The Republic of the Union of Myanmar

Ministry of Natural Resources and Environmental Conservation

Forest Department

Botanical Investigation into Orchid Biodiversity of Myanmar

Ye Lwin Aung, Range Officer

Forest Research Institute, Yezin

Forest Department

December, 2019

Contents

	စာတမ်းအကျဉ်း	i
	Abstract	ii
1.	Introduction	1
2.	Objectives	1
3.	Material and Method	2
4.	Results	5
5.	Discussion	8
6.	Conclusion	9
	Acknowledgements	10
	References	11

မြန်မာ့သစ်ခွမျိုးစုံမျိုးကွဲများအား ရုက္ခဗေဒဆိုင်ရာ သုတေသနပြု လေ့လာခြင်း

ဦးရဲလွင်အောင်၊ တောအုပ်ကြီး

စာတမ်းအကျဉ်း

မြန်မာနိုင်ငံသည် အရှေ့တောင်အာရှ၏ ပင်မကုန်းမြေထုပေါ်တွင် တည်ရှိပြီး အင်ဒို-ဗားမား ဇီဝမျိုးစုံမျိုးကွဲ အထင်ကရ ရပ်ဝန်းအတွင်း ကျရောက်လျက်ရှိပါသည်။ မြန်မာနိုင်ငံသည် ဇီဝမျိုးစုံမျိုးကွဲ ပေါကြွယ်ဝသော ဂေဟစနစ်နယ်မြေများ ပါဝင်လျက်ရှိပါသည်။ ဥပမာ အပူပိုင်း မိုးသစ်တောများ၊ ဒီရေတောများ၊ သမပိုင်းတောင်ပေါ်တောများ အထူးပေါများလျက်ရှိပါသည်။ သို့သော် ဇီဝမျိုးစုံမျိုးကွဲ သုတေသနလုပ်ငန်းများသည် အိမ်နီးချင်းနိုင်ငံများနှင့်ယှဉ်လျှင် နောက်ကျ ကျန်လျက်ရှိ နေပါသည်။ ၂၀၀၃ ခုနှစ်တွင် ပြုစုခဲ့သော မြန်မာ့အပင်မျိုးစိတ်များစာရင်းအရ မြန်မာနိုင်ငံတွင် မျိုးစိတ်ပေါင်း ၁၁,၈၀၀ မျိုးအား မှတ်တမ်းတင်ထားရှိပြီးဖြစ်ပါသည်။ အဆိုပါစာရင်းတွင် မြန်မာ့သစ်ခွမျိုးစိတ် ၈၀၀ ကျော်အားလည်း မှတ်တမ်းတင်ထားရှိခဲ့ပါသည်။ သစ်ခွမျိုးရင်းသည် မျိုးစေ့ဝှက်ပင်များအုပ်စုတွင် ဒုတိယအကြီးဆုံးမျိုးရင်းဖြစ်သည့်အားလျော်စွာ မျိုးစိတ်သစ်တွေ့ရှိမှုများသည့် မျိုးရင်းလည်းဖြစ်ပါသည်။ မြန်မာ့သစ်ခွမျိုးစုံမျိုးကွဲ ကိန်းဂဏန်းအချက်အလက်စာရင်းများသည် လွန်ခဲ့သည့် ဆယ်စုနှစ်(၅)ခုခွဲ လုပ်ဆောင်ထားခဲ့သည့် ရုက္ခဗေဒဆိုင်ရာလေ့လာမှုများကိုသာ အခြေခံထားသည့် ကိန်းဂဏန်းအချက်အလက်များဖြစ်သောကြောင့် အသစ်တဖန် လေ့လာပြုစုရန် လိုအပ်လာပါသည်။ ထို့အပြင် သစ်ခွမျိုးစိတ်အများစုသည်လည်း မျိုးသုဉ်း ပျောက်ကွယ်မည့် အန္တရာယ်အမျိုးမျိုးနှင့် ရင်ဆိုင်နေရပါသည်။ ဤသုတေသနလုပ်ငန်း၏ အဓိကရည်ရွယ်ချက်မှာ မြန်မာ့သစ်ခွမျိုးစိတ်ကြွယ်ဝမှုအား ကောင်းစွာနားလည်လာနိုင်ရန်ဖြစ်ပါသည်။ ဤသုတေသနလုပ်ငန်း၏ ရလဒ်အနေဖြင့် သစ်ခွမျိုးစိတ်သစ်(၅)မျိုးနှင့် သစ်ခွမျိုးစိတ်မှတ်တမ်းသစ်(၃၀)မျိုးတို့အား မြန်မာနိုင်ငံမှ လေ့လာတွေ့ရှိခဲ့ပါသည်။ ကွင်းဆင်းလေ့လာမှုများ၊ ပန်းပုံစံနမူနာများ လေ့လာခြင်း၊ သက်ဆိုင်ရာစာပေမှတ်တမ်းများအား အခြေခံ၍ မြန်မာ့သစ်ခွမျိုးစိတ်များစာရင်းအား အသစ် တဖန် ပြုစုထားပြီးဖြစ်ပါသည်။ အဆိုပါစာရင်းတွင် မျိုးစု(၁၅၁)စုအောက်တွင် မြန်မာ့သစ်ခွမျိုးစိတ်ပေါင်း (၁၀၄၀) မျိုးအား ပြုစုထားရှိပြီးဖြစ်ပါသည်။ ယခင်သစ်ခွမျိုးစိတ်စာရင်း(၈၀၀ မျိုး)ထက် မျိုးစိတ်ပေါင်း(၂၀၀) ကျော် တိုးများလာပါသည်။ ယခု အသစ်တဖန် ပြုစုထားသည့်စာရင်းအရ မျိုးစိတ်ပေါင်း (၇၆) မျိုးသည် မြန်မာနိုင်ငံတွင်သာ တွေ့ရှိရသော မျိုးစိတ်များ (Endemic species) ဖြစ်ပါသည်။ လက်ရှိသုတေသနအတွေ့အကြုံများနှင့် စာပေလေ့လာမှုများအရ မျိုးစိတ်ပေါင်း (၁၅၀)ခန့်အား အနာဂတ်သုတေသနလုပ်ငန်းများတွင် ဆက်လက်လေ့လာတွေ့ရှိနိုင်မည်ဖြစ်ကြောင်း ခန့်မှန်းထားရှိပါသည်။

