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WHAT DO HERBARIUM COLLECTIONS TELL US ABOUT FAMILY ORCHIDACEAE IN THE FLORA OF ETHIOPIA AND ERITREA?

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Abstract

Information on taxon names, *i.e.* names of genus and species, date of collection, altitude, floristic region, and habitat collected; and also habit on the data label of each orchid specimen in the National Herbarium (ETH) were recorded and analyzed. The study showed that orchid specimens comprise < 1% of the total vascular plant collections in the herbarium. The trend of orchid collections shows variation in magnitude in the last fifty years of collection history. The number of specimens representing the genera and species are relatively proportional to the diversity of the taxa in orchid flora of the Ethiopia and Eritrea. Few of the genera (5 out of the 37 genera, 13.5%) and some of the species (13 out of the 167 species, 7.8%) that occur in the flora area have no herbarium record. Among the floristic regions defined in the flora area: Upland Shewa (ca. 160), Welega (ca. 125), Kefa (ca. 106), and Sidamo (ca. 107) are relatively better collected and represented than the rest. Afar and Eritrea East have no record for orchid specimen. The altitudinal distribution of specimens recorded is very wide ranging from 300 to above 3000 m. a. s. l. with maximum concentration (ca. 123) between 1800 to 2100 m. The majority of the collections are of the terrestrial orchids (73.8%) inhabiting dry and wet habitats and the remaining ones are epiphytes of forests and woodlands. The specimens of endemic species are poorly represented; 28.6% of them are lacking records. This assessment highlights that collection of orchids from the flora area is not complete. Hence, more targeted collections and explorations to the species and regions have been suggested in order to better understand orchids in the flora area. This work is expected to stimulate further taxonomic and conservation research of the orchids.

Introduction

ORCHIDACEAE IS a monocot family of herbaceous perennials that includes terrestrial, saprophytic, lithophytic, and epiphytic species (Pridgeon *et al.*, 1999). It is one of the largest family among monocots and perhaps the second largest flowering plant family with an estimated 21,950 species (APG, 2003). Orchids are widely distributed in all continents except the Antarctica, but are more numerous and diverse in the humid tropic and sub-tropic regions (Judd *et al.* 1999). Because of the poor knowledge of their distribution, many species do not appear on global red data lists (Sabonet, 2000), although all orchids are listed in appendix II of the Convention on International Trade in Endangered Species (CITES) which requires certification of all plants and related material crossing international border (Tim *et al.*, 2002). In the earliest botanical literature, orchids have been shown to be the source of wonderment or medicinal power. For centuries they have been cultivated world over for the diversity, beauty, and intricacy of their flowers. The extensively grown orchid species around the world as ornamentals include *Cattleya, Epidendrum, Paphiopedilum, Vanda* and others (Judd *et al.*, 1999). *Vanilla* species are being grown commercially to produce the flavoring vanillin from their fruits (Cribb and Thomas, 1997). Tubers of several terrestrial species of the genera *Disa, Habenaria,* and *Satyrium*, are being used for food (Tim *et al.* , 2002). A number of other orchids are also being used in folk medicine particularly in countries such as China, India, Far East and Madagascar (Pridgeon *et al.*, 1999).The orchids in the flora of Ethiopia and Eritrea have been relatively well documented in the literature over many years compared with other families. The history of plant collections in Ethiopia and Eritrea dates back to the 1850's when W. G. Schimper made botanical expedition to the region. H. F. Mooney founded the National Herbarium in 1959 (Mesfin and Mooney, 1991). This herbarium has the highest number of collection of Ethiopian taxa. It is also the most active center in botanical research and provides teaching facilities and also identification services to research institutes as well as local and foreign postgraduate students. Today, the National Herbarium contains over 80,000 specimens of vascular plants. There are also few specimens of Bryophytes and Lichens (National Herbarium, 2003). The information on the data labels of herbarium specimens is crucial in taxonomic, ecological and conservation research of plants. The herbarium specimens serve as spatial and temporal occurrence of plant species that show the verifiable geographical range of the species and their habitat. They are also used to solve taxonomic problems and provide information on species richness, endemism; also used in the assessment of conservation status and in conservation decision making (Golding, 2003). With this backdrop, the present work is contemplated to explore and organize further the documented information from orchid collections in the National Herbarium. The work is aimed at availing organized information for future taxonomic, ecological and

