DIVERSITY OF ORCHIDACEAE FROM MURUM DAM, BELAGA, SARAWAK, BORNEO

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ABSTRACT

Murum Dam in Sarawak is located about 70 km upstream of Bakun Dam, on the rivers Murum, Danum and Plieran, forming a reservoir over an area of 245 km^2. The area consists of mainly lowland to hilly mixed dipterocarp forests, with riparian and alluvial forests along the main rivers and streams, as well as patches of mossy and heath forests. Most of these forests are logged over and some areas have been converted into oil palm plantations. A flora rescue project was carried out to collect selected plant species including orchids from the areas affected by the dam. Most epiphytic orchids were collected from partially submerged trees. Over 2,000 specimens of orchids from 80 genera and c. 276 species were collected from May 2013 to December 2014. The most abundant genus recorded is *Bulbophyllum* Thouars (c. 44 species). Of these, 37 species are endemic to Borneo, two (*Bulbophyllum upupops* J.J.Verm., P.O'Byrne & A.L.Lamb and *Thrixspermum lingiae* P.O'Byrne & Gokusing) are newly described and ten species are new records for Sarawak. The collection of species from this work has provided valuable material for the research and conservation of orchids from vulnerable areas around dams.

INTRODUCTION

Approximately 1,100 species of orchids occur in Sarawak (Beaman *et al.*, 2001). According to Beaman *et al.* (2001), from the inventory work on herbarium specimens collected during the late 19th and early 20th centuries, areas at a lower elevation, from sea level to 300 m, are probably richest in orchid diversity; these areas include lowland and riverine forest. The highest diversity on Mt Kinabalu, however, is found at about 1,500 m elevation. In Sarawak, lowland forest, especially riverine forest, has significantly higher orchid diversity, especially the undisturbed riparian forest where mosses are sometimes present. The trees along the rivers and streams in Murum Dam provide high levels of humidity, creating a suitable microhabitat for orchids to grow (Figs 1 & 2).

METHODOLOGY

Plant rescue work was carried out in stages, before, during and after impoundment. An intensive flora assessment survey was carried out in May 2013, before impoundment, in

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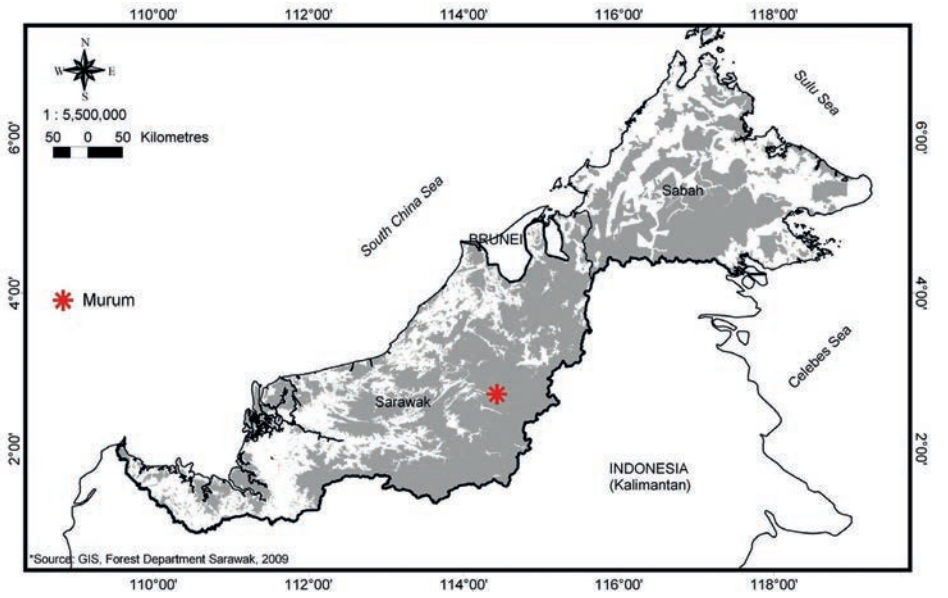

Fig. 1 Map of Sarawak showing the locality of Murum Dam. Map: Ling Chea Yiing.

Fig. 2 *Ensurai, Dipterocarpus oblongifolius*, trees along the river banks at Murum, which provide a suitable microhabitat for epiphytic orchids to grow. Photo: Ling Chea Yiing.

order to understand the floristic composition and diversity of the flora in the area. From the list of the flora assessed, a list of priority rescue species was drawn up.

Orchidaceae is one of the priority rescue families, as it is one of the Protected Plants listed in the Wildlife Protection Ordinance, 1998 (Laws of Sarawak, 1998). All orchids rescued were tagged and numbered accordingly. Herbarium specimens were made of any flowering orchids and, whenever possible, flowers were preserved in spirit. All specimens are kept in the working herbarium of the Botanical Research Centre (BRC), Kuching, Sarawak. In addition, all flowering specimens were photographed. Identification to species level was carried out by comparing the flowers with the specimens kept in the Kuching Herbarium (SAR), as well as those illustrated in various publications (Ling & Ong, 2016; O'Byrne, 2016; Vermeulen *et al.*, 2015; Wood, 2014). For species that could not be identified by the authors, more systematic photographs with scale bars were taken so that orchid experts could assist with identification.

During impoundment, flora rescue works were carried out between October 2013 and November 2014 to rescue these selected priority species, with a focus on areas along the three major rivers (Murum, Plieran and Danum) and their tributaries (Fig. 3). During this period, rescue trips were carried out around twice a month, depending on the water level. All plants rescued were planted and grown on at a nursery near the dam site. They were then replanted in the islands that remained after the impoundment. A garden (Murum Flora Conservation Garden) was specifically designed for the planting of all

