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Diversity of Orchids in Terms of Their Distribution, Uses and Conservation in Annapurna Conservation Area of Nepal

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Abstract

The Annapurna Conservation Area (ACA), the first conservation area and the largest protected area (PA) in Nepal, is incredibly rich in biodiversity. Notwithstanding this, orchids in the ACA have not been explored enough yet thus making the need for ambitious research to be carried out. Previous study only included 81 species of orchids within ACA. This study aims to update the record of species and genera richness in the ACA. In total 198 species of orchids, belonging to 67 genera (40% and 62% of the total recorded orchid species and genera in Nepal) has been recorded in ACA. This represents an increase of 144% in species and 56% in genera over the previous data. Out of the 198 species, 99 were epiphytes, 6 were holomycotrophic and 93 were terrestrial. Among the 67 genera, *Bulbophyllum* (17) species were dominant, followed by *Dendrobium* (16), *Herminium* (10), *Coelogyne*, *Plantanthera* (9 each), *Eria*, *Habenaria*, *Oberonia* (8 each), *Calanthe* (7), and *Liparis* (6). Fifty-six species were found to be ornamentally significant and 85 species medicinally significant.

Keywords

Orchids, Annapurna Conservation Area, Diversity, Distribution, Uses

1. Introduction

Orchids are among the most beautiful plants in the world. Orchids belong to the Orchidaceae family, the world's most extravagant family of flowering plants [1] [2] [3]. Taxonomically, Orchidaceae is the most evolved family among the

monocotyledons, with 750 - 1000 genera and 25,000 - 35,000 species [4] [5] [6]. Orchids contribute approximately one-tenth of the world's total flowering plants.

Nepal is predominantly a Himalayan country with extensively diverse ecology, flora, and fauna with respect to its geography. Its high altitudinal variation accounts for its high floral diversity. Nepal is home to 6653 species of flowering plants of ranging diversity [7] [8] [9]. Altogether 1590 genera of 231 families live in varying habitats ranging from low lying tropical zones to high alpine zones [9]. In fact, Nepal's flora is cosmopolitan in their distribution [10]. Orchidaceae, with 108 genera and 501 species, is the largest family of flowering plants in Nepal, which include the new confirmed species of orchids published in various journals [11]-[16]. There are 324 species of endemic flowering plants in Nepal. Among them, 20 are orchids [9] [11] [13] [17]. Among the orchid species found in the nation, more than 80 are used ornamentally [11] and more than 100 are used medicinally in different parts of the country [10] [11] [18] [19] [20]. Orchids are famous among Nepalese under local names such as "Sungava, Chandigava and Sunakhari". Nepalese orchids are very popular because of their shape, size, habit, habitat, visual appeal due to their colourful flowers, shining green leaves and variously shaped pseudobulbs. They exhibit an incredible range of diversity in the size, shape, and colour of their flowers; they are in great demand for horticultural purposes. Orchids are awesome creations of nature in terms of their ornamental, economic, food, and medicinal values [21]. They are widely recognized, and used not just in Nepal but by many cultures, and tribes in various parts of the world [22] [23].

Orchids are considered as fine examples of some of the most advanced floral evolution due to their interactions with pollinators, and their symbiosis with mycorrhizal fungi. Generally, on the basis of stem structure, orchids may be either sympodial "joint-footed" or monopodial "one-footed" [5] [10]. In sympodial orchids, new shoots arise from any auxiliary bud present in any part of older shoots that spread out from a long rhizome. Genera like *Bulbophyllum*, *Cypripedium*, and *Dendrobium* etc. are examples of sympodial orchids. In monopodial orchids, the shoots undergo indefinite apical growth but lack rhizome pseudobulbs. Genera *Arides*, *Rhynchostylis*, and *Vanda* etc. are the example of monopodial orchids [5] [24]. Based on the habitat, orchids are classified as epiphytes, terrestrials, lithophytes and saprophytes [25] [26]. Flowers are the most incredible and iconic parts of the plant body. They are arranged in two whorls: the outer most whorl is the calyx and the inner most whorl, the corolla. The outer whorl comprises sepals and the inner whorl, petals. The third petal is modified into a typical shape and structure called a lip. The lip plays a vital role in pollination because it attracts pollinators [26]. The orchid pod contains numerous microscopic seeds. In most species, there are more than a million seeds per capsule. After ripening, they blow around like dust particles or spores and are barely visible to the human eye. In general, the embryo has a rounded or spherical form without cotyledons, radicals, or endosperm. Because they lack endosperm, orc-

hid seeds must enter symbiotic relationships with mycorrhizal fungi to germinate [27] [28]. These fungi provide the necessary nutrients to seeds. Thus, all species of orchids rely upon mycorrhizal association with various fungi to germinate, mostly of the genus *Rhizoctonia* (class Basidiomycetes), for at least part of their life cycle [29]. Of all the seed released, only 5% into new orchids under natural conditions [30].

The International Union for Conservation of Nature and Natural Resources (IUCN) has included all species of orchids in its Red Data Book, and orchids have been incorporated in **Appendix** of the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES) to promote their conservation in their natural habitats. Despite this legal protection, numbers of orchids have been continually declining and exploited because of their ornamental and medicinal value and high marked demand [26].

The orchids of the Annapurna Conservation Area (ACA) have not yet been adequately explored, so ambitious research to be carried out to explore more genera and species. The previous data of orchids of ACA has included only 81 species belonging to 43 genera. Of these 81 species, 38 are epiphytes, 2 are holomycotrophic and 40 are terrestrial [31] [32], Tiruwa *et al*., [33]. The aim of this research is to update the species of orchids found in the ACA in its earlier report.