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conservation research of the orchid family; at identifying regions, genera and species that need most targeted collection and exploration; and also at identifying the floristic regions richest in endemic taxa to help local conservation efforts.

Material and Methods

Orchid specimens in the National Herbarium (ETH) were used as data source. Individual orchid specimens in the herbarium were recorded in the data sheets. The name of taxon, the date of collection, altitude, floristic region, the habitat and habit was recorded, and entered into the Microsoft Office Excel, and analyzed by SPSS software. To allow assessment on the magnitude and trend of collection since 1960 to date, the 50 years time of collection history is artificially divided into five periods each having 10 years interval. The number of collections per taxon, floristic region, habitat type, and habit classes were presented and commented. For analysis of the altitudinal distribution of orchid specimens recorded, altitudinal zones were arbitrarily defined with a width of 305 m as has been done by Friis *et al.* (2001). The floristic regions that need to be visited and genera and species that need further collection efforts were indicated.

Results

Information recorded from herbarium specimens of orchids at ETH revealed that the total number of specimens deposited in the National Herbarium was 665 while the total vascular plant species were 80,000. Of the total orchid specimens, 639 were collected from the flora area while 26 specimens were recorded from the neighboring flora of Tropical East Africa: Kenya (*ca.* 12), Tanzania (*ca.* 8), Malawi (1), Cameroon (1), USA (1), Norway (1) and Australia (2). The earliest collected orchid specimen dates back to 1960. The specimen was *Holothrix squamata.* The orchid collections in 1961 included *Polystachya bennettania, Habenaria petitiana, Holothrix aracharides, Pteroglossaopsis eustachya* and *Satyrium aethiopicum.* The orchid specimens collected were 153 during 1970-1979, 133 during 1980-1989 and 119 during 2000-2009 (Fig.1). In 2000 and 2001, Christoff Herrmann, Sebesebe Demissew and Tesfaye Awas have collected a good number of orchid specimens from the Welega floristic region; their collections were prominent in the entire orchid collection lot available with the Herbarium.

Representation in the herbarium collection of the 37 genera and 167 species of orchids from the flora area shows variations among the genera and species within each genus. What is interesting here is the positive correlation between the number of collections recorded