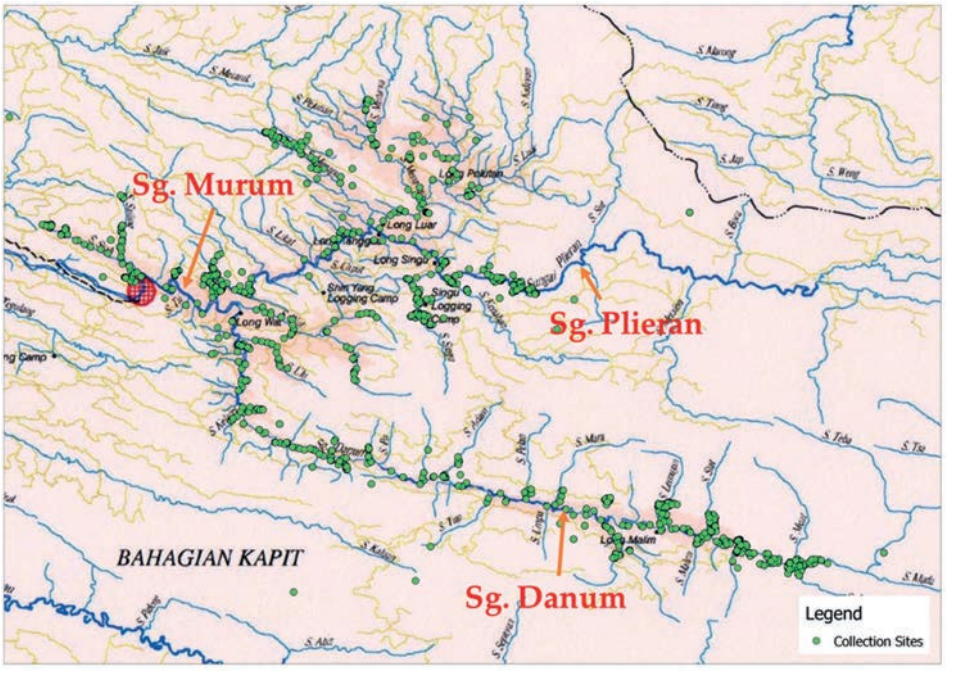

Fig. 3 Map showing the collection sites (in green dots) of the rescue work. Map: Ling Chea Yiing.

non-tree species, including the orchids, rescued from the submerged forests. In addition, duplicates of non-flowering rescued orchids were grown on in the nursery in the BRC (Botanical Research Centre), Kuching, for monitoring purposes.

FINDINGS AND DISCUSSION

A total of 2,416 individuals were collected during the rescue works. Of these, c. 276 species from 80 genera were documented. Thirty-seven species are endemic to Borneo (Fig. 4) and ten species are new records for Sarawak (Fig. 5). A checklist of all orchids discovered in Murum is listed in the Appendix. Some of the species have yet to be identified due to a lack of flowering material.

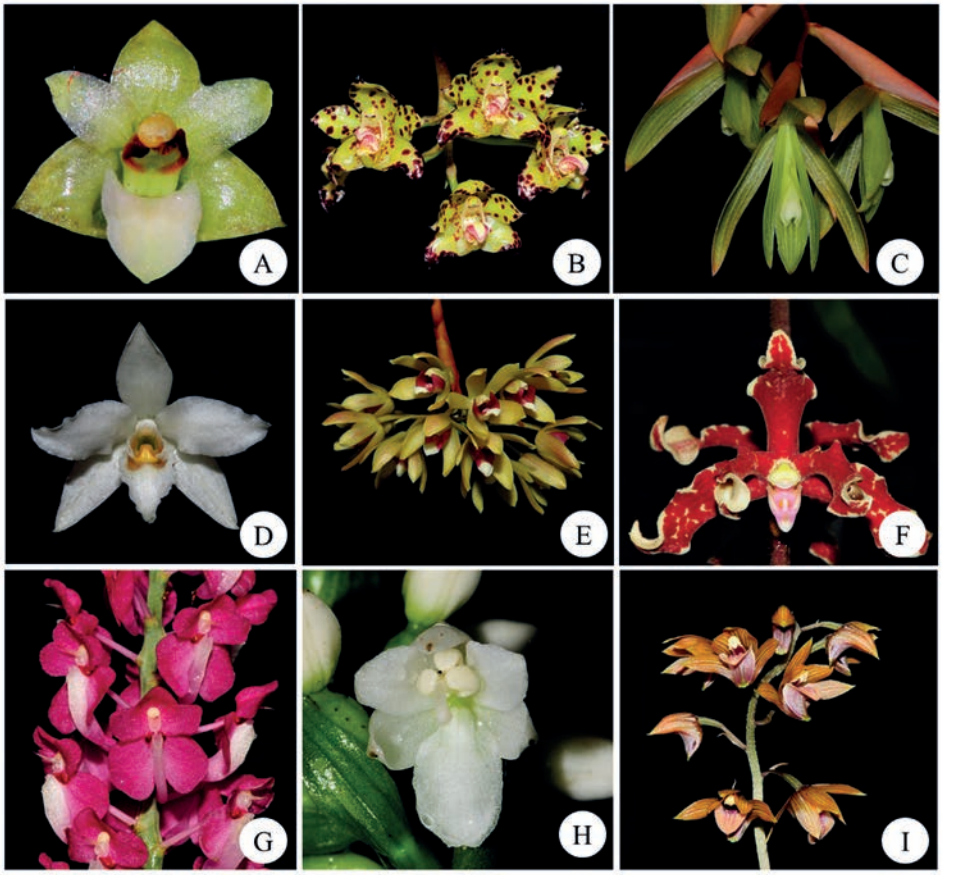

Fig. 4 Some of the orchids that are endemic to Borneo. A *Agrostophyllum laterale* J.J.Sm.; B *Bulbophyllum refractilingue* J.J.Sm.; C *Coelogyne exalata* Ridl.; D *Dendrobium tetrachroma* Rchb.f.; E *Dendrobium speculum* J.J.Sm.; F *Dimorphorchis lowii* (Lindl.) Rolfe; G *Dyakia hendersoniana* (Rchb.f.) Christenson; H *Neuwiedia borneensis* de Vogel; and I *Tainia scapigera* J.J.Sm. Photos: Ling Chea Yiing.

Fig. 5 Some of the orchids that are new records for Sarawak. A *Bulbophyllum concavilabium* P.O'Byrne & P.T.Ong; B *Dendrobium lancilobum* J.J.Wood var. *roseocalcar* (J.J.Wood & A.L.Lamb) J.J.Wood; C *Thrixspermum pulchrum* Carr; D *Thrixspermum tenuicalcar* Carr; E *Trichoglottis persicina* P.O'Byrne; F *Vanilla sumatrana* J.J.Sm. Photos: Ling Chea Yiing.

