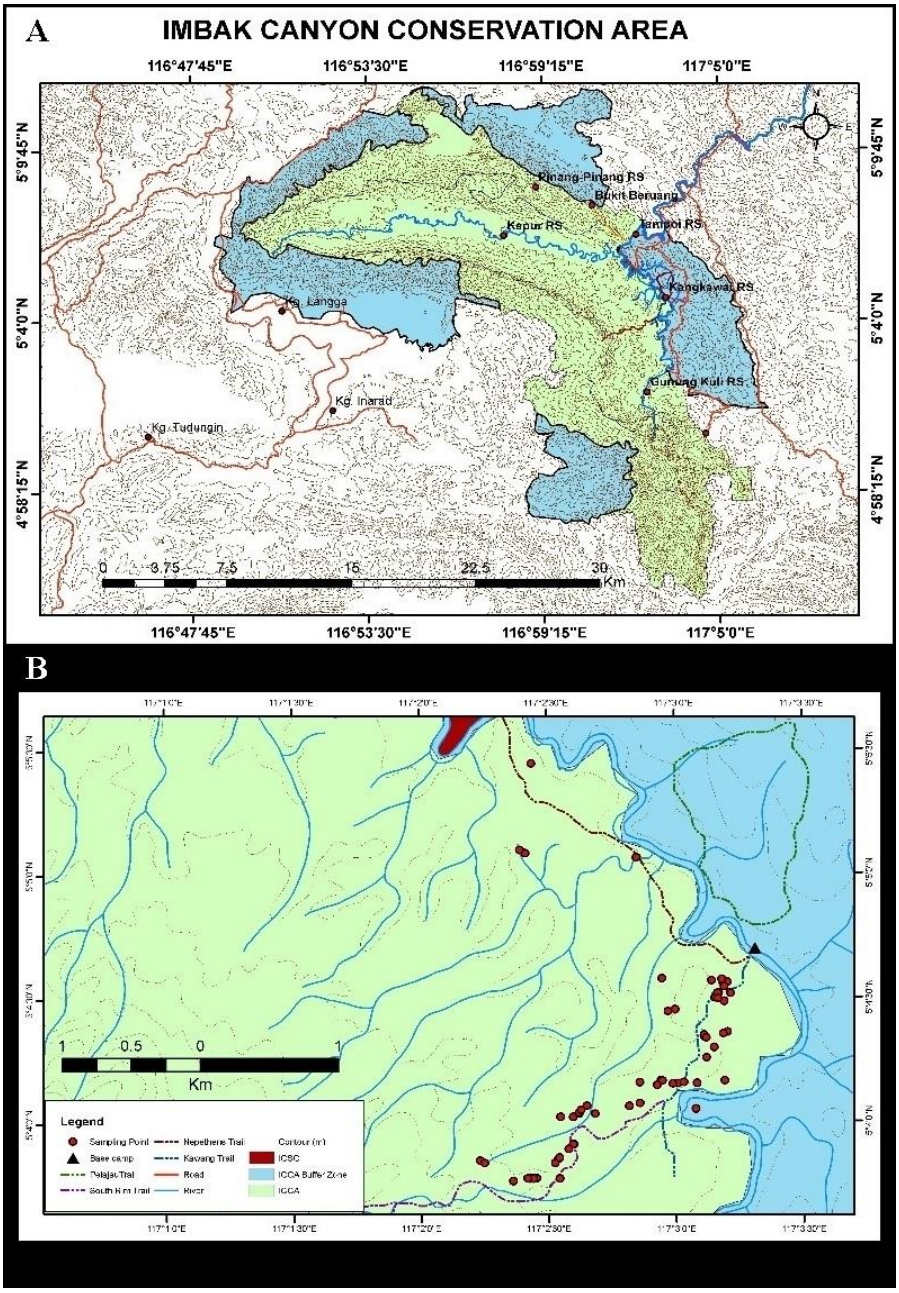

Figure 1. Imbak Canyon Conservation Area (ICCA) in Sabah (A) and locations of the sampling plots (B).