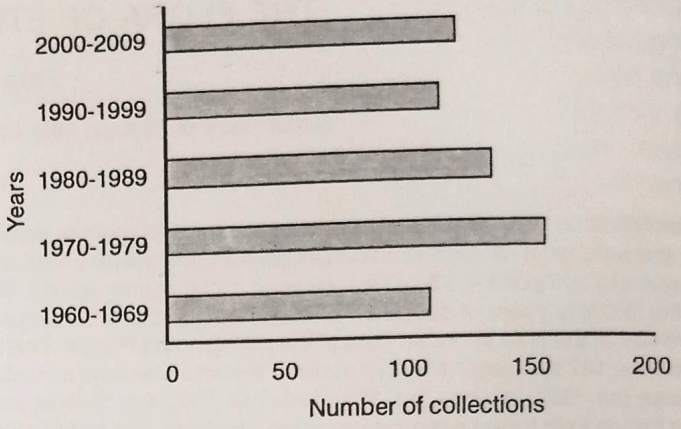

Fig 1. Magnitude and trend of orchid collection in the flora area

from the National Herbarium and the diversity of orchid taxa in the flora of Ethiopia and Eritrea. The highest number of specimens are for the largest genus with 47 species, *Habenaria* (*ca.*189) followed by *Eulophia* with 25 species (*ca.* 99), *Polystachya* with 11 species (*ca.*65) and *Satyrium* with 7 species (*ca.* 51). Similarly, representation of species within genus also varied. Within the genus *Habenaria*: *H. shimperiana* has the largest record of specimens (*ca.*19) followed by *H. vaginata* (*ca.*17), and *H. petitiana* (*ca.*14). Despite the variations exhibited, many of the orchid taxa are known from one or a few collections (mostly < *ca.* 10) and are poorly represented in the National Herbarium. What is also to be noted here is the existence of genera and species in the flora area with no records. Out of the 37 genera believed to exist in the flora area, 32 have records and the remaining 5 genera: *Vanilla, Platylepsis, Malaxis, Oberonia and Ancistrorhynchus* have no specimens in the National Herbarium (Table 1). The number of species with herbarium records is about 154 out of the 167 species in the flora area and the remaining 13 species have no records. These species with no herbarium records are distributed in various genera. For example, 3 out of the 47 species of the genus *Habenaria: H. platyanthera, H. taeniodema,* and *H. decubens* have no record in the National Herbarium (Table 3). Another aspect investigated was the varying degree of representation of orchid collections in the floristic regions recognized in the flora area. Among the floristic regions, the highest collection was recorded from Upland Shewa (*ca.*160). This is followed in declining sequence by Welega (*ca.* 125), Kefa (*ca.* 106), Sidamo (*ca.* 70), Bale (*ca.* 36), Illubabor (*ca.* 23), Gojam (*ca.*19), Upland Wello (*ca.* 18), Gonder (*ca.*16), Arsi (*ca.*14), Hararghe (*ca.* 12), Upland Tigray (*ca.* 10), Gamo Gofa (*ca.* 8), and Eritrea West (*ca.* 3). No orchid specimen was recorded for Afar and Eritrea East (Fig. 2). These figures indicate that some floristic regions were relatively better explored than others. The altitudinal distribution

Table 1. Genus-wise number of orchid specimens available in the Herbarium

Genus	Current number of collection	Current number of species	Terrestrial (T) or Epiphytic (E)
Cheirostylis	1	1	T
Corymborkis	2	1	T
Holothrix	35	7	T
Brachycorythis	7	3	T
Cynorkis	9	2	T
Habenaria	189	47	T
Bonatea	5	2	T
Platycoryne	13	1	T
Roeperocharis	2	3	T
Disa	17	5	T
Satyrium	51	7	T
Disperis	8	6	T
Epipactis	1	2	T
Nervilia	15	3	T
Vanilla	-	1	T
Platylepis	-	1	T
Malaxis	-	1	T
Liparis	2	3	T
Pteroglossaspis	9	1	T
Eulophia	99	25	T
Oberonia	-	1	E
Polystachya	65	11	E
Stolzia	7	2	E
Bulbophyllum	12	4	E
Oecelclades	1	2	E
Graphorkis	1	1	E
Calyptrochilum	2	1	E
Angraecum	1	2	E
Microceoelia	6	1	E
Diphananthe	37	6	E
Bolusiella	2	1	E
Aerangis	20	5	E
Rangaeris	2	1	E
Cyrtochis	3	2	E
Ancistrorhynchus	-	1	E
Angeraecopsis	5	2	E
Tridactyl	3	2	E
Total	632	137	20 (T), 17 (E)

of orchid specimens collected from the flora area range from ca. 300 to above 3000 m by altitude. Orchid specimens were not recorded in the zones from 0 to ca. 300 m and between ca. 600 and 900 m; only ca. 5 collections were recorded between ca. 300 and 600 m. The number of orchid collections recorded gradually increased to ca. 23 specimens between ca. 900 and 1200 m. The maximum number of collection was between ca. 1200 and 2100 m a.s.l showing the highest frequency in the higher part of this interval, ca. 123 specimens between ca. 1800 and 2100 m. Then, the number decreased to ca. 19 specimens with records to above ca. 3000 m (Fig. 3). In spite of the difficulty to distinguish between open habitats: woodlands,