According to herbarium records at SAR, prior to this project only 66 specimens of orchids were collected from Murum Dam, in 1955 and 2001. This may be due to the remoteness and inaccessibility of the area. As such, this area has not been botanically well explored. In the course of this project, close to 300 species of orchids were discovered. Orchids are not in flower most of the time, and it is almost impossible to identify an orchid without its flower. This project provided an opportunity to monitor the flowering events of the orchids. Monitoring work in the BRC nursery was carried out weekly during the study period. There are no clear patterns to the flowering events of the specimens collected. Some of the orchids flowered within a month after they were collected, most probably due to the stress caused by collection and changes of environment from their original habitat to the nursery. Some collected orchids have to date not produced any flowers or have not survived. The diversity of orchids in Murum Dam can be considered high when compared with other areas such as Mulu National Park (Wood, 1984) and Lanjak Entimau Wildlife Sanctuary (Chai, 2000). During the 1977–1978 expedition to Mulu National Park, Wood reported 174 species of orchids discovered.

From a single trip or expedition, the chances of obtaining flowering orchids are as low as 5% or less (through field observations from the past ten years in Sarawak). As such, it will be difficult to determine material to species level unless living plants are collected. Living collections have helped numerous researchers to discover orchids that are new to science (Chan *et al.*, 1994). Monitoring work on flowering events was mainly carried out in the BRC nursery. Monitoring work in the dam site was conducted monthly by the authors for around 12 months before the plants were transplanted in Murum Flora Conservation Garden on a selected permanent island along the Danum River. A total of 30% of the orchids successfully flowered in BRC and the dam site, which enabled the authors to determine these orchids to species level.

Bulbophyllum is the most abundant genus, followed by *Dendrobium* and *Coelogyne* (Table 1). These genera belong to the epiphytic group, which can be found growing abundantly on trees along rivers and streams. During the impoundment, these orchids were easily collected by hand, without the need for tools or to climb trees. Because of this, many more epiphytic species were collected and documented.

During the rescue and monitoring work, many interesting orchids were discovered. These include the two newly described species *Bulbophyllum upupops* J.J.Verm., P.O'Byrne & A.L.Lamb (Vermeulen *et al*., 2015) and *Thrixspermum lingiae* P.O'Byrne & Gokusing (O'Byrne, 2016). *Bulbophyllum upupops* can be found growing on trees along the tributaries of the three main rivers whereas *T. lingiae* is confined to tributaries of the Plieran River, hanging on small branches in riverine forest.

In the first three months of monitoring work in Murum Dam site, the mortality rate of the orchids was about 2%. Most of the more fragile and smaller orchids died, probably due to damage during the transplanting process and the nurserymen's lack of knowledge of how to care for them. Monitoring work on the orchids in the BRC nursery is still ongoing. To date, about 200 plants are still alive in the nursery or have been planted in the BRC orchid garden. Biodiversity rescue is part of the mitigation measures required in the Environmental Impact Assessment (2008) report before any dam construction in Sarawak.

To our knowledge more than 30,000 plants have been rescued, including trees and non-trees. About 52% of the plants survived and were planted back to the remaining islands at the site of Murum Dam. The plants rescued can never be sufficient to replace

Genera	Total no. of species
Bulbophyllum	36
Dendrobium	26
Coelogyne	16
Dendrochilum	11
Appendicula	10

Table 1 The five most abundant genera documented from Murum Dam.

the biodiversity loss from the dam construction, but through this project, many interesting plants and orchids were discovered. It is a relief that some plants were found growing in other parts of the dam site unaffected by the impoundment. This project has given us an opportunity to study more epiphytic orchids, as many of these orchids are quite impossible to reach without proper climbing gear and experienced field staff.

CONCLUSION

A high diversity of orchids was discovered thanks to intensive rescue work at Murum Dam. A full species list of orchids discovered at the site has still not been achieved, despite our best efforts to rescue as many plants as possible, because specimens that are either sterile or have no living material could not be identified. A higher diversity of orchids would be expected if all specimens were fertile. Taxonomic studies and monitoring of flowering events are needed in the future for species with no flowering material to date.

Ex situ conservation is part of the outcome from this project. The plants in BRC are a historic representative collection from the dam site and hold important genetic information which may be useful in the future to understand environmental changes and biodiversity loss.

For future rescue work, we would suggest planting the orchids in other areas, such as the area adjacent to the office compound of the Botanical Research Centre. By planting the rescued orchids there, the management and care of the orchids should be more effective. At the same time, the garden could showcase the plants rescued from the dam site and raise local awareness of the wild orchids of Sarawak.

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APPENDIX: CHECKLIST OF ORCHIDS DISCOVERED FROM MURUM DAM

1	*Acanthophippium javanicum* Blume	CMHEP-2700, CMHEP-6061
2	*Acriopsis liliifolia* (J.Koenig) Ormerod	BMHEP-4064, CMHEP-05174
3	*Acriopsis sp*.	CMHEP-2632, AMHEP-2827, BMHEP-2249
4	*Aerides odorata* Lour.	CMHEP-0237, CMHEP-2808, CMHEP-2845, CMHEP-1351, BMHEP-3999, CMHEP-03618, BMHEP-03674, CMHEP-5996, CMHEP-3302, CMHEP-6543, CMHEP-0236, AMHEP-1092
5	*Agrostophyllum cyathiforme* J.J.Sm.	AMHEP-894, CMHEP-5935
6	*Agrostophyllum laterale* J.J.Sm.	BMHEP-2397, BMHEP-1615, BMHEP-3920 (endemic to Borneo)
7	*Agrostophyllum saccatum* Ridl.	BMHEP-3972
8	*Agrostophyllum sumatranum* Schltr. & J.J.Sm.	BMHEP-3803
9	*Agrostophyllum stipulatum* Schltr.	CMHEP-2210, BMHEP-3982
10	*Agrostophyllum spp*.	BMHEP-1402, BMHEP-2152, BMHEP-2513, CMHEP-1361
11	*Anoectochilus sp.*	CMHEP-03629
12	*Aphyllorchis montana* Rchb.f.	CMHEP-0051, CMHEP-0161
13	*Apostasia wallichii* R.Br.	CMHEP-0536, BMHEP-3863
14	*Appendicula anceps* Blume	AMHEP-870, BMHEP-2415
15	*Appendicula cornuta* Blume	CMHEP-0064
16	*Appendicula cristata* Blume	AMHEP-1071, CMHEP-5910, CMHEP-06217
17	*Appendicula longirostrata* Ames & C.Schweinf.	CMHEP-05088, CMHEP-5905, CMHEP-5956 (endemic to Borneo)
18	*Appendicula pendula* Blume	AMHEP-0204, CMHEP-6101
19	*Appendicula recondita* J.J.Sm.	CMHEP-0159, BMHEP-3840 (endemic to Borneo)
20	*Appendicula reflexa* Blume	CMHEP-2633, CMHEP-2942
21	*Appendicula torta* Blume	AMHEP-0440, AMHEP-3198
22	*Appendicula spp*.	BMHEP-0296, CMHEP-2212, CMHEP-1335
23	*Arundina graminifolia* Hochr.	CMHEP-1441, BMHEP-1691
24	*Ascochilus emarginatus* (Blume) Schuit.	CMHEP-1437
25	*Bromheadia finlaysoniana* (Lindl.) Miq.	AMHEP-1292, BMHEP-3862-1
26	*Bromheadia sp.*	BMHEP-1607
27	*Bryobium hyacinthoides* (Blume) Y.P.Ng & P.J.Cribb	AMHEP-0418, AMHEP-0463, AMHEP-1284, BMHEP-4010, CMHEP-6083
28	*Bryobium sp.*	BMHEP-1401, BMHEP-1528
29	*Bulbophyllum acuminatum* Ridl.	AMHEP-890, CMHEP-2259