Botanical Investigation into Orchid Biodiversity of Myanmar

Ye Lwin Aung , Range Officer

Forest Research Institute

Abstract

Myanmar is situated in mainland Southeast Asia and included in Indo-Burma biodiversity hotspot. Myanmar is well endowed with biodiversity-rich areas such as tropical rainforest, tropical savannah, coastal mangrove forest and subtropical montane forest. However, its biodiversity research has still lagged behind the neighboring countries. There is over 11,800 species of vascular plant recorded in Myanmar, out of which are 800 orchid species. Orchidaceae is the largest family of angiosperm, with high discovery rate of new species to science. However, the species richness data of Myanmar orchid diversity is based on the botanical collections conducted in Myanmar in the past five decades. Most orchids are under various threats for their survival due to the population growth and economic development, habitat loss, unsustainable harvesting of wild orchids and climate change impacts. The present study aims to understand the species richness of orchid flora in Myanmar. Our botanical investigations result in discoveries of five new species and 30 new records for Myanmar. Based on fieldwork, herbarium specimen examination and literature, we updated the checklist of Myanmar orchid flora which includes 1040 species in 151 genera. In the updated checklist, the number of species is increased by ca. 200 species more than that in the checklist of Kress et al. (2003). There are 76 endemic species of Orchidaceae in Myanmar which need special conservation attentions. It is estimated that ca. 150 species might remain unexplored and are expected to be discovered in future studies on orchid biodiversity of Myanmar.

Key Words: Checklist, Herbarium specimens, Indo-Burma, Orchidaceae, Species richness.

Botanical Investigation into Orchid Biodiversity of Myanmar

1. Introduction

As for biodiversity richness, Myanmar is included in Indo-Burma biodiversity hotspot with high species richness and diversity. According to the checklist of Myanmar flora (Kress et al., 2003), there are 273 families, 2371 genera, and over 11800 species of vascular plant recorded in Myanmar. On the other hand, its biodiversity research had lagged behind the neighbouring countries due to various reasons since last decades. Biodiversity conservation attempts are urgently needed for species survival and sustainability of biodiversity resources in Myanmar (Mittermeier et al., 2011; Sodhi et al., 2004; Myers et al., 2000).

In the past, there were about 800 orchid species recorded from Myanmar but the number of species is increasing over recent years (Kurzweil and Lwin, 2014; Kress et al., 2003; Pedersen, 1995). Historically, orchid studies in Myanmar dates back to 1852 and in those days Charles Parish, clergyman of British colonial rule, collected orchids as specimens and living plants in Mawlamyine (formerly Moulmein) and its adjacent areas, southern Myanmar between 1852 and 1878 (Clayton, 2014). Parish had sent his collections of plant materials and watercolor sketches to Sir William Hooker at Kew and living plants to the British orchid nursery of Messrs Hugh Low & Co. of Upper Clapton. Reichenbach and Joseph Hooker had named the following taxa collected from Myanmar (formerly Burma) in honor of Parish, *Cleisostoma parishii* (Hook. f.) Garay, *Coelogyne parishii* Hook.f., *Cymbidium parishii* Rchb.f., *Dendrobium parishii* Rchb.f., *Paphiopedilum parishii* (Rchb.) Pfitzer, *Peristylus parishii* Rchb.f., *Phalaenopsis parishii* Rchb.f. and *Porpax parishii* (Lindl. & Rchb.f.) Rolfe (Clayton, 2014).

Myanmar orchid flora is highly diverse but very poorly known mainly due to few botanical explorations in Myanmar after 1950 (Kurzweil and Lwin, 2014; Ormerod and Sathish Kumar, 2003). Unlike some neighboring countries, the orchid flora of Myanmar lacks a modern taxonomic treatment (Pedersen et al., 2014; Ormerod, 2012; Pedersen et al., 2011; Chen et al., 2009; Pearce et al., 2002). Recently there are international cooperation of orchid research activities in Myanmar, leading to discoveries of new species to science and new species records (Aung et al., 2017; Jin and Kyaw, 2017; Liu et al., 2017; Yang et al., 2017; Tanaka et al., 2015; Watthana et al., 2015; Kurzweil, 2013; Kurzweil and Lwin, 2012a; 2012b; 2014 & 2015; Kurzweil et al., 2010; Tanaka et al., 2010). As for orchid conservation in Myanmar, all recorded species of Orchidaceae have been legally protected by national legislation and CITES management authority of Myanmar Forest Department. But there are some major challenges on the pathway of orchid conservation in Myanmar such as few taxonomists, few financial supports and illegal wildlife trade.

In this regard, the present study is conducted to investigate the orchid species richness in Myanmar. The present study will bridge the gap of knowledge on orchid flora of Myanmar.

2. Objectives

The main objectives of the present study are as follows;

- To understand the orchid biodiversity of Myanmar and
- To update the current checklist of Myanmar orchid flora.

3. Materials and Methods

3.1 Study Areas

In order to investigate species richness of Myanmar orchid flora, a program of fieldwork has been conducted in various ecosystems across Myanmar. Seven protected areas across Myanmar, namely Hponkanrazi Wildlife Sanctuary and Hkakaborazi National Park of Kachin State, Popa Mountain Park of Mandalay Region, Nat Ma Taung National Park of Chin State, Alaungdaw Kathapa National Park of Sagaing Region, Taunggyi Bird Sanctuary and its adjacent areas of Shan State and Tanintharyi Nature Reserve of Tanintharyi Region (Figure 1), had been investigated two to five times in each protected area during 2016-2018. The general landscape ecosystems of study areas can be described as follows;

- Hponkanrazi Wildlife Sanctuary (2704 km^2) and Hkakaborazi National Park (3812 km^2) are situated in Putao and Naungmon townships, Putao District, Kachin State, **Northern Myanmar** where there are vast areas of intact subtropical montane forest ecosystems with high species richness and diversity.
- Alaungdaw Kathapa National Park (1403 km^2) is tropical dry deciduous dipterocarp forest ecosystem extensively situated both in Minkin Township of Kale District and Kani Township of Yinmapin District, Sagaing Region, **Northwest Myanmar**.
- Nat Ma Taung National Park (713 km^2) is tropical montane forest ecosystem extensively situated in Kanpatlet, Mindat and Matupi Townships, Mindat District, Chin State, **Northwest Myanmar**.
- Popa Mountain Park (129 km^2) is oasis of dry zone area surrounded by dry scrub forests and situated in Kyaukpadaung Township, Nyaung-Oo District, Mandalay Region, **Central Myanmar**.
- Taunggyi Bird Sanctuary (7 km^2) is tropical forest ecosystem situated in limestone area of Taunggyi Township, Taunggyi District, Shan State of **Eastern Myanmar**.
- Tanintharyi Nature Reserve (1700 km^2) is tropical evergreen rainforest ecosystem situated in Yephyu Township, Dawei District, Tanintharyi Region, **Southern Myanmar**.