Sample collection and processing

The field exploration was done using opportunistic sampling method. The samples, with or without floral structures, were preserved using standard herbarium technique after Bridson & Forman (2000), and the ones without floral structures were transplanted into an ex-situ conservatory in the Institute for Tropical Biology and Conservation (ITBC), Universiti Malaysia Sabah (UMS), as living collections, where the plants were further nourished for flowering.

Sample identification

The orchid taxa were identified according to the monographs of Seidenfaden & Wood (1992), Wood (1997), Beaman et al. (2001), Comber (2001), and Wood (2003). The legitimate nomenclatures were checked through the KEW World Checklist of Selected Plant Families (WCSP) (Govaerts et al., 2020). A total of 65 species of these were identified only at genus level due to the lack of floral structures or flowers alcohol collections. Some of the fertile specimens had damaged flowers, making photography and dissection difficult. Moreover, upon making this checklist, only a few of the living plants cultivated in the ex-situ conservatory were blooming. Hence, the identifications of the incomplete specimens were made based on the diagnostic morphology of the vegetative structures alone. The distribution status was validated by referring to the monographs and checklists of Wood et al. (1993), Wood & Cribb (1994), and Beaman et al. (2001); and digitalised herbarium collection deposited in the international databases, such as Swiss Orchid Foundation (SOF) (https://orchid.unibas.ch/index.php/en/), National Herbarium of the Netherlands (NHN) accessed through Browse Dutch Natural History Collections: BioPortal (Naturalis) (http://bioportal.naturalis.nl/), and also WCSP (Govaerts et al., 2020).

Results and Discussions

A total of 147 orchid specimens were collected from South Rim (40 specimens), Kawang (47 specimens), and Nepenthes (60 specimens) trails. The total specimens are confined to 95 species and 30 genera, and consisting of 91 epiphytes, two terrestrials, and two mycoheterotrophs. Of these, only 31 specimens were completely identified to their respective taxa. The findings are listed in Table 1. The checklist includes brief information on each species growth habits, trails, and elevations. Some of the collected orchid species are shown in the Colour Plate (Figure 2, 3, 4 & 5). Of these identifiable specimens, two species are recorded as endemic to Borneo; *Phalaenopsis modesta* (Blume) Blume and *Trichoglottis borneensis* (J.J.Wood) Kocyan & Schuit. (Figure 2).

However, *Trichoglottis borneensis* was only identified based on the narrowly elliptic with acuminate apex, well-spaced, and dark green leaves that describe the homotypic genus, *Ventricularia,* a recircumcribed genus belonged to the subtribe Aeridinae (Kocyan & Schuiteman, 2014), and the very short inflorescence and scale-like floral bracts (Seidenfaden & Wood, 1992). It is comparable to the closely related *Trichoglottis ventricularis* Kocyan & Schuit by having a distinctly larger plant.

Figure 2. Orchids endemic to Borneo found in ICCA, *Phalaenopsis modesta*; A: flower (of a plant cultivated in the ex-situ conservatory), B: plant; *Trichoglottis borneensis*; C: plant.

In addition, we had an interesting finding of *Agrostophyllum trifidum* Schltr. and *Appendicula merrillii* Ames (Figure 3), two rare species with a small range of distribution (Govaerts et al., 2020) or small area of occupancy in Malaysia. Also, we encountered terrestrial species that are often overlooked to the inconspicuous appearance yet diminishing in the wild due to forest disturbance. Some species with striking appearance are also threatened by illegal collection, and now mostly confined to undisturbed or primary habitats (Besi et al., 2020). This includes jewel orchids *Cystorchis javanica* Blume, one species of genus

Zeuxine Lindl., a ghost orchid *Taeniophyllum* Blume (Figure 3), and two mycoheterotrophs, a small plant of *Aphyllorchis pallida* Blume and *Lecanorchis multiflora* J.J.Sm. (Figure 4).