30	*Bulbophyllum antenniferum* Rchb.f.	BMHEP-2966
31	*Bulbophyllum apodum* Hook.f.	CMHEP-0980, CMHEP-0233, CMHEP-1331, CMHEP-05171, CMHEP-6516, CMHEP-05156, AMHEP-2825, BMHEP-2862, CMHEP-1343
32	*Bulbophyllum armeniacum* J.J.Sm.	AMHEP-1175, AMHEP-1104
33	*Bulbophyllum artvogelii* J.J.Verm., P.O'Byrne & A.L.Lamb	BMHEP-2850, BMHEP-3814, CMHEP-06216
34	*Bulbophyllum biseriale* Carr	BMHEP-3893, CMHEP-5933
35	*Bulbophyllum caudatisepalum* Ames & C.Schweinf.	CMHEP-0134
36	*Bulbophyllum* cf. *caecilii* J.J.Sm.	CMHEP-1332
37	*Bulbophyllum* cf. *mahakamense* J.J.Sm.	AMHEP-451, AMHEP-1142, BMHEP-3856
38	*Bulbophyllum* cf. *osyricera* Schltr.	BMHEP-4036
39	*Bulbophyllum* cf. *virescens* J.J.Sm.	CMHEP-2790
40	*Bulbophyllum concavilabium* P.O'Byrne & P.T.Ong	AMHEP-839 (new record)
41	*Bulbophyllum coniferum* Ridl.	BMHEP-3851, BMHEP-4009
42	*Bulbophyllum ecornutum* J.J.Sm.	BMHEP-2247
43	*Bulbophyllum flavescens* Lindl.	AMHEP-852, BMHEP-4049
44	*Bulbophyllum hirtulum* Ridl.	CMHEP-201
45	*Bulbophyllum lasianthum* Lindl.	AMHEP-1114, CMHEP-6571
46	*Bulbophyllum laxiflorum* Lindl.	AMHEP-1106, BMHEP-2954, BMHEP-2592, BMHEP-3848
47	*Bulbophyllum lobbii* Lindl.	BMHEP-4068, BMHEP-4101
48	*Bulbophyllum macrochilum* Rolfe	AMHEP-1285
49	*Bulbophyllum membranifolium* Hook.f.	CMHEP-4292
50	*Bulbophyllum odoratum* Lindl.	BMHEP-2388, CMHEP-2646
51	*Bulbophyllum otochilum* J.J.Verm.	CMHEP-1830 (endemic to Borneo)
52	*Bulbophyllum penduliscapum* J.J.Sm.	CMHEP-1347, CMHEP-6555, CMHEP-6572
53	*Bulbophyllum puguahaanense* Ames	AMHEP-1087 (new record)
54	*Bulbophyllum purpurascens* Teijsm. & Binn.	CMHEP-2749
55	*Bulbophyllum putidum* J.J.Sm.	CMHEP-5940
56	*Bulbophyllum refractilingue* J.J.Sm.	CMHEP-2264, BMHEP-1367, BMHEP-4041, BMHEP-04741, BMHEP-1912 (endemic to Borneo)
57	*Bulbophyllum simii* J.J.Verm. & A.L.Lamb	AMHEP-1128 (endemic to Borneo)
58	*Bulbophyllum sulcatum* Lindl.	CMHEP-05127-1
59	*Bulbophyllum tortuosum* Lindl.	AMHEP-1107