2. Materials and Methods

2.1. Study Area

The present study was conducted across the entire area of ACA (7629 km^2), which is the first conservation area and the largest protected area of Nepal [34]. Geographically, it lies between 83˚34'E to 84˚25'E longitude and 28˚15'N to 28˚50'N latitude in Northern Gandaki Province in the Western Development Region of Nepal. ACA is bordered to the east by Marsyangdi Valley, to the west by Kali Gandaki River, to the north by the dry alpine desert of Dolpa and Tibet (China), and to the south by the valleys and foothills of Pokhara. It spreads over five administrative districts of Nepal, namely Lamjung, Kaski, Manang, Mustang, and Myagdi districts. The altitudes of ACA ranges between 950 masl (Madi Valley) to 8,091 masl (Annapurna-I) [35]. ACA's typical climatic zones range from tropical to nival. The annual mean temperature of ACA is 14˚C with maximum and minimum temperature 35˚C & −30˚C respectively. The southern Annapurna region has the highest precipitation ratees in the country while northern Annapurna receives 25 mm to 500 mm of precipitation annually. Microclimate vary with altitude and aspect and annual rainfall ranges between193 mm to 2987 mm from the trans-Himalayan region of Mustang to the Cis-Himalayan region of Ghandruk, Kaski [36]. Because of its geographical variation, ACA has become the home of diverse flora and fauna totaling about 2814 species. Among them, 1047 species of animals and 1767 species are plants. They are 1605 angiosperms, 16 gymnosperm, 118 pteridophytes, and 28 phytoplankton [31], Ti-

ruwa *et al*., [33] (**Figure 1**).

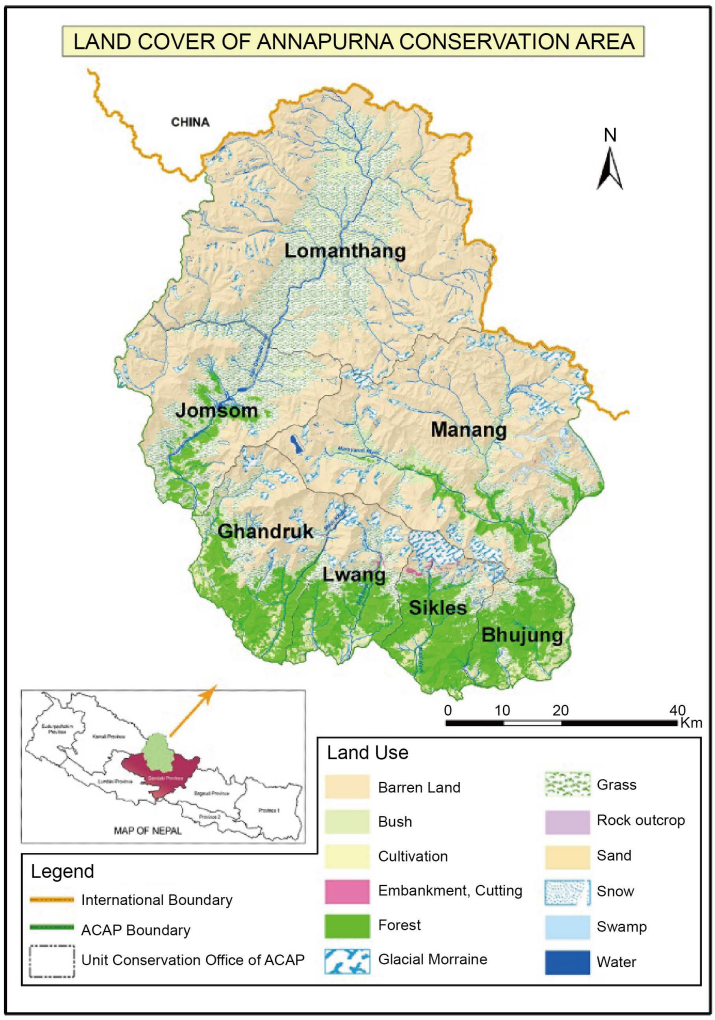

Figure 1. Map of study area (Annapurna Conservation Area).

2.2. Sources of Data

Two major methods were used to gather data for this study: a field survey and a literature review. In the field survey, we surveyed all Manang District, all the Unit Conservation Office (UCO) Bhujung, which is the part of Lamjung District that lies inside the ACA. We collected plant specimens and made a herbarium. Additionally, we also took photos of the relevant specimens for their further identification by comparing them with the plant specimens deposited in the National Herbarium and Plant Laboratories (KATH).

We assembled data of orchids found in all of Mustang district, certain parts of Kaski district (all of UCO Ghandruk, Sikles, and Lwang), and Myagdi district (certain parts of UCO Ghandruk) from the literature review. We reviewed and used data from validly published literature. These included books [10] [37] [38] [39], reports [31] [36] [40], various scientific research publications [1] [7] [11] [12] [15] [16] [17] [18] [19] [25] [38] [41]-[47], including online blog sources

http://plantdatabase.kath.gov.np/ [48]. The assembled data were analyzed by using MS-excel 2016. The extracted data included names of species and genera of different orchids, their locations and elevations, and their medicinal and ornamental uses.