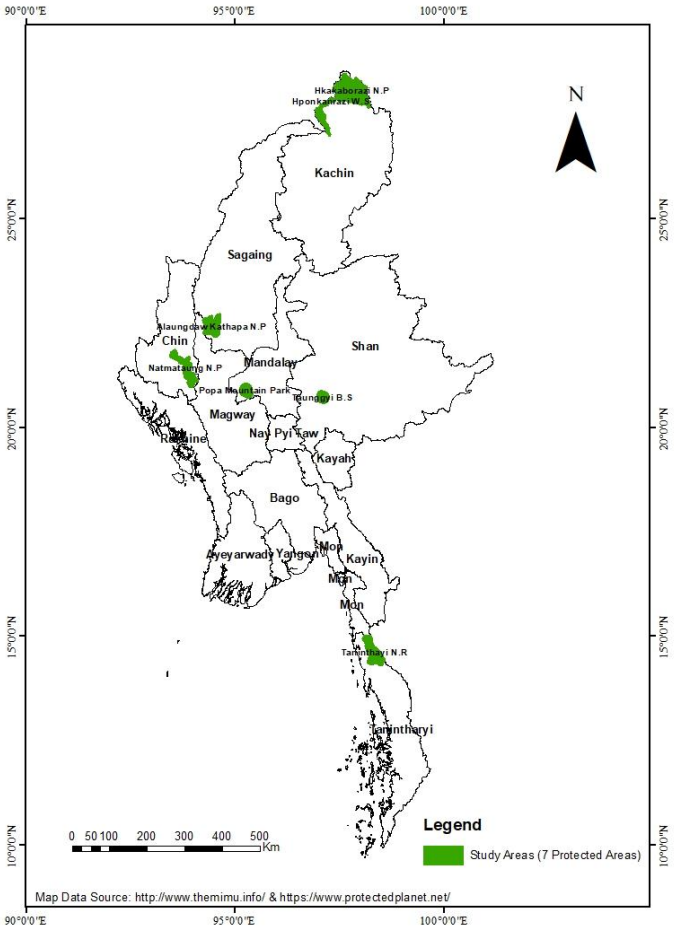

Figure 1. Map of Myanmar, showing the study areas for orchid survey

3.2 Specimen Collections

In total, approximately 1000 specimens of orchids were collected for vouchers (kept in PE and RAF). More than 75 % of total specimens were collected from Hponkanrazi Wildlife Sanctuary and Hkakaborazi National Park, Putao District, Kachin State, Northern Myanmar. Putao is the northernmost district of Myanmar where there are vast areas of primary forest with high species richness and diversity. The remaining proportions were collected from other study areas. In the collections, most species are species of *Dendrobium*, *Bulbophyllum* and *Coelogyne*. The remaining proportions are species of some common genera *Eria*, *Liparis* and *Oberonia*.

Dendrobium species and *Bulbophyllum* species are widespread and collected from different study areas. Some terrestrial orchids are found in mountains with high elevation, especially in the mountains of Kachin and Chin States. *Coelogyne* species and *Eria* species are also widespread across Myanmar. In tropical deciduous dipterocarp forest, species of *Dendrobium* and *Vanda* are widespread and can be found in flower during April-May. In subtropical montane forest, most orchid species are in flower during rainy seasons of June-August.

3.3 Specimen Identification

All collected specimens were taxonomically identified based on relevant literature, field notes, photographs taken during fieldwork, herbarium specimens (PE) and online herbarium specimens such as Kew Herbarium Catalogue and Chinese Virtual Herbarium (Chase et al., 2015; Kurzweil and Lwin, 2014; Pedersen et al., 2011 & 2014; Pridgeon et al., 2005 & 2014; Chen et al., 2009; Dressler, 1993; Kress et al., 2003; Seidenfaden, 1992). For verification of taxonomic status of all species, all relevant literature and online databases such as WCSP are reviewed to confirm its respective taxonomic status (WCSP, 2019; Ng et al., 2018; Raskoti et al., 2017; Raskoti et al., 2016; Chase et al., 2015; Jin et al., 2014; Pridgeon et al., 2005 & 2014; Vermeulen et al., 2014; Gardiner et al., 2013; Gardiner, 2012; Chen et al., 2009).

It is obvious that specimens having flowers are more convinced for identification because identification keys of Orchidaceae are mainly based on floral morphology and its related distinct features. In some species, vegetative morphology is similar to each other so that floral morphology is the set of key features for identification. Most species of *Bulbophyllum* and *Dendrobium* can be readily identified based on its flowers collected and photographs taken during fieldwork. Some species can be readily identified by its vegetative morphology, e.g., *Appendicula cornuta* and *Podochilus khasianus*.

3.4 Herbarium Specimen Examination

In total, there are ca. 3000 herbarium specimens examined, including specimens of my own collections and previous collections (PE), Kew herbarium specimens (K) and specimens from online herbaria: AMES, BM, E, GH, K, L, NY, P, US and W (herbarium codes from Index Herbariorum at http://sweetgum.nybg. org/ih/). In addition to my own collections and previous collections at PE (ca. 1000 specimens), Kew herbarium specimens (ca. 700 specimen photographs) were examined by having access to specimen photographs taken by my supervisor Dr. Xiaohua Jin during his research cooperation at Kew Herbarium, Royal Botanic Gardens Kew, UK.

In addition, all available datasets of herbarium specimens (ca. 1500 specimens) and specimen photographs were downloaded from online herbaria and examined to enumerate the number of species and to investigate the species occurrences in Myanmar. The followings are specimen records downloaded from each online herbarium, AMES (12 records), BM (420 records), E (496 records), GH (3 records), K (324 records), L (39 records), NY (116 records), P (87 records), US (81 records) and W (11 records). During my field trips in Myanmar, some old herbarium specimens at RAF (ca. 200 specimens) were also examined at herbarium (RAF) of Forest Research Institute in Yezin, Nay Pyi Taw.

As for species occurrences, the herbarium specimens (BM, E, K) provide the information on past record of species occurrences in Myanmar, for example; old collections (past 100 years) by some well-known plant collectors such as Charles Parish, George Forrest, J. H. Lace, Frank Kingdon-Ward, W. A. Robertson, F. G. Dickason, C. W. D. Kermode during last half of 19th century and first half of 20th century. The herbarium specimens (PE) provide information on current status of species occurrences across Myanmar. In addition, some literature provide information on specimens collected from Myanmar so that it can be cited as specimen-based species occurrences in Myanmar (Aung and Jin, 2018; Aung et al.,

2018; Kurzweil and Ormerod, 2018; Liu et al., 2018; Tanaka et al., 2018; Zhou et al., 2018; Aung et al., 2017; Jin and Kyaw, 2017; Liu et al., 2017; Yang et al., 2017; Kurzweil and Lwin, 2015; Tanaka et al., 2015; Watthana et al., 2015).