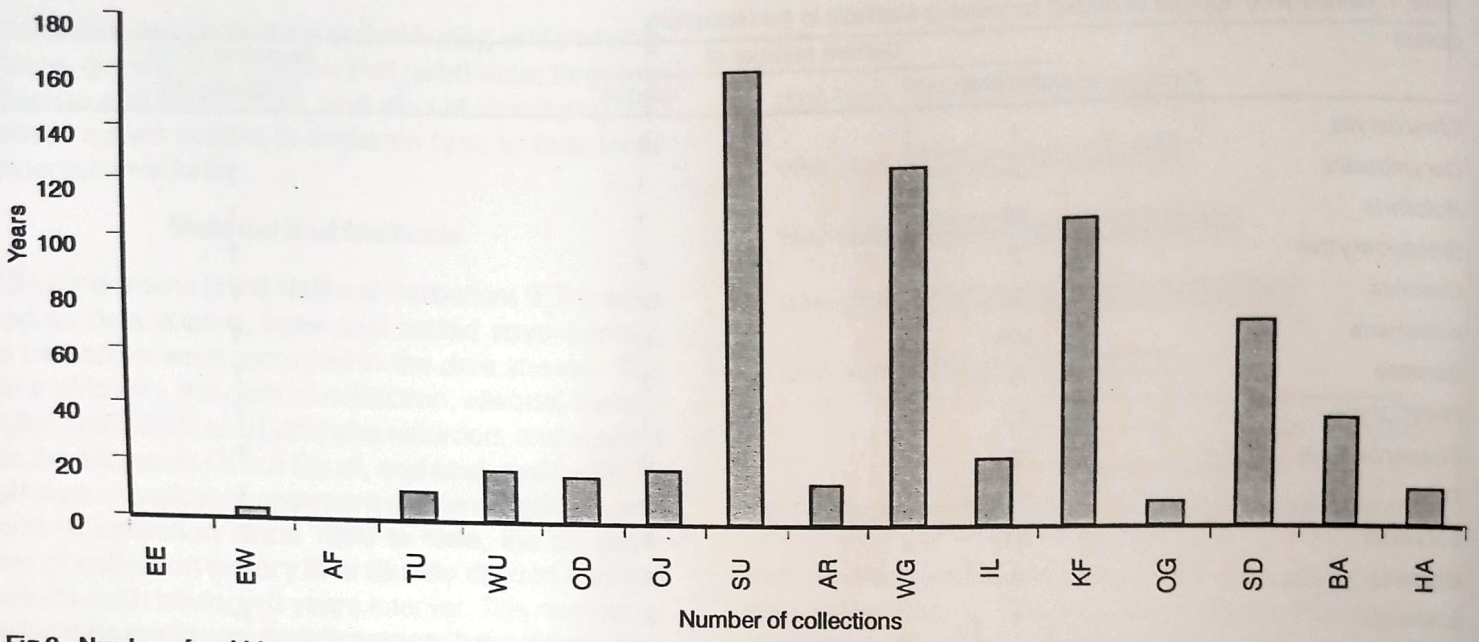

Fig 2. Number of orchid specimens collected from floristic regions defined in the flora of Ethiopia and Eritrea (EW: Eritrea West, EE: Eritrea East, AF: Afar, TU: Upland Tigray, WU: Upland Wello, GD: Gonder, GJ: Gojam, SU: Upland Shewa, AR: Arisi, WG: Welega, IL: Illubabor, KF: Kefa, GG: Gamo Gofa, SD: Sidamo, BA: Bale, HA: Harerghe).