3. Results

3.1. Status and Distribution of Orchids within the ACA

This study revealed that the ACA is the home to 198 species of orchids belonging to 67 genera, which make up 40 % and 62 % data of Nepal's total orchid species and genera respectively. This data is 144% and 56% more than that recorded in the most previous study. Among these 67 genera, *Bulbophyllum* was the most dominant genera with 17 species, followed by *Dendrobium* (16), *Heminium* (10), *Coelogyne*, *Plantanthera* (9 each), *Eria*, *Habenaria*, *Oberonia* (8 each), *Calanthe* (7), *Liparis* (6), *Cymbidium*, *Goodyera* (5 each), *Oreorchis*, *Peristylus*, *Pholidota* (4 each), *Crepidium*, *Cypripedium*, *Neottia*, *Neottainthe*, *Otochilus*, *Pleione* and *Zeuxine* (3 each), and *Aerides*, *Epipactis*, *Epipogium*, *Eulophia*, *Malaxis*, *Nervilia*, *Phalaenopsis*, *Satyrium*, *Spiranthes*, *Sunipia* and *Thunia* (2 each). The rest of the genera comprised onlya single species. Of the five districts in the ACA, Lamjung district (UCO Bhujung) had the highest diversity of orchids, 55 genera and 143 species, followed by Kaski, Manang, Myagdi, and Mustang district respectively. Mustang had the least diversity of orchids, 16 genera and 26 species. The details of orchids are shown in **Figure 2**.

Similarly, in terms of habitat, only epiphytes, holomycotrophic, and terrestrial were considered. Out of the 198 species of orchids in ACA, 99 were epiphytes, 6 were holomycotrophic, and 93 were terrestrial. These represented 39%, 38%, and 40% of all orchids in Nepal respectively. In comparison to the previous study, epiphytes increased by 161%, holomycotrophic by 100%, and terrestrial orchids by 133% in this study. Within ACA, the largest numbers of epiphytic orchid species were recorded in Lamjung (88), and the fewest in Mustang (3). The largest number of holomycotrophic orchid species were recorded in Myagdi, and Lamjung (2 each) and the fewest in rest of district (1 each). The greatest number of terrestrial orchid species were recorded in Lamjung (53) and the fewest in Myagdi (20). Details on the distribution of orchids according to their habitat are given in **Figure 3**.

3.2. Comparative Study of Top Genera

The comparative study of genera richness of orchid of ACA with national total had also carried out in reference to the recent publication [16]. The study shown that *Bulbophyllum* was found to be the richest genera both in national and ACA total *i.e.* 42 and 17 species respectively. However, *Peristylus* was recorded as the genera abided the least number of species in ACA while *Eria* in national total. The details of genera richness are show in the below **Figure 4**.

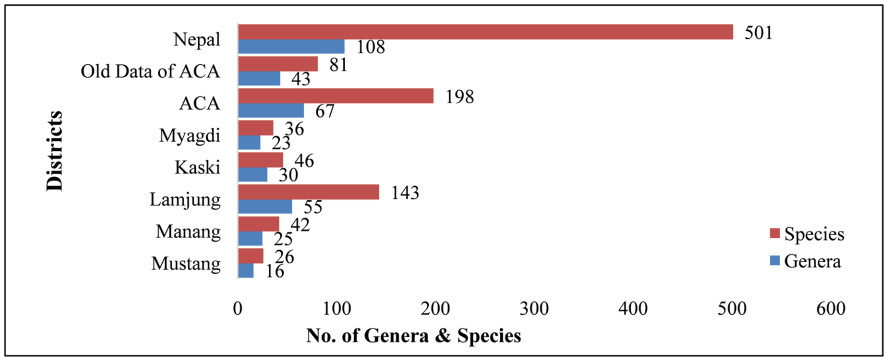

Figure 2. Comparative distribution of orchids in ACA according to their genera and species.

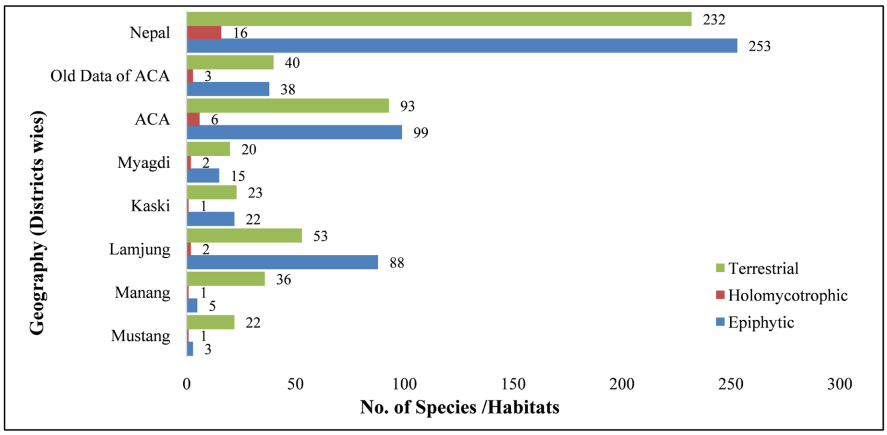

Figure 3. Comparative distribution of orchids in ACA according to their habitats.