4. Results

4.1 Botanical Investigations

As a result of botanical investigations in Myanmar, five new species and 30 new records were discovered from Myanmar (Aung et al., 2017; Aung et al., 2018; Aung and Jin, 2018; Aung et al., 2019b; Mu et al., 2019) (Tables 1-2) (**Figures 2-5**). The discoveries contribute to the increased number of species (ca. 200 species) in the updated checklist (1040 species). Botanical collections still remain under-represented the whole diversity of Myanmar orchid flora. Although there are 1040 species currently known from Myanmar, it is estimated that at least ca. 150 species still remain unexplored and are expected to be discovered in future studies on Myanmar orchid flora.

Table 1. New species of Orchidaceae discovered from Myanmar

No.	Species	Type Locality
1	*Bulbophyllum nyinyikyawii* X.H.Jin, H.A.Mung & L.A.Ye	Putao Township, Kachin State
2	*Coelogyne putaoensis* X.H.Jin, L.A.Ye & Schuit.	Hponkanrazi Wildlife Sanctuary, Putao Township, Kachin State
3	*Gastrodia kachinensis* X.H.Jin & L.A.Ye	Hponkanrazi Wildlife Sanctuary, Putao Township, Kachin State
4	*Liparis popaensis* X.H.Jin, A.T.Mu & L.A.Ye	Mt. Popa, Mandalay Region
5	*Odontochilus putaoensis* X.H. Jin, L.A. Ye & A.T. Mu	Hponkanrazi Wildlife Sanctuary, Putao Township, Kachin State

Table 2. New records of Orchid aceae discovered from Myanmar

No.	Species	Local Distribution
1	*Acampe cephalotes* Lindl.	Putao, Kachin; Taunggyi, Shan
2	*Agrostophyllum brevipes* King & Pantl.	Putao, Kachin
3	*Agrostophyllum glumaceum* Hook.f.	YePhyu, Tanintharyi
4	*Agrostophyllum superpositum* Schltr.	Putao, Kachin
5	*Bulbophyllum andersonii* (Hook.f.) J.J.Sm.	Putao, Kachin
6	*Calanthe baliensis* J.J.Wood & J.B.Comber	Putao, Kachin
7	*Cephalantheropsis halconensis* (Ames) S.S.Ying	Putao, Kachin
8	*Collabium formosanum* Hayata	Putao, Kachin
9	*Cryptostylis arachnites* (Blume) Hassk.	Putao, Kachin
10	*Cryptostylis carinata* J.J.Sm.	Putao, Kachin
11	*Lecanorchis nigricans* Honda	Putao, Kachin
12	*Luisia filiformis* Hook.f.	Mt. Victoria, Chin; Alaungdaw Kathapa National Park, Sagaing
13	*Luisia hancockii* Rolfe	Putao, Kachin; Alaungdaw Kathapa National Park, Sagaing
14	*Nephelaphyllum tenuiflorum* Blume	Putao, Kachin
15	*Oberonia angustifolia* Lindl.	YePhyu, Tanintharyi
16	*Oberonia bantaengensis* J.J.Sm.	YePhyu, Tanintharyi
17	*Oberonia falcata* King & Pantl.	YePhyu, Tanintharyi
18	*Oberonia insectifera* Hook.f.	Mt. Victoria, Chin

No.	Species	Local Distribution
19	*Oberonia pachyrachis* Rchb.f. ex Hook.f.	Mt. Victoria, Chin
20	*Oberonia seidenfadenii* (H.J.Su) Ormerod	Alaungdaw Kathapa National Park, Sagaing
21	*Odontochilus grandiflorus* (Lindl.) Benth. ex Hook.f.	Putao, Kachin
22	*Odontochilus poilanei* (Gagnep.) Ormerod	Putao, Kachin
23	*Panisea yunnanensis* S.C.Chen & Z.H.Tsi	Mt. Victoria, Chin
24	*Pelatantheria ctenoglossum* Ridl.	ALaungdaw Kathapa National Park, Sagaing
25	*Pelatantheria rivesii* (Guillaumin) Tang & F.T.Wang	ALaungdaw Kathapa National Park, Sagaing
26	*Sarcoglyphis smithiana* (Kerr) Seidenf.	Alaungdaw Kathapa National Park, Sagaing
27	*Thelasis khasiana* Hook.f.	Putao, Kachin
28	*Uncifera obtusifolia* Lindl.	Putao, Kachin; YePhyu, Tanintharyi
29	*Vanda flabellata* (Rolfe ex Downie) Christenson	Taunggyi, Shan State
30	*Vanda garayi* (Christenson) L.M.Gardiner	Alaungdaw Kathapa National Park, Sagaing

Figure 2. *Coelogyne putaoensis* X.H.Jin, L.A.Ye & Schuit., new species discovered from Myanmar; (A) Habit of *Coelogyne putaoensis*, (B) Close-up of flower of *Coelogyne putaoensis.* Photo by X. H. Jin.