grasslands, bush lands, wooded grassland, etc., major habitat types collected were recorded as noted in the labels of herbarium sheets. This was done because habitat types collected, particularly for orchids are indicative to some extent of their habit (whether terrestrial/ground or epiphytic). The majority of the collections were of terrestrial orchids, *ca.* 424 inhabiting dry and wet habitats of various types. Only *ca.* 167 of the collections were from epiphytes of forests and woodlands; and *ca.* 48 were from orchids growing on rocky outcrops and cliffs (lithophytes) (Table 2). The current number of endemic species in the flora area is *ca.* 28 distributed in twelve genera. These endemic species are poorly represented in the National Herbarium with current total physical collection found to be *ca.* 75. Out of the *ca.* 28 species known to be endemic in the flora area, *ca.* 8 species have no records. Among the endemic species, species of genera *Disa* (*D. pulchella ca.* 4), *Eulophia* (*E. albobrunnea ca.* 6), *Habenaria* (*H. aethiopica* ca. 7), *Holothrix* (*H. unifolia ca.* 7), *Polstachya* (*P. rivae* ca. 7 *and P. caduca ca.* 7), and *Satyrium* (*S. aethiopicum ca.* 11) are relatively better represented. Half of the endemics (about 14 species) of orchids in the other genera are represented by three or even less number of specimens. Upland Shewa (*ca.* 9), Sidamo (*ca.* 8), Welega (*ca.* 8), Kefa (*ca.* 5), and Bale (*ca.* 4), Gonder (*ca.* 2), Arsi (*ca.* 2), Upland Wello (*ca.*

Table 2. Relative proportion of orchid specimens collected by habitat types

Major habitat types	Proportion of specimen collected(%)
Forest	25.3
Woodland	14.6
Grassland	15.1
Wooded grassland	6.9
Permanent swaps (wetland)	6.5
Bush land	4.3
Scrubland	10.8
Cultivated areas	8.1
Rocks and cliffs	8.3

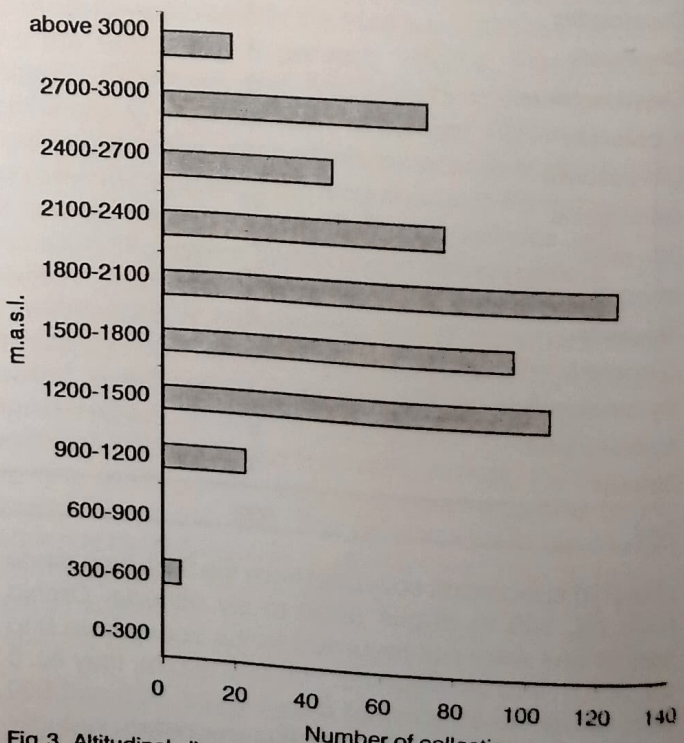

Fig 3. Altitudinal distribution of orchid specimens collected from flora area.