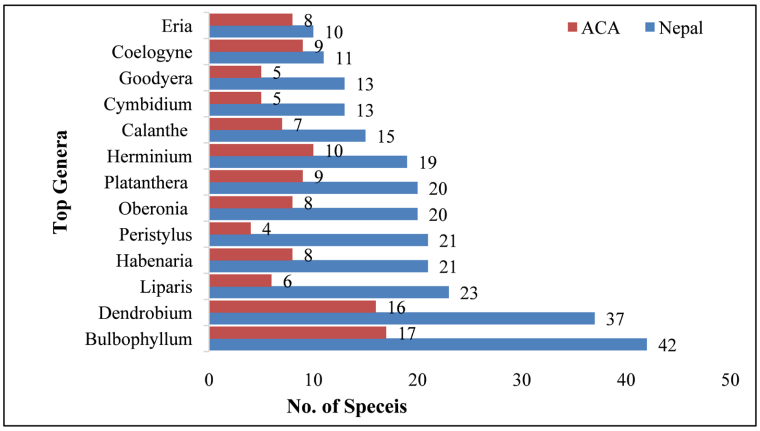

Figure 4. Comparative study of genera richness with national total.

3.3. Uses: Medicinal and Ornamental

Orchids have been categorized into two major uses in the local and national contexts of Nepal: ornamental and medicinal. Among 67 genera and 198 species of orchids in ACA, 56 species belonging to 22 genera were ornamentally valuable. These figures represent 79% and 70% respectively of the national totals. Similarly, 85 species of 41 genera were used medicinally. These figures represented

84% and 89% of the national totals. In comparison with the old data, the numbers of genera and species increased by 29% and 60% respectively for ornamental orchids and 86 % and 98 % for medicinally used orchids. The details of the data are presented in Figure 5.

4. Threats and Conservation Status of Orchids in the ACA

Orchids are among the most threatened flowering plant species. They are rapidly depleting from their natural habitats due to over-exploitation, the destruction of habitat, and the impact of climate change [1]. In the ACA, orchids are over-exploited because local people harvest them to meet their basic needs, including those for food, traditional medicine and enhance livelihoods by raising local economy. To meet the enormous demand for orchids and take advantage of its high economic value in national and international markets, orchids are collected and traded illegally at the local and national levels. Overgrazing in high Himalayan pastureland is another big reason that orchids in the high mountains are being depleted. Urbanization, unplanned physical planning and development, deforestation, forest fires, and encroachment are major challenges: all resulting in the rapid destruction of orchid habitats. Drought, excessive rainfall, too much snow, landslides, floods, avalanches, and variations in temperature because of the impacts of climate change directly influence the destruction of the orchid habitats, thereby preventing their regeneration and growth. These are among the greatest threats to orchids. Shifting of cropland, overutilization of chemical on crops, reduction in the number of pollinators, and destructive diseases are other reasons for the loss of orchids from their habitats [18]. The majority of highly valuable ornamental and medicinal orchids are under considerable threat of depletion due to over and indiscriminate collection [49]. Even with well-developed monitoring mechanisms to constrain the illegal collection and trade of orchids in ACA, it is not easy to eliminate these threats because of the ACA's

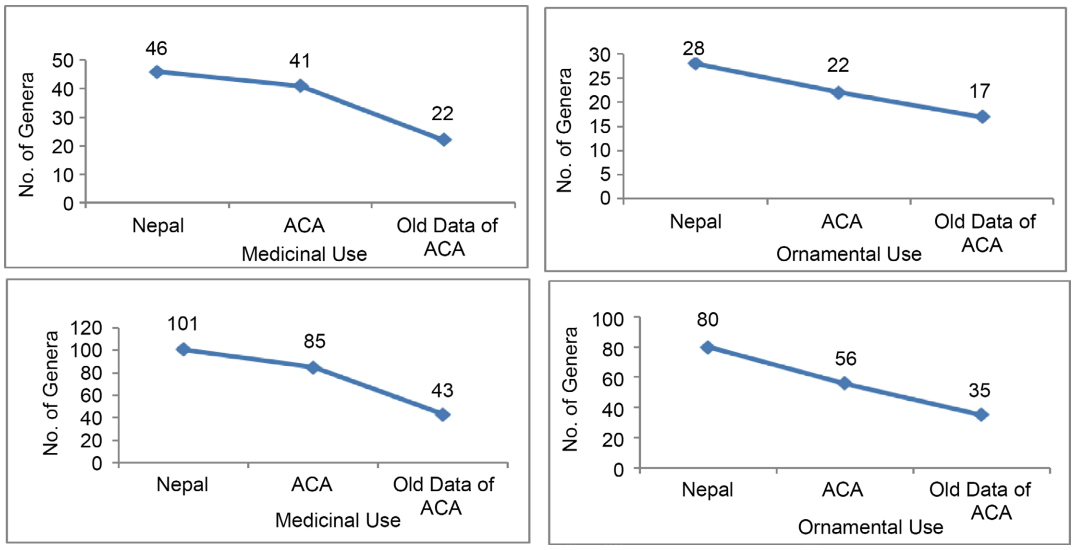

Figure 5. Comparative distribution of orchids in ACA according to their uses.

geographical structure.

To protect all orchid species in their natural habitats, the International Union for Conservation of Nature, and Natural Resources (IUCN) has incorporated them in its Red Data Book. They all are found in **Appendix** of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) [10]. Despite these efforts, some valuable orchids are extinct. Therefore, it is time to plan and execute effective strategies to conserve them throughout the globe. The conservation of orchids is a big challenge and issue that should be seriously considered by all stakeholders, especially government line agencies, the private sector of the concerned nations, research institutions, non-government organization, community-based groups, and local people. Rare and endangered valuable orchids out to be conserved using both *in-situ* and *ex-situ* practices. To ensure the rapid rehabilitation and spread of vulnerable species of orchids in their habitats, tissue culture and micropropagation techniques can be applied. In tissue culture, mass scales of desired orchid plantlets can be developed in a short period. More effective monitoring mechanisms of orchids ought to be devised and implemented to halt the illegal collection and trade. Awareness building is a powerful tool to conserve orchids at the local level, so enhanced awareness among local people about orchids will be critical for their conservation success.