60	*Bulbophyllum trifolium* Ridl.	BMHEP-2442
61	*Bulbophyllum upupops* J.J.Verm., P.O'Byrne & A.L.Lamb	BMHEP-3878, CMHEP-4313 (endemic to Borneo)
62	*Bulbophyllum vaginatum* Rchb.f.	CMHEP-2813, AMHEP-2836
63	*Bulbophyllum vermiculare* Hook.f.	AMHEP-1108
64	*Bulbophyllum sp.*	AMHEP-1016
65	*Bulbophyllum spp*.	AMHEP-885, CMHEP-0232, CMHEP-0234, CMHEP-0259, BMHEP-0298, BMHEP-1604, BMHEP-1606, BMHEP-1710, BMHEP-1722, CMHEP-2674, CMHEP-2816, AMHEP-2826, AMHEP-2832, AMHEP-2839, BMHEP-2860, CMHEP-1313, CMHEP-1322, CMHEP-1341, CMHEP-1355, BMHEP-1368, CMHEP-1397, CMHEP-0903, CMHEP-05004, CMHEP-05021, CMHEP-05025, CMHEP-05077, CMHEP-05078, CMHEP-05105, CMHEP-05175, CMHEP-05188, AMHEP-1062, BMHEP-2418, MHEP-4146
66	*Calanthe pulchra* Lindl.	BMHEP-1579, BMHEP-1656, BMHEP-1675, BMHEP-4066, BMHEP-04539, BMHEP-06400
67	*Calanthe vestita* Lindl.	BMHEP-04742
68	*Calanthe sp.*	BMHEP-1420, BMHEP-04748
69	*Callostylis pulchella* (Lindl.) S.C.Chen & Z.H.Tsi	AMHEP-823, AMHEP-0475, BMHEP-0294, BMHEP-2119, BMHEP-3986, CMHEP-05013, CMHEP-05173
70	*Campanulorchis leiophylla* (Lindl.) Y.P.Ng & P.J.Cribb	CMHEP-1356, CMHEP-05050
71	*Campanulorchis pseudoleiophylla* (J.J.Wood) J.J.Wood	AMHEP-1001
72	*Ceratostylis* cf. *octomerioides* J.J.Woods & A.L.Lamb	AMHEP-2364
73	*Ceratostylis pendula* Hook.f.	BMHEP-4056
74	*Ceratostylis sp.1*	CMHEP-1348
75	*Chelonistele ingloria* (J.J.Sm.) Carr	CMHEP-0249 (endemic to Borneo)
76	*Chelonistele sulphurea* Pfitzer	CMHEP-2819, BMHEP-1372, BMHEP-4038
77	*Chelonistele sp.1*	CMHEP-2731
78	*Claderia viridiflora* Hook.f.	CMHEP-0505, BMHEP-04959
79	*Cleisostoma suaveolens* Blume	CMHEP-2811, BMHEP-04792, BMHEP-6903, BMHEP-3947
80	*Cleisostoma spp*.	BMHEP-3881, CMHEP-03638
81	*Coelogyne asperata* Lindl.	BMHEP-2401, CMHEP-2817, BMHEP-2581
82	*Coelogyne* cf. *mayeriana* Rchb.f.	CMHEP-5946
83	*Coelogyne endertii* J.J.Sm.	CMHEP-659 (endemic to Borneo)

84	*Coelogyne exalata* Ridl.	CMHEP-271 (endemic to Borneo)
85	*Coelogyne foerstermanni* Rchb.f.	CMHEP-2677, CMHEP-1379, CMHEP-06340
86	*Coelogyne gibbifera* J.J.Sm.	CMHEP-03614
87	*Coelogyne incrassata* Lindl.	AMHEP-1051, CMHEP-6077
88	*Coelogyne mayeriana* Rchb.f.	AMHEP-1100, BMHEP-1506, CMHEP-05042, CMHEP-06300
89	*Coelogyne pandurata* Lindl.	AMHEP-0469, CMHEP-0265, CMHEP-2678, CMHEP-1304, CMHEP-5947
90	*Coelogyne pholidotoides* J.J.Sm.	AMHEP-1116 (endemic to Borneo)
91	*Coelogyne pulverula* Teijsm. & Binn.	AMHEP-0425, BMHEP-04510, BMHEP-04733, BMHEP-04920, BMHEP-05784, CMHEP-6553, BMHEP-2399
92	*Coelogyne rochusseni* de Vriese	BMHEP-1642, BMHEP-2972, CMHEP-2814, BMHEP-3811, BMHEP-3910, CMHEP-05148, CMHEP-5922, BMHEP-05740
93	*Coelogyne sanderiana* Rchb.f	AMHEP-1014, AMHEP-0205, CMHEP-2771, CMHEP-1400
94	*Coelogyne septemcostata* J.J.Sm.	CMHEP-2745, BMHEP-2154, BMHEP-2855, CMHEP-03601, CMHEP-03701, CMHEP-5963
95	*Coelogyne swaniana* Rolfe	BMHEP-2449, AMHEP-2542, BMHEP-03656, BMHEP-05785, BMHEP-3343, CMHEP-6545, AMHEP-0211
96	*Coelogyne testacea* Lindl.	CMHEP-5904
97	*Coelogyne spp*.	CMHEP-0242, CMHEP-0262, BMHEP-1728, BMHEP-2863, BMHEP-2864, BMHEP-2893, BMHEP-2569, CMHEP-2265, CMHEP-1333, CMHEP-1396, AMHEP-1288, CMHEP-0611, CMHEP-05141, CMHEP-06203, CMHEP-06358, CMHEP-05012
98	*Collabium* cf. *simplex* Rchb.f.	CMHEP-6601, (live plant planted in garden at dam site)
99	*Corymborkis veratrifolia* (Reinw.) Blume	AMHEP-1275, CMHEP-2904
100	*Crepidium damusicum* (J.J.Sm.) Marg. & Szlach.	AMHEP-1133, CMHEP-6006 (endemic to Borneo)
101	*Crepidium micranthum* (Hook.f.) Szlach.	BMHEP-04967
102	*Cymbidium bicolor* Lindl. subsp. *pubescens* (Lindl.) Du Puy & P.J.Cribb	BMHEP-4022, BMHEP-04515
103	*Cymbidium finlaysonianum* Lindl.	CMHEP-6557
104	*Cymbidium spp*.	AMHEP-0213, CMHEP-0229, CMHEP-2666, CMHEP-2810, CMHEP-2202, BMHEP-3895
105	*Cystorchis javanica* (Blume) Blume	BMHEP-4067
106	*Cystorchis variegata* Blume	CMHEP-03626