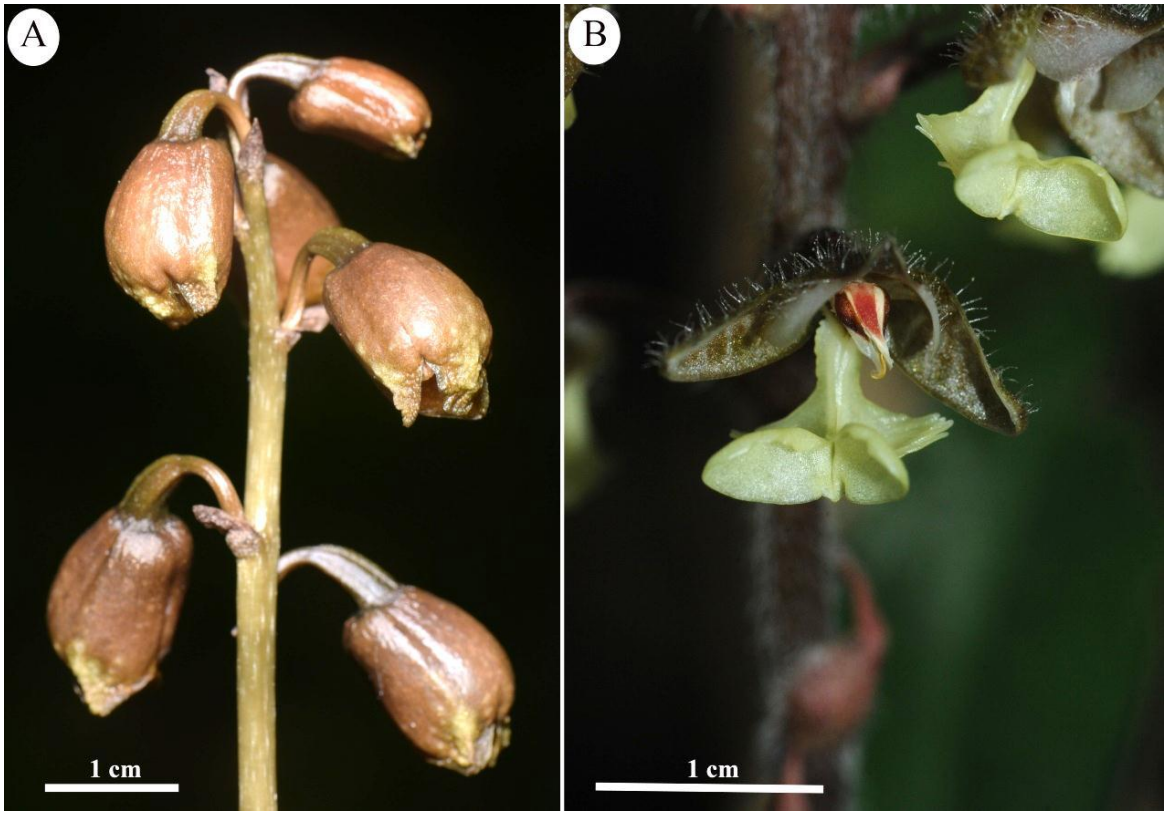

Figure 3. New species discovered from Myanmar; (A) *Gastrodia kachinensis* X.H.Jin & L.A.Ye., (B) *Odontochilus putaoensis* X.H.Jin, L.A.Ye & A.T.Mu. Photos by X.H. Jin.

Figure 4. New species discovered from Myanmar; (A) *Bulbophyllum nyinyikyawii* X.H.Jin, H.A.Mung & L.A.Ye, (B) *Liparis popaensis* X.H.Jin, A.T.Mu & L.A.Ye. Photos by X.H. Jin.

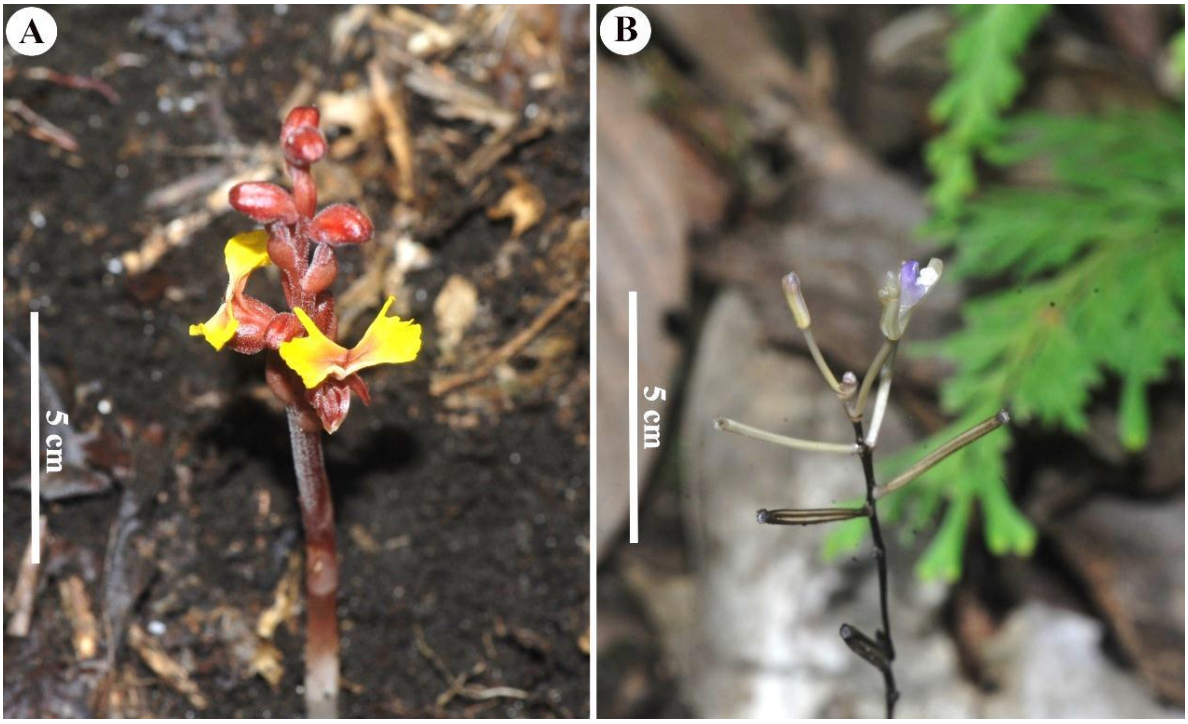

Figure 5. New records discovered from Myanmar; (A) *Odontochilus poilanei* (Gagnep.) Ormerod (B) *Lecanorchis nigricans* Honda. Photos by Ye Lwin Aung.

4.2 Updated Checklist

The updated checklist of Myanmar orchid flora includes 1040 species and 151 genera, currently known from Myanmar (Aung et al., 2019a). The number of species is increased by ca. 200 species more than the checklist of Kress et al. (2003). The increase in number of species is mainly due to the recent discoveries of new species to science as well as new species records for Myanmar. There are 76 endemic species of Orchidaceae in Myanmar which need high conservation attentions.

The updated checklist provides the accepted species names, their respective distribution in Myanmar and voucher specimen citations. Species distribution ranges (usually provincial level) in Myanmar are provided for almost all species. Specific locality information is also provided if known for some species. Voucher specimen citations are provided for almost all species. In cases where herbarium specimens are lacking, the species occurrences are mainly based on the most reliable references of Kress et al. (2003) and Kurzweil & Lwin (2014). By the number of species, most genera consist of one to ten species per genus, while *Dendrobium* and *Bulbophyllum* consist of more than 100 species in each.

5. Discussion

Myanmar orchid flora is highly diverse but still far less known because of few botanical explorations in past 100 years. Particularly, botanical explorations had sharply decreased in Myanmar since 1950 (Kress et al., 2003). At the dawn of 21st century, botanical explorations become resumed in Myanmar, leading to discoveries of new species to science and new species records for Myanmar. Kress et al. (2003) enumerated the vascular plants of Myanmar,

resulting in a checklist of Myanmar flora (11,800 species) including ca. 800 species of Orchidaceae from Myanmar.