5. Conclusion

Some research on orchids has been conducted in certain parts of the ACA, but the entire ACA has not been covered yet. This study helped refine data on the orchids found in the ACA, focusing on their uses, number, and distribution. This study shows that the ACA is a treasure house of over 198 species belonging to 67 genera. Most of them are medicinally very significant. It is important to preserve all species in their natural habitats. They can be utilized, but only in moderation and with consideration for the variables that could negatively impact their ability to regenerate. ACA is rich in diversity of flora which has abided 1767 species of plants [31], Tiruwa *et al*., [33]. Furthermore, 117 species of orchids enlisted to the previous study of plants of ACA, thus making a total of 1884 species in total. Additional comprehensive and ambitious research is recommended in order to discover, catalog, and protect more species in the ACA.

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Some photos of Orchids collected from various parts of ACA

Some photos of Orchids collected from various parts of ACA

Statements & Declarations

Author Contributions

All authors contributed to this research work. Material preparation, data collection and analysis were performed by Babu Lal Tiruwa, Basu Dev Neupane, Rabin Kadariya, Chirnajibi Prasad Pokheral and Bijaya Pant. The first draft of the manuscript was written by Babu Lal Tiruwa and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

S. No.	Scientific name	Habitat	Sources (Ref.)		
			Ornamental	Medicinal	Species Data
1	*Acampe rigida* (Buch.-Ham. ex Sm.) P.F.Hunt	Epiphytic	1	1	1, 8
2	*Acampe praemorsa* (Roxb.) Blatt. & McCann	Epiphytic	1	1, 2, 3, 4, 5	1
3	*Aerides multiflora* Roxb.	Epiphytic	1	1, 2, 3, 4	1, 8, 3
4	*Aerides odorata* Lour.	Epiphytic	1	1, 2, 3, 4, 5	1, 3
5	*Agrostophyllum callosum* Rchb.f.	Epiphytic		1	1
6	*Anthogonium gracile* Wall. ex Lindl.	Terrestrial		1	1
7	*Arundina graminifolia* (D.Don) Hochr.	Terrestrial	1	1, 2, 3, 4, 5, 6	1, 8
8	*Brachycorythis obcordata* (Lindl. ex Wall.) Summerh.	Terrestrial		1, 2, 3, 4, 5, 6	4, 10
9	*Bulbophyllum affine* Wall. ex Lindl.	Epiphytic	1		1, 8
10	*Bulbophyllum ambrosia* (Hance) Schltr. *subsp. Nepalensis* J. J. Wood	Epiphytic			3
11	*Bulbophyllum careyanum* Spreng.	Epiphytic		1, 2, 3, 4, 5	1
12	*Bulbophyllum cariniflorum* Rchb. f.	Epiphytic			1
13	*Bulbophyllum caudatum* Lindl.	Epiphytic			1
14	*Bulbophyllum cylindraceum* Lindl.	Epiphytic			1
15	*Bulbophyllum eublepharum* Rchb.f.	Epiphytic			1
16	*Bulbophyllum leopardinum* (Wall.) Lindl. ex Wall.	Epiphytic	1	12, 3, 4, 5	1, 3
17	*Bulbophyllum moniliforme* C.S.P.Parish & Rchb.f.	Epiphytic			1
18	*Bulbophyllum muscicola* Rchb.f.	Epiphytic			1
19	*Bulbophyllum odoratissimum* (Sm.) Lindl. ex Wall.	Epiphytic	1	1, 2, 3, 4	1
20	*Bulbophyllum polyrrhizum* Lindl.	Epiphytic			1
21	*Bulbophyllum reptans* (Lindl.) Lindl. ex Wall.	Epiphytic			1
22	*Bulbophyllum rolfei* (Kuntze) Seidenf.	Epiphytic			10
23	*Bulbophyllum striatum* Rchb.f.	Epiphytic			1
24	*Bulbophyllum umbellatum* Lindl.	Epiphytic	1	2, 3, 4, 5	4
25	*Bulbophyllum viridiflorum* (Hook.f.) Schltr.	Epiphytic			1
26	*Calanthe alpina* Hook. f. ex Lindl.	Terrestrial			1
27	*Calanthe brevicornu* Lindl.	Terrestrial	1		1, 8
28	*Calanthe mannii* Hook.f.	Terrestrial			1
29	*Calanthe plantaginea* Lindl.	Terrestrial	1	1, 2, 3, 4, 5	1, 4, 8
30	*Calanthe puberula* Lindl.	Terrestrial		1, 2, 3, 4, 5	2
31	*Calanthe sylvatica* (Thouars) Lindl.	Terrestrial	1	1, 2, 3, 4, 5	10
32	*Calanthe tricarinata* Lindl.	Terrestrial	1	1, 2, 3, 4	1, 2, 3, 4, 5, 6, 7, 8
33	*Cephalanthera longifolia* (L.) Fritsch	Terrestrial	1	1, 2, 3, 4	2, 8