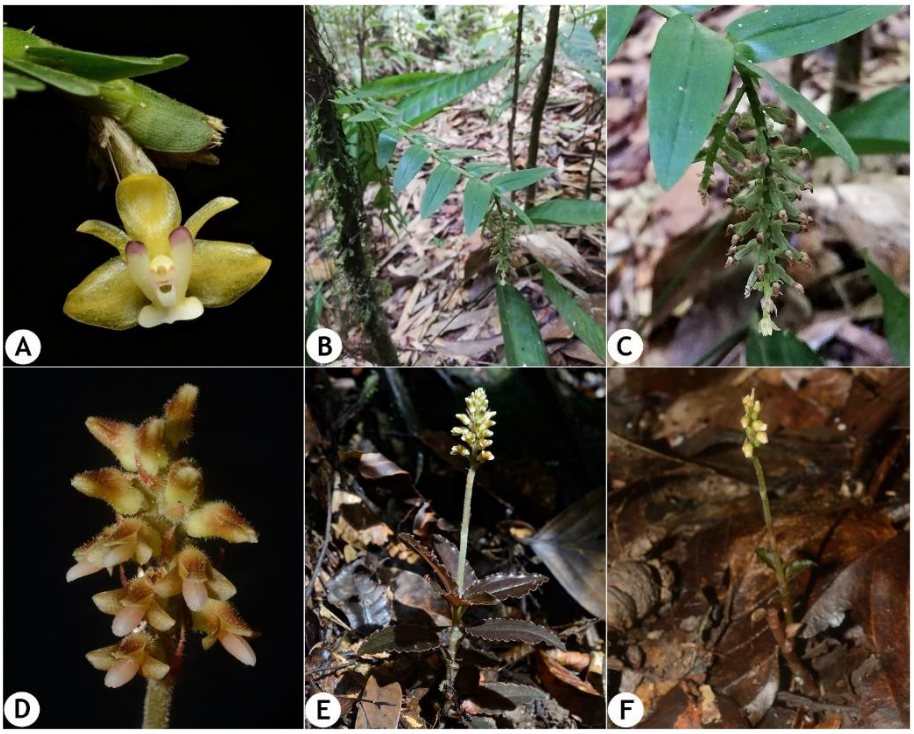

Figure 3. Rare orchids found in ICCA, *Agrostophyllum trifidum*; A: flower, *Appendicula merrilii*; B: plant, C: inflorescence, *Cystorchis javanica* (jewel orchid); D: inflorescence, E: plant, *Zeuxine* sp. 1; F: plant.

Moisture-demanding orchid species depend primarily on vegetation types and the ground condition (Besi et al., 2019, 2020). Nepenthes trail harboured the most abundant orchid species, where the mycoheterotrophic orchid species were discovered growing on the moist riverine forest floor (Figure 4). Its location close by the river, a water source, provides more moisture and nutrients to the area, hence, the most favourable condition for mycoheterotrophy. The extent of their leaf reduction is an adaptation to the heterotrophic mode of nutrition of these peculiar orchid species. They normally produce green leaves abd occasionally achlorophyllous (Salmia, 1989). Adaptation to heterotrophy was limited in this species since leaves are still well developed in the achlorophyllous

form. Progressive reduction in the length and numbers of leaves which parallel reduction in green pigmentation and change of habitat from open sites to shaded woodland habitats (Cribb, 1978).

Figure 4. Mycoheterotrophic and ghost orchids found in ICCA, *Aphyllorchis pallida* (mycoheterotroph); A: flowers, B: plant, *Lecanorchis multiflora* (mycoheterotroph); C: flower, *Taeniophyllum* sp. 1 (ghost orchid); D: plant.