Historically, orchid studies in Myanmar dates back to 1852 and in those days Charles Parish, clergyman of British colonial rule, collected orchids as specimens and living plants in Mawlamyine (formerly Moulmein) and its adjacent areas, southern Myanmar between 1852 and 1878 (Clayton, 2014). Even though there were such historically remarkable orchid studies in Myanmar, orchid flora of Myanmar still lacks modern taxonomic treatments and needs much more research attentions.

In 2010s, orchid studies become resumed and accelerated in Myanmar after a long pause in botanical explorations (more than 50 years). As a result, there are discoveries of new species to science and new species records (Aung and Jin, 2018; Aung et al., 2018; Kurzweil and Ormerod, 2018; Tanaka et al., 2018; Aung et al., 2017; Jin and Kyaw, 2017; Liu et al., 2017; Yang et al., 2017; Tanaka et al., 2015; Watthana et al., 2015; Kurzweil, 2013; Kurzweil and Lwin, 2012a; 2012b; 2014 & 2015; Kurzweil et al., 2010; Tanaka et al., 2010). Our botanical investigations resulted in discoveries of five new species and 30 new records for Myanmar, with contributions to floristic studies and biodiversity conservation of Myanmar. The present study resulted in an updated checklist of Myanmar orchid flora which includes 1040 species and 151 genera. As for endemism, there are 76 endemic species of Orchidaceae in Myanmar which need special conservation attentions.

The botanical explorations still remain under-represented the whole diversity of Myanmar orchid flora. In consequence, at least 150 species might remain unexplored and are expected to be discovered in future studies. But there are some major threats to species survival such as habitat loss due to deforestation and land use change. Under such threats, some species might be locally extinct before recorded their occurrences and distribution in Myanmar. In order to counteract such threats, botanical explorations are urgently needed to better understand orchid biodiversity of Myanmar and to take proactive conservation measures. With more botanical explorations, orchid studies will contribute to better understanding of Myanmar orchid flora and also contribute to the biodiversity conservation and research in Myanmar.

6. Conclusion

The present study is the preliminary step into orchid studies in Myanmar, with contributions to both floristic studies of Myanmar and biodiversity conservation of Myanmar. The present study provides the updated checklist of Myanmar orchid flora which provides the number of species, its local distribution ranges and respective conservation status. The present study is mainly based on my own collections of specimens, herbarium specimen sheets available, relevant literature and online databases. With intensive botanical investigations, it is expected to obtain good results in future studies on orchid flora of Myanmar.

Acknowledgements

Firstly I am very grateful to my supervisor Dr. Xiaohua Jin for his guidelines on my research. My special thanks go to Academic Committee for their good suggestions on my research. As well, I feel thankful to all my Chinese colleagues, for their generous supports to me during my three-year-stay in Beijing. In addition, I am thankful to Institute of Botany, Chinese Academy of Sciences (IBCAS) for providing research facilities. Last but not least, all progress and achievements of my research are due to the academic and financial supports of Chinese Academy of Sciences (CAS) and hence my special thanks go to CAS for its generous supports to me.

For nominating and granting me permission to study at Institute of Botany, Chinese Academy of Sciences (IBCAS), my special thanks go to Forest Department, Ministry of Natural Resources and Environmental Conservation, Nay Pyi Taw, Myanmar. In addition, I feel thankful to everyone who helps me during my fieldwork in Myanmar.

I am thankful to my parents and relatives for their forever supports to me. In addition, I would like to thank my friends who support me in various ways.

This study was supported by grants from the National Natural Science Foundation of China (31870195 and 31670194 to X.H.J), and Southeast Asia Biodiversity Research Institute, Chinese Academy of Sciences (Y4ZK111B01 to X.H.J).

References

Aung MH, Aung YL, Jin XH. *Bulbophyllum nyinyikyawii* (Orchidaceae, Epidendroideae, Malaxidieae), a new species from Kachin State, Myanmar. In: Jin XH, Xia N, Tan YH (Eds) Plant diversity of Southeast Asia-II. PhytoKeys, 2019b, [In press].

Aung YL, Jin XH, Schuiteman A. *Coelogyne putaoensis* (Orchidaceae), a new species from Myanmar. PhytoKeys, 2017, 82: 27–34.

Aung YL, Jin XH. *Gastrodia kachinensis* (Orchidaceae), a new species from Myanmar. In: Jin XH, Shui YM, Tan YH, Kang M (Eds) Plant diversity in Southeast Asia. PhytoKeys, 2018, 94: 23–29.

Aung YL, Mu AT, Jin XH. *Odontochilus putaoensis* (Cranichideae, Orchidaceae), a new species from Myanmar. PhytoKeys, 2018, 103: 19–26.

Aung YL, Mu AT, Aung MH, Liu Q, Jin XH. An annotated checklist of Myanmar orchid flora. In: Jin XH, Xia N, Tan YH (Eds) Plant diversity of Southeast Asia-II. PhytoKeys, 2019a, [In press].

Blume CL. Collection des orchidées les plus remarquables de l'archipel Indien et du Japon. Sulphe, Amsterdam, icons, 1858.

Brown R. Prodromus florae Novae Hollandiae, et Insulae van Diemen. Johnson, London, 1810.

Chase MW, Cameron KM, Freudenstein JV, et al. An updated Classification of Orchidaceae. Botanical Journal of the Linnean Society, 2015, 177: 151–174.

Chen XQ, Liu ZJ, Zhu GH, et al. Orchidaceae. In: Wu ZY, Raven PH, Hong DY (Eds.) Flora of China (Vol. 25). Beijing: Science Press and St. Louis: Missouri Botanical Garden Press, 2009.

Chinese Virtual Herbarium. Published on the Internet; 2018. http://www.cvh.ac.cn/ (accessed: 1 January 2018).

Clayton D. The genus *Coelogyne*: a synopsis. Natural History Publications, Kota Kinabalu, 2002.

Clayton D. The Reverend Charles Samuel Pollock Parish -plant collector & botanical illustrator of the orchids from Tenasserim Province, Burma. LANKESTERIANA, 2014, 13: 215–227.

Dressler RL. Phylogeny and Classification of the Orchid Family. Dioscorides Press, Oregon, 1993.

Gardiner LM. New combinations in the genus *Vanda* (Orchidaceae). Phytotaxa, 2012, 61: 47–54.

Gardiner LM, Kocyan A, Motes M, et al. Molecular phylogenetics of *Vanda* and related genera (Orchidaceae). Botanical Journal of the Linnean Society, 2013, 173: 549–572.

Govaerts RHA. 101 Nomenclatural Corrections in Preparation for the Plants of the World Online (POWO). Skvortsovia, 2018, 4: 74 –99.

Jin WT, Jin XH, Schuiteman A, et al. Molecular systematics of subtribe Orchidinae and Asian taxa of Habenariinae (Orchideae, Orchidaceae) based on plastid matK, rbcL and nuclear ITS. Molecular Phylogenetics and Evolution, 2014, 77: 41–53.