Continued

34	*Coelogyne corymbosa* Lindl.	Epiphytic	1	1, 2, 3, 4, 5, 6	1, 3, 4, 5
35	*Coelogyne cristata* Lindl.	Epiphytic	1	1, 2, 3, 4, 5, 6	1, 3, 4, 5, 8
36	*Coelogyne flaccida* Lindl.	Epiphytic	1	1, 2, 3, 4, 5	3, 10
37	*Coelogyne fuscescens* Lindl.	Epiphytic	1	1, 2, 3, 4, 5, 6	1, 8
38	*Coelogyne nitida* (Wall. ex D.Don) Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1, 2, 3, 4, 8
39	*Coelogyne ovalis* Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1
40	*Coelogyne prolifera* Lindl.	Epiphytic		1, 2, 3, 4, 5	1
41	*Coelogyne punctulata* Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1
42	*Coelogyne stricta* (D. Don) Schltr.	Epiphytic	1	1, 2, 3, 4, 5, 6	1, 3
43	*Cremastra appendiculata* (D.Don) Makino	Terrestrial		1	1
44	*Crepidium acuminatum* (D.Don) Szlach.	Terrestrial		1, 2, 3, 4	1, 6
45	*Crepidium calophyllum* (Rchb.f.) Szlach.	Terrestrial			4
46	*Crepidium purpureum* (Lindl.) Szlach.	Terrestrial			1
47	*Cryptochilus luteus* Lindl.	Epiphytic			3, 8
48	*Cymbidium aloifolium* (L.) Sw.	Epiphytic	1	1, 2, 3, 4, 5, 6	1
49	*Cymbidium bicolor* Lindl.	Epiphytic			1
50	*Cymbidium elegans* Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1
51	*Cymbidium erythraeum* Lindl.	Epiphytic			1
52	*Cymbidium iridioides* D.Don	Epiphytic	1	1, 2, 3, 4, 5, 6	1, 5,
53	*Cypripedium cordigerum* D.Don	Terrestrial	1	1, 2, 3, 4, 5	3, 8
54	*Cypripedium elegans* Rchb. f.	Terrestrial	1	1, 2, 3, 4, 5, 6	1, 8
55	*Cypripedium himalaicum* Rolfe ex Hemsl	Terrestrial	1	1, 2, 3, 4, 5	1, 3, 8
56	*Dactylorhiza hatagirea* (D. Don) Soó	Terrestrial		1, 2, 3, 4, 5, 6	1, 2, 3, 5, 6, 7, 8
57	*Dendrobium amoenum* Wall. ex Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1, 2, 3, 4, 5, 8
58	*Dendrobium amplum* Lindl.	Epiphytic	1		1
59	*Dendrobium aphyllum* (Roxb.) C.E.C.Fisch.	Epiphytic	1		1
60	*Dendrobium chrysanthum* Wall. ex Lindl.	Epiphytic		1, 2	1
61	*Dendrobium crepidatum* Lindl. & Paxton	Epiphytic	1	1, 2, 3, 4, 5	1
62	*Dendrobium densiflorum* Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1, 2, 8
63	*Dendrobium denudans* D.Don	Epiphytic		1	1
64	*Dendrobium eriiflorum* Griff.	Epiphytic	1	1, 2, 3, 4	1, 3
65	*Dendrobium fimbriatum* Hook.	Epiphytic	1	1, 2, 3, 4, 5, 6	4
66	*Dendrobium heterocarpum* Wall. ex Lindl.	Epiphytic	1	2, 3, 4	1
67	*Dendrobium longicornu* Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1, 4
68	*Dendrobium moniliforme* (L.) Sw.	Epiphytic		1, 4	1
69	*Dendrobium moschatum* (Buch.-Ham.) Sw.	Epiphytic		1, 2, 3, 4, 5	1