Comparable to the ghost orchid, *Taeniophyllum*, is another type of achlorophyllous orchid living uniquely by being leafless and only has photosynthetic roots for survival. Their narrowness to the shaded pristine forest area has made them the best biological indicator for climatic changes and soil health. This also simply means that the Nepenthes trail was very much undisturbed compared to the other trails explored during the short expedition. Consequently, the results indicate conservation priorities, and can be used for conservation planning, as well as for the management of habitats in which orchids grow.

Conclusions and Recommendations

The collection of 95 orchid species only represents a very small percentage of the orchid diversity of ICCA. Most of the specimens lacked floral structures upon identification. Nevertheless, the species richness could be higher if the specimens were fertile. It can be concluded that the cool, moist, and shaded conditions in the riverine forest are pleasant for orchids. Our results particularly show that the indicator species have a significant presence in the riverine area, the undisturbed area and area near to a water source. However, a deeper study is required to assess the impact of other factors on the distribution and abundance of orchids, including the effects of mycorrhizal fungi and different types of management. It is very important to keep this pristine environment protected to ensure the survival of precious orchids and other organisms. In response to foreseen threats, the integrated conservation approaches sponsored by Malaysia's national oil company, Petronas, and managed by the Yayasan Sabah, are highly recommended to be continued.

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Table 1. Preliminary List of Orchid Taxa found in three Selected Trail in Sungai Kangkawat, ICCA, Sabah

Genera		Taxa	Trails	Growth Habits	Elevation, Δ (m)
(1) *Acriopsis* Reinw. ex Blume	(1)	*Acriopsis indica* C.Wright	Kawang	Epiphytic	207
	(2)	*Acriopsis liliifolia* (J.Koenig) Ormerod var. *liliifolia*	South Rim	Epiphytic	285
(2) *Agrostophyllum* Blume	(3)	*Agrostophyllum glumaceum* Hook.f.	Kawang	Epiphytic	238
	(4)	*Agrostophyllum trifidum* Schltr.	Kawang	Epiphytic	207