Jin XH, Kyaw M. *Gastrodia putaoensis* sp. nov. (Orchidaceae, Epidendroideae) from North Myanmar. Nordic Journal of Botany, 2017, 35: 730–732.

Kang DY, Cho SH, Ong HG, et al. Two new generic records in the orchid flora of Myanmar. Korean Journal of Plant Taxonomy, 2019, 49: 96−99.

Kress WJ, DeFilipps RA, Farr E, Kyi YY. A checklist of the trees, shrubs, herbs, and climbers of Myanmar (revised from the original works by JH Lace, R. Rodger, HG Hundley and U Chit Ko Ko on the "List of trees, shrubs, herbs and principal climbers etc. recorded from Burma"). Contributions from the United States National Herbarium 2003, 45: 1–590.

Kurzweil H, Watthana S, Lwin S. *Phaius takeoi* (Orchidaceae) Newly Recorded from Thailand and Myanmar. Gardens' Bulletin Singapore, 2010, 62: 105–109.

Kurzweil H, Lwin S. New records in the orchid flora of Myanmar. Thai Forest Bulletin (Botany), 2012a, 40: 108–113.

Kurzweil H, Lwin S. First record of *Taeniophyllum* (Orchidaceae) in Myanmar . Gardens' Bulletin Singapore, 2012b, 64: 133–137.

Kurzweil H. *Calanthe punctata* (Orchidaceae), a new species from southern Myanmar. Gardens' Bulletin Singapore, 2013, 65: 163–168.

Kurzweil H, Lwin S. A guide to orchids of Myanmar. Natural History Publications (Borneo), Kota Kinabalu, 2014.

Kurzweil H, Lwin S. New orchid records for Myanmar, including the first record of the genus *Stereosandra*. Gardens' Bulletin Singapore, 2015, 67: 107–122.

Kurzweil H, Ormerod P. Precursory studies on the orchid flora of Myanmar with one new species and thirty eight new distribution records. Rheedea, 2018, 28: 01−15.

Lindley J. Collectanea Botanica. Richard & Arthur Taylor, London, 1821.

Liu Q, Zhou SS, Li R, et al. *Bulbophyllum putaoensis* (Orchidaceae: Epidendroideae; Malaxideae), a new species from Kachin State, Myanmar. Phytotaxa, 2017, 305: 57–60.

Liu Q, Zhou SS, Jin XH, et al. *Dendrobium naungmungense* (Orchidaceae, Dendrobieae), a new species from Kachin State, Myanmar. In: Jin XH, Shui YM, Tan YH, Kang M (Eds) Plant diversity in Southeast Asia. PhytoKeys, 2018, 94: 31–38.

Mittermeier RA, Turner WR, Larsen FW, et al. Global biodiversity conservation: the critical role of hotspots. In: Zachos FE, Habel JC (Eds) Biodiversity Hotspots. Springer Publishers, London, 2011, 3–22.

Mu AT, Aung YL, Jin XH. *Liparis popaensis* (Orchidaceae), a new species from Myanmar. Phytotaxa, 2019, 413: 67–70. https://doi.org/10.11646/phytotaxa.413.1.8

Myers N, Mittermeier RA, Mittermeier CG, et al. Biodiversity hotspots for conservation priorities. Nature, 2000, 403: 853–858.

Natural History Museum Dataset: Collection specimens. Natural History Museum Data Portal (data.nhm.ac.uk). 2014. https://doi.org/10.5519/0002965 (accessed: 30 April 2019).

Ng YP, Schuiteman A, Pedersen HÆ, et al. Phylogenetics and systematics of Eria and related genera (Orchidaceae: Podochileae). Botanical Journal of the Linnean Society, 2018, 186: 179–201.

Ormerod P, Sathish Kumar C. Orchidaceous Additions to the Flora of Burma (Myanmar). Rheedea, 2003, 13: 43–50.

Ormerod P. Notulae Goodyerinae (II). Taiwania, 2005, 50: 1–10.

Ormerod P, Wood EW. A New Species of *Pinalia* (Orchidaceae: Eriinae) from Myanmar. Harvard Papers in Botany, 2010, 15: 349–351.

Ormerod P. Orchidaceous Additions to the Floras of China and Myanmar. Taiwania, 2012, 57: 117–126.

Pearce NR, Cribb PJ. Flora of Bhutan (Vol. 3, Part 3): The Orchids of Bhutan. Royal Botanic Gardens, Edinburgh, 2002.

Pedersen HÆ. Thirteen new species of *Dendrochilum* (Orchidaceae), a new record from Burma, and a checklist of the genus in East Malesia. Nordic Journal of Botany, 1995, 15: 381–402.

Pedersen HÆ, Suksathan P, Indhamusika S. *Sirindhornia*, a new orchid genus from Southeast Asia. Nordic Journal of Botany, 2002 (publ. 2003), 22: 391–404.

Pedersen HÆ, Kurzweil H, Suddee S, et al. Flora of Thailand (Vol. 12, Part 1), Orchidaceae 1 (Cypripedioideae, Orchidoideae, Vanilloideae). Forest Herbarium, Bangkok, 2011.

Pedersen HÆ, Kurzweil H, Suddee S, et al. Flora of Thailand (Vol. 12, Part 2), Orchidaceae 2 (Epidendroideae P.P. : Neottieae, Tropidieae, Nervilieae, Gastrodieae, Thaieae, Calypsoeae, Arethuseae, Collabieae, Cymbidieae). Forest Herbarium, Bangkok, 2014.

Pridgeon AM, Cribb PJ, Chase MW, Rasmussen FN. Genera Orchidacearum, Vol. 2. Orchidoideae (Part 1). Oxford University Press, Oxford, 2001.

Pridgeon AM, Cribb PJ, Chase MW, Rasmussen FN. Genera Orchidacearum, Vol. 4. Epidendroideae (Part 1). Oxford University Press, Oxford, 2005.

Pridgeon AM, Cribb PJ, Chase MW, Rasmussen FN. Genera Orchidacearum, Vol. 6. Epidendroideae (Part 3). Oxford University Press, Oxford, 2014.

Raskoti BB, Jin WT, Xiang XG, et al. A phylogenetic analysis of molecular and morphological characters of *Herminium* (Orchidaceae, Orchideae): evolutionary relationships, taxonomy, and patterns of character evolution. Cladistics, 2016, 32: 198–210.

Raskoti BB, Schuiteman A, Jin WT, Jin XH. A taxonomic revision of *Herminium* L. (Orchidoideae, Orchidaceae). PhytoKeys, 2017, 79: 1–74.