107	*Dendrobium acerosum* Lindl.	AMHEP-806, BMHEP-04490
108	*Dendrobium bancanum* J.J.Sm.	CMHEP-2846, CMHEP-2261, CMHEP-2268
109	*Dendrobium bicostatum* J.J.Sm.	CMHEP-2847
110	*Dendrobium connatum* var. *connatum* (Blume) Lindl.	AMHEP-2351, AMHEP-0576, CMHEP-1820, BMHEP-2246, CMHEP-1375, BMHEP-3953, CMHEP-03641, BMHEP-04526, BMHEP-05703, CMHEP-6576
111	*Dendrobium endertii* J.J.Sm.	AMHEP-2114 (endemic to Borneo)
112	*Dendrobium geminatum* (Blume) Lindl.	CMHEP-2176, CMHEP-5926, BMHEP-6911
113	*Dendrobium hendersonii* A.D.Hawkes & A.H.Heller	BMHEP-2394
114	*Dendrobium heterocarpum* Wall. ex Lindl.	BMHEP-2385, BMHEP-04511, BMHEP-04943
115	*Dendrobium hosei* Ridl.	AMHEP-831, CMHEP-0496, CMHEP-0528, CMHEP-0244, CMHEP-1454, BMHEP-1556, BMHEP-1649, CMHEP-2769, CMHEP-1354, CMHEP-5953, BMHEP-05819
116	*Dendrobium lancilobum* var. *roseocalcar* (J.J.Wood & A.L.Lamb) J.J.Wood	CMHEP-0079 (endemic to Borneo; new record)
117	*Dendrobium lobbii* Teijsm. & Binn.	CMHEP-0532, CMHEP-6076
118	*Dendrobium luxurians* J.J.Sm.	CMHEP-6026
119	*Dendrobium microglaphys* Rchb.f.	BMHEP-1723, BMHEP-3018, CMHEP-1398, AMHEP-1068
120	*Dendrobium planibulbe* Lindl.	BMHEP-04513
121	*Dendrobium pleasancium* P.O'Byrne & J.J.Verm.	CMHEP-05187 (endemic to Borneo)
122	*Dendrobium rosellum* Ridl.	AMHEP-807, CMHEP-0231, CMHEP-0243, BMHEP-1683, CMHEP-1363, BMHEP-4104
123	*Dendrobium secundum* (Blume) Lindl. ex Wall.	BMHEP-3991
124	*Dendrobium setifolium* Ridl.	BMHEP-2393
125	*Dendrobium spathipetalum* J.J.Sm.	CMHEP-2476, CMHEP-0495, BMHEP-6917 (endemic to Borneo)
126	*Dendrobium speculum* J.J.Sm.	AMHEP-834, AMHEP-893, BMHEP-2412, BMHEP-1720, BMHEP-3883, BMHEP-3979 (endemic to Borneo)
127	*Dendrobium stuposum* Lindl.	BMHEP-2391, BMHEP-3901, BMHEP-3937
128	*Dendrobium tetrachromum* Rchb.f.	CMHEP-2964, BMHEP-2965, BMHEP-3815 (endemic to Borneo)
129	*Dendrobium treacherianum* Rchb.f. ex Hook.f.	BMHEP-1721, CMHEP-2262, CMHEP-1318, BMHEP-1366, CMHEP-1374, BMHEP-2150, BMHEP-1935
130	*Dendrobium xantholeucum* Rchb.f.	CMHEP-2206

131	*Dendrobium spp.*	CMHEP-1450, CMHEP-2649, CMHEP-2746, CMHEP-2752, CMHEP-2178, AMHEP-2831, BMHEP-2576, CMHEP-2209, BMHEP-2245, CMHEP-1312, CMHEP-1357, BMHEP-3850, CMHEP-5016, CMHEP-5051, CMHEP-5172, CMHEP-6366, BMHEP-4633, CMHEP-6298
132	*Dendrochilum anomalum* Carr	CMHEP-1337, BMHEP-2327 (endemic to Borneo)
133	*Dendrochilum cruciforme* var. *longicuspe* J.J.Wood	AMHEP-851, CMHEP-2461 (endemic to Borneo)
134	*Dendrochilum integrilabium* Carr	CMHEP-6091, CMHEP-06351 (endemic to Borneo)
135	*Dendrochilum kingii* (Hook.f.) J.J.Sm.	AMHEP-869, AMHEP-1111, AMHEP-1191, CMHEP-0501, CMHEP-0270, BMHEP-1370, BMHEP-3810, BMHEP-3921, BMHEP-04451, BMHEP-04789, BMHEP-04919
136	*Dendrochilum longifolium* Rchb.f.	AMHEP-1110
137	*Dendrochilum longipes* J.J.Sm.	CMHEP-2775 (endemic to Borneo)
138	*Dendrochilum oxylobum* Schltr.	BMHEP-4115 (endemic to Borneo)
139	*Dendrochilum pallidiflavens* Blume	AMHEP-853, AMHEP-1182, CMHEP-0241, CMHEP-0272, CMHEP-2770, CMHEP-1350, CMHEP-1385, CMHEP-03645, CMHEP-06354, CMHEP-5915, AMHEP-1006, CMHEP-6070
140	*Dendrochilum pubescens* L.O.Williams	AMHEP-0407 (endemic to Borneo)
141	*Dendrochilum rufum* (Rolfe) J.J.Sm.	CMHEP-0526, CMHEP-1464, CMHEP-1492, BMHEP-1551, CMHEP-6049 (endemic to Borneo)
142	*Dendrochilum spp.*	AMHEP-0207, CMHEP-0283, BMHEP-1603, CMHEP-1302, CMHEP-2802, CMHEP-1317, CMHEP-05047
143	*Dienia ophrydis* (J.Koenig) Seidenf.	AMHEP-1058
144	*Dilochia rigida* (Ridl.) J.J.Wood	CMHEP-4214 (endemic to Borneo)
145	*Dilochia wallichii* Lindl.	CMHEP-0055, CMHEP-2809, BMHEP-04795
146	*Dilochia sp.*	CMHEP-1359, CMHEP-05019
147	*Dimorphorchis lowii* (Lindl.) Rolfe	CMHEP-2823, BMHEP-05719, CMHEP-6574 (endemic to Borneo)
148	*Dipodium purpureum* J.J.Sm.	CMHEP-0252, CMHEP-2735, BMHEP-2416
149	*Dipodium sp.1*	BMHEP-2223
150	*Dyakia hendersoniana* (Rchb.f.) Christenson	AMHEP-2842, BMHEP-4046, CMHEP-03624 (endemic to Borneo)
151	*Entomophobia kinabaluensis* (Ames) de Vogel	CMHEP-2460, CMHEP-0522, CMHEP-0246, CMHEP-2774, AMHEP-2837, CMHEP-2260, CMHEP-1387, CMHEP-6028
152	*Eria crassipes* Ridl.	CMHEP-1316, CMHEP-03623
153	*Eria javanica* (Sw.) Blume	CMHEP-6531
154	*Eria neglecta* Ridl.	CMHEP-2472