(3) *Aphyllorchis* Blume	(5)	*Aphyllorchis pallida* Blume	Nepenthes	Mycoheterotroph	203
(4) *Appendicula* Blume	(6)	*Appendicula merrillii* Ames	South Rim	Epiphytic	220
	(7)	*Appendicula reflexa* Blume var. *reflexa*	Kawang	Epiphytic	203
	(8)	*Appendicula* sp. 1	Kawang	Epiphytic	227
(5) *Bryobium* Lindl.	(9)	*Bryobium pudicum* (Ridl.) Y.P.Ng & P.J.Cribb	Kawang	Epiphytic	197
	(10)	*Bryobium* sp. 1	Nepenthes	Epiphytic	213
	(11)	*Bryobium* sp. 2	Nepenthes	Epiphytic	213
(6) *Bulbophyllum* Thouars	(12)	*Bulbophyllum apodum* Hook.f.	South Rim	Epiphytic	285
	(13)	*Bulbophyllum caudatisepalum* Ames & C.Schweinf.	South Rim	Epiphytic	264
	(14)	*Bulbophyllum flavescens* (Blume) Lindl.	Nepenthes	Epiphytic	227
	(15)	*Bulbophyllum longerepens* Ridl.	Nepenthes	Epiphytic	213
	(16)	*Bulbophyllum macranthum* Lindl.	Nepenthes	Epiphytic	227
	(17)	*Bulbophyllum macrochilum* Rolfe	South Rim	Epiphytic	221
	(18)	*Bulbophyllum* sp. 1	South Rim	Epiphytic	235
	(19)	*Bulbophyllum* sp. 2	Nepenthes	Epiphytic	230
	(20)	*Bulbophyllum* sp. 3	South Rim	Epiphytic	218
	(21)	*Bulbophyllum* sp. 4	South Rim	Epiphytic	321
	(22)	*Bulbophyllum* sp. 5	Nepenthes	Epiphytic	182
	(23)	*Bulbophyllum* sp. 6	Nepenthes	Epiphytic	204
	(24)	*Bulbophyllum* sp. 7	Nepenthes	Epiphytic	203
	(25)	*Bulbophyllum* sp. 8	Kawang	Epiphytic	207
	(26)	*Bulbophyllum* sp. 9	Kawang	Epiphytic	201
	(27)	*Bulbophyllum* sp. 10	Kawang	Epiphytic	224
	(28)	*Bulbophyllum* sp. 11	Kawang	Epiphytic	219
	(29)	*Bulbophyllum* sp. 12	Kawang	Epiphytic	234
(7) *Callostylis* Blume	(30)	*Callostylis pulchella* (Lindl.) S.C.Chen & Z.H.Tsi	Nepenthes	Epiphytic	230
	(31)	*Callostylis* sp. 1	Nepenthes	Epiphytic	213
(8) *Coelogyne* Lindl.	(32)	*Coelogyne foerstermannii* Rchb.f.	South Rim	Epiphytic	273
	(33)	*Coelogyne septemcostata* J.J.Sm.	Kawang	Epiphytic	201
	(34)	*Coelogyne* sp. 1	Nepenthes	Epiphytic	219
	(35)	*Coelogyne* sp. 2	Nepenthes	Epiphytic	203
	(36)	*Coelogyne trinervis* Lindl.	Kawang	Epiphytic	239
(9) *Cylindrolobus* Blume	(37)	*Cylindrolobus neglectus* (Ridl.) J.J.Wood	Nepenthes	Epiphytic	230
	(38)	*Cylindrolobus* sp. 1	Nepenthes	Epiphytic	230
	(39)	*Cylindrolobus* sp. 2	Nepenthes	Epiphytic	230
	(40)	*Cylindrolobus* sp. 3	Kawang	Epiphytic	245