Roberts DL, Gardiner LM, Motes M. *Vanda longitepala* (Orchidaceae): a new species from Burma. Kew Bulletin, 2008, 63: 495–497.

Schuiteman A. *Thelasis perpusilla* . Orchideen Journal, 2014, 21: 52–57.

Seidenfaden G. The Orchids of Indochina. Opera Botanica, 1992, 114: 1–502.

Suarez W, Cootes J. New name combinations for Phillipine members of the genera *Pinalia* and *Ascidieria*. Orchideen Journal, 2009, 16: 69–84.

Swartz O. Dianome epidendri generis Linn. Nova Acta regiae Societatis Scientiarum upsaliensis, 1799, 6: 61–88.

Tanaka N. Plant Inventory Research: Contributions to the Flora of Myanmar. Acta Phytotaxonomica et Geobotanica, 2005, 56: 21–26.

Tanaka N, Yukawa T, Murata J. New or Noteworthy Plant Collections from Myanmar (5): *Dendrobium koyamae*, a New Species in sect. Formosa (Orchidaceae). Acta Phytotaxonomica et Geobotanica, 2010, 60: 71–174.

Tanaka N, Yukawa T, Htwe KM, et al. An Orchid Checklist of Mt. Popa, Central Myanmar. Bulletin of the National Museum of Nature and Science. Series B, Botany, 2015, 41: 69–89.

Tanaka N, Tagane S, Naiki A, et al. Contributions to the Flora of Myanmar I: Nine taxa of monocots newly recorded from Myanmar. Bulletin of the National Museum of Nature and Science, Series B, Botany, 2018, 44: 31–39.

The Botany Collections, Smithsonian National Museum of Natural History. Published on the Internet; 2019. https://collections.nmnh.si.edu/search/botany/?ti=3 (accessed: 27 April 2019).

The BioPortal of Naturalis Biodiversity Center, National Herbarium of the Netherlands. Published on the Internet; 2019. https://bioportal.naturalis.nl/ (accessed: 30 April 2019).

The C. V. Starr Virtual Herbarium, New York Botanical Garden. Published on the Internet; 2019. http://sweetgum.nybg.org/science/vh/ (accessed: 27 April 2019).

The Herbarium Catalogue, Royal Botanic Garden Edinburgh. Published on the Internet; 2019. https://data.rbge.org.uk/search/herbarium/ (accessed: 27 April 2019).

The Herbarium Catalogue, Royal Botanic Gardens, Kew. Published on the Internet; 2018. http://www.kew.org/herbcat (accessed: 12 April 2018).

The Index of Botanical Specimens, Harvard University Herbaria & Libraries. Published on the Internet; 2019. https://kiki.huh.harvard.edu/ databases/specimen_index.html (accessed: 27 April 2019).

The International Plant Names Index. Published on the Internet; 2012. http://www.ipni.org (accessed: 1 July 2018).

The Plant List. Version 1.1. Published on the Internet; 2013. http://www.theplantlist.org/ (accessed: 5 July 2018).

The Vascular Plants, Muséum National d'Histoire Naturelle. Published on the Internet; 2019. https://science.mnhn.fr/institution/mnhn/collection/p/item/search/form?lang= en_US (accessed: 30 April 2019).

The Virtual Herbaria, Naturhistorisches Museum Wien. Published on the Internet; 2019. https://nhm-wien.ac.at/en/research/botany (accessed: 30 April 2019).

Thouars LMA. Histoire particulière des plantes orchidées recueillies sur les trois îles Australes d'Afrique, de France, de Bourbon et de Madagascar. Arhus Bertrand, Paris, tab. 93, 1822.

Vermeulen JJ, Schuiteman A, De Vogel EF. Nomenclatural changes in *Bulbophyllum* (Orchidaceae; Epidendroideae). Phytotaxa, 2014, 166: 101–113.

Watthana S, Fujikawa K, Kertsawang K. First Record of *Cremastra* Lindl. (Orchidaceae) in Myanmar. Acta Phytotaxaonomica et Geobotanica, 2015, 66: 197–200.

WCSP. *World Checklist of Selected Plant Families*. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; *2019*. http://wcsp.science.kew.org/ (accessed: 1 January 2019).

Yang B, Zhou SS, Liu Q, et al. *Coelogyne magnifica* (Orchidaceae), a new species from northern Myanmar. PhytoKeys, 2017, 88: 109–117.

Zhou SS, Tan YH, Jin XH, et al. *Coelogyne victoria-reginae* (Orchidaceae, Epidendroideae, Arethuseae), a new species from Chin State, Myanmar. PhytoKeys, 2018a, 98: 125–133.

1.	**Name**	U Ye Lwin Aung
2.	**Occupation**	Range Officer, Forest Research Institute Forest Department Ministry of Natural Resources and Environmental Conservation
3.	**Educational Status**	B. Sc. (Forestry) M. Sc. (Plant Taxonomy)

4. Work Experience

Position	**Period**
Planning and Statistics Division, Forest Department (HQ), Nay Pyi Taw	1-11-2013 to 20-8-2019
Forest Research Institute, Yezin	21-8-2019 to present

5.	**Research Experience**	Taxonomic Studies on Orchid flora of Myanmar
6.	**Number of Research Papers**	Five papers (detail in publication list)
7.	**Current Research Title**	Botanical Investigation into Orchid Biodiversity of Myanmar

Publication List

1. **Aung YL**, Jin XH, Schuiteman A (2017) *Coelogyne putaoensis* (Orchidaceae), a new species from Myanmar. PhytoKeys 82: 27–34. https://doi.org/10.3897/phytokeys.82.13172
2. **Aung YL**, Jin XH (2018) *Gastrodia kachinensis* (Orchidaceae), a new species from Myanmar. In: Jin XH, Shui YM, Tan YH, Kang M (Eds) Plant diversity in Southeast Asia. PhytoKeys 94: 23–29. https://doi.org/10.3897/phytokeys.94.21348
3. **Aung YL**, Mu AT, Jin XH (2018) *Odontochilus putaoensis* (Cranichideae, Orchidaceae), a new species from Myanmar. PhytoKeys 103: 19–26. https://doi.org/10.3897/phytokeys.103.25913
4. **Aung YL**, Mu AT, Aung MH, Liu Q, Jin XH (2019) An annotated checklist of Myanmar orchid flora. In: Jin XH, Xia N, Tan YH (Eds) Plant diversity of Southeast Asia-II. PhytoKeys [In press].
5. Mu AT, **Aung YL**, Jin XH (2019) *Liparis popaensis* (Orchidaceae), a new species from Myanmar. Phytotaxa 413: 67–70. https://doi.org/10.11646/phytotaxa.413.1.8