155	*Eria nutans* Lindl.	CMHEP-2175, CMHEP-6562
156	*Eria robusta* (Blume) Lindl.	CMHEP-0523, BMHEP-1719, CMHEP-2779, AMHEP-2829, CMHEP-1384, BMHEP-3861, BMHEP-4118, BMHEP-04518, CMHEP-05108, CMHEP-5921, BMHEP-2389
157	*Eria spp*.	CMHEP-2457, CMHEP-0538, AMHEP-1283, CMHEP-0981, CMHEP-0247, CMHEP-0253, CMHEP-0255, CMHEP-0256, CMHEP-0261, BMHEP-0297, BMHEP-1617, BMHEP-1618, BMHEP-1648, CMHEP-2671, CMHEP-2675, CMHEP-2676, CMHEP-2806, CMHEP-2807, CMHEP-2824, AMHEP-2835, CMHEP-2205, CMHEP-2211, BMHEP-2250, CMHEP-2254, CMHEP-2255, CMHEP-1326, CMHEP-1345, BMHEP-1365, BMHEP-4008, CMHEP-05010, CMHEP-05028, CMHEP-05071, CMHEP-05126, CMHEP-05185, CMHEP-05189, CMHEP-2181, CMHEP-3308, BMHEP-04496
158	*Geesinkorchis sp.*	CMHEP-0245, CMHEP-1496, CMHEP-1632, AMHEP-2838, CMHEP-2267, CMHEP-1315, BMHEP-4037, CMHEP-5930, AMHEP-815, BMHEP-6908
159	*Grammatophyllum speciosum* Blume	CMHEP-0524, CMHEP-0021, CMHEP-1349, CMHEP-3193, CMHEP-05075
160	*Hylophila cheangii* Holttum	CMHEP-5984, CMHEP-6051
161	*Lecanorchis multiflora* J.J.Sm.	CMHEP-5972
162	*Liparis barbata* Lindl.	AMHEP-1041, AMHEP-0436, CMHEP-2736, BMHEP-3028, BMHEP-3911, CMHEP-5964
163	*Liparis cespitosa* (Lam.) Lindl.	CMHEP-2458
164	*Liparis elegans* Lindl.	BMHEP-2881, BMHEP-3854
165	*Liparis grandiflora* Ridl.	AMHEP-1272, BMHEP-3806 (endemic to Borneo)
166	*Liparis lacerata* Ridl.	AMHEP-858, AMHEP-0419, CMHEP-0116, BMHEP-3994, CMHEP-05011
167	*Liparis latifolia* Lindl.	BMHEP-04941
168	*Liparis rheedei* Lindl.	BMHEP-1580, CMHEP-6541, BMHEP-04908
169	*Liparis spp*.	BMHEP-3027, BMHEP-0684, BMHEP-04502, BMHEP-04540, BMHEP-05730
170	*Luisia antennifera* Blume	CMHEP-1376, CMHEP-05079, CMHEP-5931
171	*Macodes petola* (Blume) Lindl.	BMHEP-2315
172	*Malleola sp.*	AMHEP-0598
173	*Mycaranthes citrina* (Ridl.) Rauschert	BMHEP-1616, CMHEP-2201, CMHEP-1330, CMHEP-1344
174	*Mycaranthes latifolia* Blume	CMHEP-1327, CMHEP-1380
175	*Mycaranthes magnicallosa* (Ames & C.Schweinf.) J.J.Wood	CMHEP-1342, CMHEP-0230 (endemic to Borneo)

176	*Mycaranthes obliqua* Lindl.	CMHEP-1478, CMHEP-1334, CMHEP-0650, BMHEP-4054, AMHEP-889, BMHEP-04794
177	*Mycaranthes oblitterata* Blume	CMHEP-0235, BMHEP-1682-1, BMHEP-1610, CMHEP-2723, BMHEP-3859, BMHEP-3922, BMHEP-04514, BMHEP-04942, CMHEP-05005, CMHEP-5906, BMHEP-05704
178	*Mycaranthes pannea* (Lindl.) S.C.Chen & J.J.Wood	CMHEP-1821, CMHEP-1353, CMHEP-05184
179	*Mycaranthes sp.*	CMHEP-2214, BMHEP-06395
180	*Nephelaphyllum pulchrum* Blume	BMHEP-04708
181	*Neuwiedia borneensis* de Vogel	CMHEP-06339 (endemic to Borneo)
182	*Neuwiedia veratrifolia* Blume	CMHEP-6012
183	*Oberonia* cf. *rubra* Ridl.	AMHEP-0596
184	*Oberonia ciliolata* Hook f.	BMHEP-4017
185	*Oberonia insectifera* Hook. f.	AMHEP-1140
186	*Oberonia padangensis* Schltr.	BMHEP-2229, BMHEP-2253, CMHEP-2257, CMHEP-1377, AMHEP-884, CMHEP-05182
187	*Oberonia spp*.	BMHEP-4058, CMHEP-05176, CMHEP-6029
188	*Ornithochilus difformis* (Wall. ex Lindl.) Schltr.	BMHEP-4057
189	*Oxystophyllum sinuatum* (Lindl.) M.A.Clem.	AMHEP-1112
190	*Oxystophyllum spp*.	CMHEP-4296, CMHEP-5981
191	*Pennilabium struthio* Carr	AMHEP-597
192	*Peristylus gracilis* Blume	AMHEP-0437
193	*Peristylus hallieri* J.J.Sm.	CMHEP-0515, BMHEP-1688, CMHEP-2786, BMHEP-4004 (endemic to Borneo)
194	*Phaius sp.*	BMHEP-2858, BMHEP-2875, CMHEP-1399
195	*Phalaenopsis cornu-cervi* (Breda) Blume & Rchb.f.	AMHEP-1199, CMHEP-0663, CMHEP-6525
196	*Phalaenopsis maculata* Rchb.f.	CMHEP-2788, CMHEP-6104
197	*Pholidota carnea* (Blume) Lindl.	BMHEP-2323, BMHEP-2432
198	*Pholidota gibbosa* (Blume) Lindl. ex de Vriese	AMHEP-1152-1, CMHEP-0043, CMHEP-1346, BMHEP-04512, BMHEP-04727, BMHEP-04901, CMHEP-6507, CMHEP-6540, CMHEP-05149
199	*Pholidota imbricata* Lindl.	CMHEP-6549
200	*Pholidota sulcata* J.J.Sm.	AMHEP-878, CMHEP-5917
201	*Pholidota sp.*	BMHEP-4122