(10) *Cystorchis* Blume	(41)	*Cystorchis javanica* (Blume) Blume	Nepenthes	Terrestrial	230
(11) *Dendrobium* Sw.	(42)	*Dendrobium angustifolium* (Blume) Lindl.	Nepenthes	Epiphytic	207
	(43)	*Dendrobium brevicolle* J.J.Sm.	Nepenthes	Epiphytic	230
	(44)	*Dendrobium* cf. *speculum*	South Rim	Epiphytic	281
	(45)	*Dendrobium pachyphyllum* (Kuntze) Bakh.f.	Nepenthes	Epiphytic	203
	(46)	*Dendrobium prostratum* Ridl.	South Rim	Epiphytic	283
	(47)	*Dendrobium setifolium* Ridl.	Kawang	Epiphytic	238
	(48)	*Dendrobium* sp. 1	Nepenthes	Epiphytic	230
	(49)	*Dendrobium* sp. 2	Nepenthes	Epiphytic	230
	(50)	*Dendrobium* sp. 3	South Rim	Epiphytic	208
	(51)	*Dendrobium* sp. 4	South Rim	Epiphytic	221
	(52)	*Dendrobium* sp. 5	Kawang	Epiphytic	200
	(53)	*Dendrobium* sp. 7	Kawang	Epiphytic	236
	(54)	*Dendrobium* sp. 8	Nepenthes	Epiphytic	213
	(55)	*Dendrochilum* sp. 1	South Rim	Epiphytic	285
	(56)	*Dendrochilum* sp. 2	Kawang	Epiphytic	197
	(57)	*Dendrochilum* sp. 3	Kawang	Epiphytic	197
(12) *Eria* Lindl.	(58)	*Eria* sp. 1	South Rim	Epiphytic	281
	(59)	*Eria* sp. 2	Nepenthes	Epiphytic	213
(13) *Grosourdya* Rchb.f.	(60)	*Grosourdya* sp. 1	South Rim	Epiphytic	295
(14) *Lecanorchis* Blume	(61)	*Lecanorchis multiflora* J.J.Sm.	Kawang	Mycoheterotroph	201
(15) *Liparis* Rich.	(62)	*Liparis* sp. 1	Nepenthes	Epiphytic	230
	(63)	*Liparis* sp. 2	South Rim	Epiphytic	247
	(64)	*Liparis* sp. 3	Nepenthes	Epiphytic	203
	(65)	*Liparis* sp. 4	Kawang	Epiphytic	201
(16) *Mycaranthes* Blume	(66)	*Mycaranthes pannea* (Lindl.) S.C.Chen & J.J.Wood	Kawang	Epiphytic	235
	(67)	*Mycaranthes* sp. 1	Kawang	Epiphytic	244
(17) *Oberonia* Lindl.	(68)	*Oberonia* sp. 1	Nepenthes	Epiphytic	NA
	(69)	*Oberonia* sp. 2	Kawang	Epiphytic	201
(18) *Oxystophyllum* Blume	(70)	*Oxystophyllum sinuatum* (Lindl.) M.A.Clem.	Nepenthes	Epiphytic	213
	(71)	*Oxystophyllum* sp. 1	Kawang	Epiphytic	238
(19) *Pennilabium* J.J.Sm.	(72)	*Pennilabium* sp. 1	South Rim	Epiphytic	221
(20) *Phalaenopsis* Blume	(73)	*Phalaenopsis modesta* J.J.Sm.	Kawang	Epiphytic	235
	(74)	*Phalaenopsis* sp. 1	Kawang	Epiphytic	235
(21) *Pinalia* Lindl.	(75)	*Pinalia* sp. 1	Nepenthes	Epiphytic	213
	(76)	*Pinalia* sp. 2	South Rim	Epiphytic	285
	(77)	*Pinalia* sp. 3	Nepenthes	Epiphytic	204
	(78)	*Pinalia* sp. 4	Nepenthes	Epiphytic	227
	(79)	*Pinalia* sp. 5	Kawang	Epiphytic	238
	(80)	*Pinalia* sp. 6	Kawang	Epiphytic	201
(22) *Pomatocalpa* Breda	(81)	*Pomatocalpa* sp. 1	South Rim	Epiphytic	210
(23) *Pteroceras* Hasselt ex Hassk.	(82)	*Pteroceras* sp. 1	Kawang	Epiphytic	212
(24) *Robiquetia* Gaudich.	(83)	*Robiquetia* sp. 1	Nepenthes	Epiphytic	93
	(84)	*Robiquetia* sp. 2	Kawang	Epiphytic	208
	(85)	*Robiquetia* sp. 3	Kawang	Epiphytic	198