Continued

70	*Dendrobium polyanthum* Wall. ex Lindl.	Epiphytic			1
71	*Dendrobium porphyrochilum* Lindl.	Epiphytic			1, 5
72	*Dendrobium transparens* Wall. ex Lindl.	Epiphytic	1	1, 2, 3, 4, 5	1
73	*Dienia cylindrostachya* Lindl.	Terrestrial		1, 2, 3, 4	6
74	*Epipactis helleborine* (L.) Crantz	Terrestrial		1, 2, 3, 4, 5, 6	1, 2, 8
75	*Epipactis royleana* Lindl.	Terrestrial			1, 7, 8
76	*Epipogium aphyllum* Sw.	Holomycotrophic			2
77	*Epipogium roseum* (D.Don) Lindl.	Holomycotrophic			1
78	*Eria annapurnensis* L.R.Shakya & M.R.Shrestha	Epiphytic			3, 8
79	*Eria carinata* Gibson ex Lindl.	Epiphytic			3
80	*Eria clausa* King & Pantl.	Epiphytic			1, 3, 4, 5
81	*Eria coronaria* (Lindl.) Rchb.f.	Epiphytic			3
82	*Eria excavata* Lindl.	Epiphytic			3
83	*Eria pokharensis Bajrach.,* Subedi & K. K. Shrestha	Epiphytic	1	1, 2, 3, 4, 5, 6	1
84	*Eria spicata* (D.Don) Hand.-Mazz.	Epiphytic		1, 2, 3, 4, 5, 6	8
85	*Eria apertiflora* Summerh.	Epiphytic			1
86	*Eulophia dabia* (D.Don) Hochr.	Terrestrial			3
87	*Eulophia explanata* Lindl.	Terrestrial			2, 8
88	*Flickingeria fugax* (Rchb.f.) Seidenf.	Epiphytic			1
89	*Galearis spathulata* (Lindl.) P.F.Hunt	Terrestrial	1		1, 3, 4
90	*Galeola lindleyana* (Hook.f. & Thomson) Rchb.f.	Holomycotrophic			10
91	*Gastrochilus calceolaris* (Buch.-Ham. ex Sm.) D.Don	Epiphytic			2, 6
92	*Gastrodia elata* Blume	Holomycotrophic			3
93	*Geodorum densiflorum* (Lam.) Schltr.	Terrestrial			1
94	*Goodyera fusca* (Lindl.) Hook.f.	Terrestrial		1, 2, 3, 4	1, 2, 8
95	*Goodyera henryi* Rolfe	Terrestrial			1
96	*Goodyera procera* (Ker Gawl.) Hook.	Terrestrial		1, 2, 3, 4, 5, 6	3
97	*Goodyera repens* (L.) R.Br.	Terrestrial			2, 3
98	*Goodyera vittata* (Lindl.) Benth. ex Hook.f.	Terrestrial		2	3, 4
99	*Gymnadenia orchidis* Lindl.	Terrestrial		1	1, 4
100	*Habenaria aitchisonii* Rchb.f.	Terrestrial			1
101	*Habenaria arietina* Hook.f.	Terrestrial		2, 3, 4, 5	4
102	*Habenaria dentata* (Sw.) Schltr.	Terrestrial	1	1, 2, 3, 4	1, 2, 3, 4, 7, 8
103	*Habenaria digitata* Lindl.	Terrestrial			1
104	*Habenaria gibsonii foetida* Blatt. & McCann	Terrestrial			3
105	*Habenaria intermedia* D.Don	Terrestrial			3
106	*Habenaria pectinata* D.Don	Terrestrial			1

Continued

107	*Habenaria pubescens* Lindl.	Terrestrial			1
108	*Herminium alaschanicum* Maxim.	Terrestrial			3, 6
109	*Herminium albomarginatum* (King) X.H.Jin, Schuit., Raskoti & Lu Q.Huang	Terrestrial			1
110	*Herminium chloranthum* Tang & F.T.Wang	Terrestrial			3, 6
111	*Herminium clavigerum* (Lindl.) X.H.Jin, Schuit., Raskoti & Lu Q.Huang	Terrestrial		1, 2, 3, 4	2, 3
112	*Herminium duthiei* Hook.f.	Terrestrial			3, 6, 8
113	*Herminium josephi* Rchb.f.	Terrestrial		2, 3, 4	1, 2, 3, 8
114	*Herminium lanceum* (Thunb. ex Sw.) Vuijk	Terrestrial			1
115	*Herminium mackinnonii* Duthie	Terrestrial			1
116	*Herminium macrophyllum* (D.Don) Dandy	Terrestrial			1
117	*Herminium monorchis* (L.) R.Br.	Terrestrial			1
118	*Liparis campylostalix* Rchb.f.	Terrestrial			1, 3
119	*Liparis deflexa* Hook.f.	Terrestrial			1, 4
120	*Liparis elliptica* Wight	Epiphytic		2, 5, 6	1
121	*Liparis petiolata* (D.Don) P.F.Hunt & Summerh.	Terrestrial	1	1, 2, 3, 4, 5, 6	1
122	*Liparis resupinata* Ridl.	Epiphytic			3, 6, 8
123	*Liparis rostrata* Rchb.f.	Terrestrial		1, 2, 3, 4, 5	2, 3, 4, 5, 7, 8
124	*Luisia trichorrhiza* (Hook.) Blume	Epiphytic			1
125	*Malaxis monophyllos* (L.) Sw.	Terrestrial			3
126	*Malaxis muscifera* (Lindl.) Kuntze	Terrestrial			3
127	*Mycaranthes floribunda* (D.Don) S.C.Chen & J.J.Wood	Epiphytic			5
128	*Myrmechis pumila* (Hook.f.) Tang & F.T.Wang	Terrestrial			3
129	*Neottia listeroides* Lindl.	Holomycotrophic		3, 4	2, 4
130	*Neottia pinetorum* (Lindl.) Szlach.	Terrestrial		2	2
131	*Neottia tenii* Schltr.	Holomycotrophic			1, 7
132	*Neottianthe calcicola* (W.W.Sm.) Schltr.	Terrestrial			1
133	*Neottianthe cucullata* (L.) Schltr.	Terrestrial			1
134	*Neottianthe secundiflora* (Kraenzl.) Schltr.	Terrestrial			1
135	*Nervilia concolor* (Blume) Schltr.	Terrestrial			1
136	*Nervilia plicata* (Andrews) Schltr.	Terrestrial			1
137	*Oberonia acaulis* Griff.	Epiphytic			1, 5
138	*Oberonia cavaleriei* Finet	Epiphytic			3
139	*Oberonia ensiformis* (Sm.) Lindl.	Epiphytic			1
140	*Oberonia falcata* King & Pantl.	Epiphytic			8
141	*Oberonia longilabris* King & Pantl.	Epiphytic			1, 2, 3, 4, 8
142	*Oberonia obcordata* Lindl.	Epiphytic			1