202	*Phreatia densiflora* (Blume) Lindl.	CMHEP-0627
203	*Pinalia* aff. *saccifera* (Hook.f.) Kuntze	CMHEP-05165, CMHEP-6041
204	*Pinalia cepifolia* (Ridl.) J.J.Wood	CMHEP-2478 (live plant planted in garden at dam site)
205	*Pinalia floribunda* (Lindl.) Kuntze	AMHEP-1228-1, BMHEP-04904, BMHEP-04790-1
206	*Pinalia latibracteata* (Ridl.) J.J.Wood	CMHEP-1338
207	*Pinalia tenuiflora* (Ridl.) J.J.Wood	CMHEP-2183, CMHEP-6513, CMHEP-05153
208	*Pinalia xanthocheila* (Ridl.) W.Suarez & Cootes	CMHEP-4233
209	*Plocoglottis hirta* Ridl.	CMHEP-6013 (endemic to Borneo; live plant planted in garden at dam site)
210	*Plocoglottis plicata* (Roxb.) Ormerod	CMHEP-6526, CMHEP-6550, CMHEP-6568
211	*Plocoglottis sp.*	BMHEP-1703, CMHEP-2905, BMHEP-2859, BMHEP-4000, BMHEP-04543
212	*Poaephyllum sp.*	BMHEP-5712 (live plant planted in garden at dam site)
213	*Podochilus microphyllus* Lindl.	CMHEP-0258
214	*Podochilus* cf. *schistanthera* Schltr.	BMHEP-3877
215	*Podochilus sp.1*	BMHEP-1550
216	*Pteroceras fragrans* (Ridl.) Garay	CMHEP-5951 (endemic to Borneo)
217	*Pteroceras teres* (Blume) Holttum	CMHEP-2940
218	*Renanthera breviflora* (Rchb.f.) R.Rice & J.J.Wood	BMHEP-3802 (new record)
219	*Renanthera elongata* (Blume) Lindl.	CMHEP-1329
220	*Robiquetia transversisaccata* (Ames & C.Schweinf.) J.J.Wood	CMHEP-5901 (endemic to Borneo)
221	*Robiquetia sp.*	CMHEP-2263
222	*Saccolabiopsis viridiflora* Aver.	BMHEP-3889, BMHEP-4035 (new record)
223	*Spathoglottis aurea* Lindl.	CMHEP-2163, CMHEP-1388
224	*Spathoglottis plicata* Blume	BMHEP-2436, AMHEP-0466, BMHEP-3897, CMHEP-6022
225	*Stichorkis* cf. *gibbosa* (Finet) J.J.Wood	AMHEP-1064, AMHEP-0443
226	*Taeniophyllum sp*.	AMHEP-1247
227	*Tainia obpandurata* H.Turner	AMHEP-2358 (new record)

228	*Tainia paucifolia* (Breda) J.J.Sm.	CMHEP-2740, BMHEP-3828, BMHEP-03668, BMHEP-05749
229	*Tainia scapigera* (Hook.f.) J.J.Sm.	CMHEP-6050 (endemic to Borneo)
230	*Tainia speciosa* Blume	CMHEP-0030
231	*Tainia sp.*	BMHEP-2857
232	*Thecopus secunda* (Ridl.) Seidenf.	BMHEP-04530
233	*Thelasis macrobulbon* Ridl.	AMHEP-1180, CMHEP-0510, CMHEP-1319
234	*Thelasis micrantha* (Brongn.) J.J.Sm.	BMHEP-3890
235	*Thelasis pygmaea* (Griff.) Lindl.	CMHEP-1438
236	*Thrixspermum centipeda* Lour.	AMHEP-833, CMHEP-2177, CMHEP-5907, BMHEP-3351
237	*Thrixspermum lingiae* P.O'Byrne & Gokusing	AMHEP-1944 (endemic to Borneo)
238	*Thrixspermum pulchrum* Carr	BMHEP-3892 (new record)
239	*Thrixspermum raciborskii* J.J.Sm.	CMHEP-1491, CMHEP-2266, BMHEP-3882, CMHEP-6001
240	*Thrixspermum ridleyanum* Schltr.	AMHEP-1098, CMHEP-2910, AMHEP-3195, CMHEP-5952
241	*Thrixspermum scopa* (Rchb.f. ex Hook.f.) Holttum	CMHEP-1324
242	*Thrixspermum tenuicalcar* Carr	BMHEP-3835 (new record)
243	*Thrixspermum spp*.	CMHEP-2751, CMHEP-2818, BMHEP-2251, BMHEP-3019, CMHEP-1352, CMHEP-05186, CMHEP-05183
244	*Trichoglottis persicina* P.O'Byrne	AMHEP-2840, CMHEP-2256, CMHEP-5994 (endemic to Borneo; new record)
245	*Trichoglottis* aff. *scaphigera* Ridl.	BMHEP-0299, CMHEP-2941, AMHEP-2841, CMHEP-2258, BMHEP-3996
246	*Trichoglottis smithii* Carr	BMHEP-6909
247	*Trichoglottis sp.*	CMHEP-1336
248	*Trichotosia ferox* Blume	CMHEP-6074
249	*Trichotosia gracilis* (Hook.f.) Kraenzl.	CMHEP-0498, CMHEP-0254, CMHEP-2680, CMHEP-2174, CMHEP-2204, CMHEP-2221, BMHEP-3985, CMHEP-6005, CMHEP-3327
250	*Trichotosia microphylla* Blume	AMHEP-2830, BMHEP-1373
251	*Trichotosia teysmannii* (Hook.f.) Kraenzl.	AMHEP-1176
252	*Trichotosia vestita* (Wall. ex Lindl.) Kraenzl.	BMHEP-1546, CMHEP-2916, BMHEP-2155, AMHEP-2834, CMHEP-2213, CMHEP-03639, CMHEP-05103, CMHEP-06202
253	*Trichotosia spp*.	AMHEP-1170, CMHEP-0240, BMHEP-2600, CMHEP-2203

254	*Vanilla* aff. *borneensis* Rolfe	BMHEP-3119
255	*Vanilla sumatrana* J.J.Sm.	CMHEP-5950 (new record)
256	*Vrydagzynea sp.1*	CMHEP-5986
257	*Zeuxine purpurascens* Blume	BMHEP-5759 (live plant planted in garden at dam site)
258	Unknown species (two species)	BMHEP-1605, CMHEP-2634, CMHEP-05049, BMHEP-05735, CMHEP-06608