(25) *Strongyleria* (Pfitzer) Schuit.	(86)	*Strongyleria* sp. 1	Nepenthes	Epiphytic	204
(26) *Taeniophyllum* Blume	(87)	*Taeniophyllum* sp. 1	South Rim	Epiphytic	295
(27) *Thrixspermum* Lour.	(88)	*Thrixspermum* sp. 1	Nepenthes	Epiphytic	214
	(89)	*Thrixspermum* sp. 2	Kawang	Epiphytic	201
(28) *Trichoglottis* Blume	(90)	*Trichoglottis borneensis* (J.J.Wood) Kocyan & Schuit.	South Rim	Epiphytic	248
	(91)	*Trichoglottis* sp. 1	Kawang	Epiphytic	219
(29) *Trichotosia* Blume	(92)	*Trichotosia* sp. 1	Nepenthes	Epiphytic	202
	(93)	*Trichotosia* sp. 2	Nepenthes	Epiphytic	213
	(94)	*Trichotosia* sp. 3	Nepenthes	Epiphytic	215
(30) *Zeuxine* Lindl.	(95)	*Zeuxine* sp. 1	Nepenthes	Terrestrial	214
30		**95**			

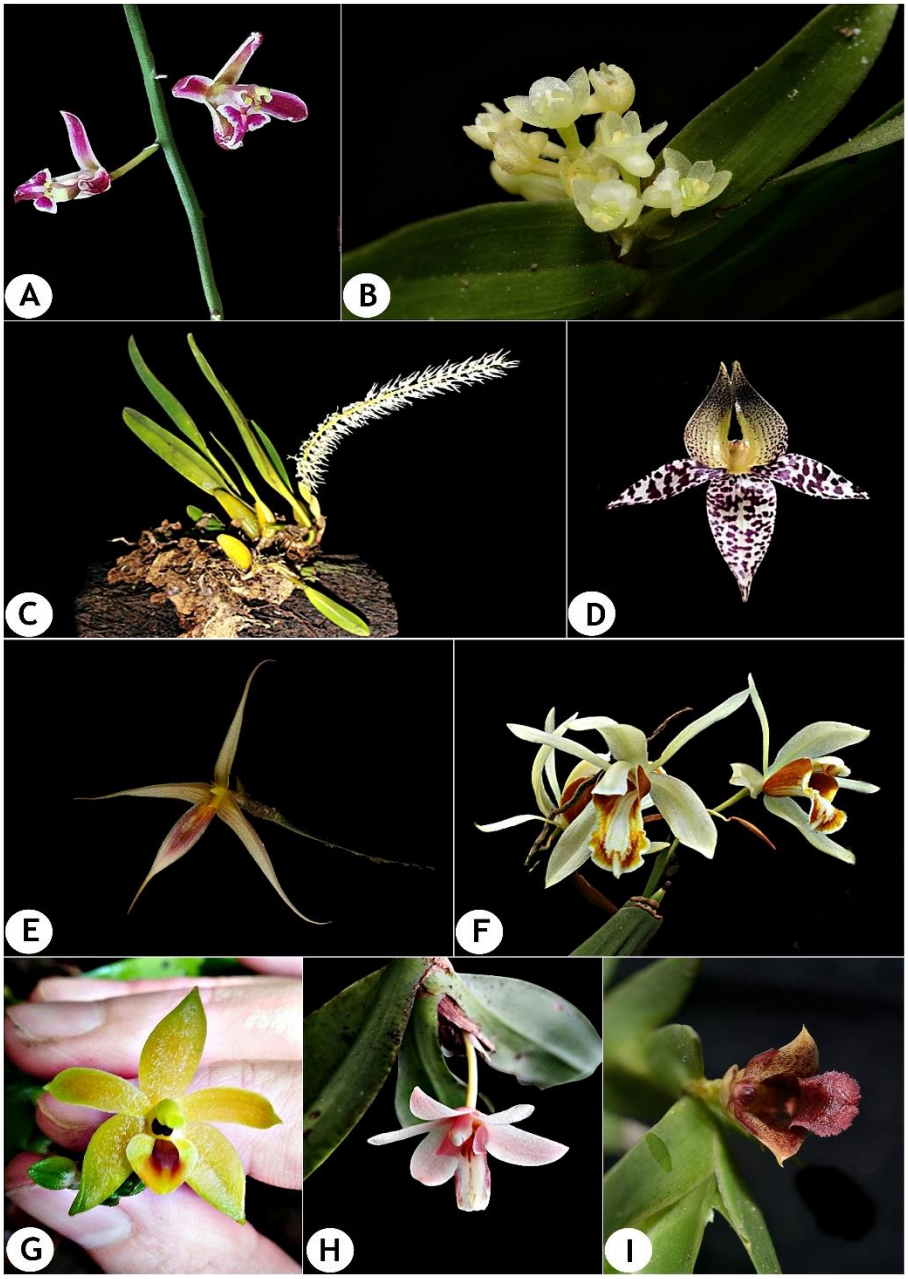

Figure 5. Orchids of Imbak Canyon Conservation Area; A: *Acriopsis liliifolia* var. *liliifolia*, B: *Appendicula reflexa* var. *reflexa*, C: *Bulbophyllum apodum*, D: *Bulbophyllum macranthum*, E: *Bulbophyllum macrochilum*, F: *Coelogyne trinervis*, G: *Callostylis pulchella*, H: *Cylindrolobus neglectus*, I: *Oxystophyllum sinuatum*