Continued

143	*Oberonia pachyrachis* Rchb.f. ex Hook.f.	Epiphytic			2
144	*Oberonia rufilabris* Lindl.	Epiphytic			2, 3, 4, 5
145	*Odontochilus lanceolatus* (Lindl.) Blume	Terrestrial			1
146	*Oreorchis foliosa* (Lindl.) Lindl.	Terrestrial			1
147	*Oreorchis foliosa var. indica* (Lindl.) N. Pearce & P. J. Cribb	Terrestrial	1	1, 2, 3, 4, 5	1
148	*Oreorchis micrantha* Lindl.	Terrestrial	1	2	1
149	*Oreorchis nepalensis* N. Pearce & P. J. Cribb	Terrestrial			1
150	*Otochilus albus* Lindl.	Epiphytic			10
151	*Otochilus fuscus* Lindl.	Epiphytic			4
152	*Otochilus lancilabius* Seidenf.	Epiphytic			4
153	*Panisea demissa* (D.Don) Pfitzer	Epiphytic			1, 3
154	*Pecteilis susannae* (L.) Raf.	Terrestrial			3
155	*Peristylus affinis* (D.Don) Seidenf.	Terrestrial		2	1
156	*Peristylus elizabethae* (Duthie) R.K.Gupta	Terrestrial	1		1
157	*Peristylus fallax* Lindl.	Terrestrial	1		1
158	*Peristylus goodyeroides* (D.Don) Lindl.	Terrestrial	1	1, 2, 3, 4, 5, 6	1, 8
159	*Phalaenopsis difformis* (Wall. ex Lindl.) Kocyan & Schuit.	Epiphytic	1	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 8
160	*Phalaenopsis taenialis* (Lindl.) Christenson & Pradhan	Epiphytic		1, 2, 3, 4	4
161	*Pholidota articulata* Lindl.	Epiphytic			4
162	*Pholidota imbricata* Hook.	Epiphytic			1
163	*Pholidota pallida* Lindl.	Epiphytic		2, 3, 4, 5, 6	1
164	*Pholidota protracta* Hook.f.	Epiphytic		2, 3, 4	3
165	*Pinalia bipunctata* (Lindl.) Kuntze	Epiphytic		2	8
166	*Platanthera bakeriana* (King & Pantl.) Kraenzl.	Terrestrial		1	3
167	*Platanthera edgeworthii* (Hook.f. ex Collett) R.K.Gupta	Terrestrial			1
168	*Platanthera japonica* (Thunb.) Lindl.	Terrestrial			1
169	*Platanthera latilabris* Lindl.	Terrestrial			3
170	*Platanthera leptocaulon* (Hook.f.) Soó	Terrestrial			1
171	*Platanthera sikkimensis* (Hook.f.) Kraenzl.	Terrestrial			1
172	*Platanthera stenantha* (Hook.f.) Soó	Terrestrial			1, 4
173	*Platanthera stenoglossa* Hayata	Terrestrial	1	1, 2, 3, 4, 5	1, 2, 3, 4, 5, 8
174	*Platanthera urceolata* (Hook.f.) R.M.Bateman	Terrestrial	1	2, 3, 4, 5	8, 10
175	*Pleione hookeriana* (Lindl.) J. Moore	Epiphytic			1
176	*Pleione humilis* (Sm.) D.Don	Terrestrial		2, 5	1, 2, 3, 4, 7, 8
177	*Pleione praecox* (Sm.) D.Don	Terrestrial	1	1, 2, 3, 4, 5, 6	1, 3, 8
178	*Podochilus cultratus* Lindl.	Epiphytic			1
179	*Ponerorchis chusua* (D.Don) Soó	Terrestrial	1	1, 2, 3, 4, 5, 6	1, 2, 4, 5, 7, 8

Continued

180	*Porpax elwesii* Rolfe	Epiphytic			1
181	*Rhynchostylis retusa* (L.) Blume	Epiphytic		1, 2, 3, 4, 5	1
182	*Satyrium nepalense var. ciliatum* (Lindl.) Hook.f.	Terrestrial	1		4, 8
183	*Satyrium nepalense* D.Don	Terrestrial	1	1, 2, 3, 4, 5, 6	2, 3, 4, 7, 8
184	*Smitinandia micrantha* (Lindl.) Holttum	Epiphytic			1
185	*Spathoglottis ixioides* (D.Don) Lindl.	Terrestrial			1
186	*Spiranthes spiralis* (L.) Chevall.	Terrestrial			1
187	*Spiranthes sinensis* (Pers.) Ames	Terrestrial			3
188	*Sunipia bicolor* Lindl.	Epiphytic			1
189	*Sunipia cirrhata* (Lindl.) P.F.Hunt	Epiphytic	1	1, 2, 3, 4, 5	1
190	*Taeniophyllum scaberulum* Hook.f.	Epiphytic	1	1, 2, 3, 4, 5, 6	1, 4, 10
191	*Tainia minor* Hook.f.	Epiphytic			1
192	*Thunia alba* (Lindl.) Rchb.f.	Epiphytic		1, 2, 3, 5	1
193	*Thunia alba var. bracteata* (Roxb.) N.Pearce & P.J.Cribb	Epiphytic			1
194	*Vanda cristata* Wall. ex Lindl.	Epiphytic		2, 3	1
195	*Vandopsis undulata* (Lindl.) J.J.Sm.	Epiphytic			1
196	*Zeuxine affinis* (Lindl.) Benth. ex Hook.f.	Terrestrial			1
197	*Zeuxine flava* (Wall. ex Lindl.) Trimen	Terrestrial			1
198	*Zeuxine strateumatica* (L.) Schltr.	Terrestrial		1, 2, 3, 4, 5	1

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