Table 3. Number of specimens of endemic orchid species collected in the flora area and floristic region

Endemic species	Current number. of collection	Floristic region collected
Holothrix unifolia	7	SU
Habenaria montolivaea	3	SU, WU
Habenaria platyanthera	-	-
Habenaria trircuris	3	SD, SU
Habenaria aethiopica	7	GJ, SU, WG
Habenaria gilbertii	2	SU
Habenaria taeniodema	-	-
Habenaria excela	1	BA
Habenaria vollesenii	1	SD
Habenaria rivae	1	WG
Habenaria perbella	3	WG, SU
Habenaria decubens	-	-
Roepercharis alcicornis	-	-
Roepercharis urbaniana	1	GD
Disa pulchella	4	WU, SD
Satyarium aethiopicum	11	KF, SU, WG
Disperis crassicauilis	3	SD, SU
Disperis galerita	-	-
Disperis meirax	-	-
Liparis abyssinica	-	-
Polystachya rivae	7	KF, SU, WG
Polystachya aethiopica	3	AR, SD, WG
Polystachya caduca	7	AR, BA, GD, KF, WG
Stolzia gandiflora	3	BA, SD, WG
Eulophia abyssinica	-	-
Eulophia albobrunnea	6	SD, KF, SU
Diphananthe candida	1	KF
Cyrtorchis erythrareae	2	KF, SD

2) and Gojam (*ca.* 2) are floristic regions arranged in the declining sequence of endemic species specimen representation. The rest of the floristic regions have no records of specimens of endemic orchids (Table 3).

Discussion

Orchidaceae is the fifth largest and diverse family of monocots in the flora area and the documentation of the orchids of Ethiopia and Eritrea had started many years ago (Tournary, 1972). The earliest orchid specimen recorded is *Holothrix squmata*, collected a year after the establishment of the National Herbarium (ETH). The current total of *ca.* 665 orchid collections in ETH are relatively greater in proportion when compared to collections of other "Lily" families in wider sense: Asphodelaceae, Alliaceae, Eriospermaceae, Colchicaceae and others (National Herbarium, 2003). This may be attributed to the diversity and probably the popularity orchids have with collectors, and showy and beautiful flowers. After the publication of the orchid account in the Flora of Ethiopia and Eritrea, Vol. 6 (Cribb and Thomas, 1997), inadequate understanding of the orchids in the flora area has subsequently been stressed (Cribb *et al.*, 2001, 2002; Sebsebe *et al.* , 2003). This is due to the inadequate exploration made in the past and exemplified by the fact that many of the flora area are poorly represented in the herbaria. What authorities reported agrees with the findings of this piece of work as many of the orchids are found to be known from one or few fragmentary collections in the National Herbarium and was later evidenced by discovery of new species: *Vanilla roscheri* (Bidgood and Cribb, 1999) from Gamo Gofa region, one of the under explored floristic regions and poorly represented in the National Herbarium. Several new records have also been made subsequently in more targeted collection in Welega floristic region (Cribb *et al.*, 2002). Except for Gonder and Upland Shewa, regions poorly represented in herbarium specimens are those with lowest number of orchid species reported. However, some deviations are

observed when comparison is made with relatively better collected and represented regions. According to Cribb *et al.* (2001), regions in declining sequence of number of species reported are Kefa, Sidamo, Upland Shewa, Gonder, Upland Tigeray, and Welega. However, in declining sequence of the number of orchid collections in the National Herbarium are Upland Shewa (*ca.* 160), Welega (*ca.*125), Kefa (*ca.*106), Sidamo (*ca.*70) and Bale (ca.36). These deviations may be due to the reason that Upland Shewa is the floristic region where Addis Ababa is located, and therefore, the region where the most intensive collecting activity had taken place. The other reason seems to be intensive orchid targeted collection in years 2000 and 2001 in the Welga floristic region that has increased its representation in the National Herbarium.

The majority of Ethiopian orchids are terrestrials occurring in woodlands and grasslands and only 20% are epiphytes (Cribb *et al.*, 2001). Representation of orchid specimens in terms of habitat types collected agree with the above report in that *ca.* 472 specimens (73.8%) are terrestrials inhabiting dry and wet habitats (including rocky and cliffy areas) and *ca.* 167 specimens (26.2%) collected are epiphytes of forests and woodlands. Not only with taxa, floristic regions, habitat types and habit classes, but orchid collections in the National Herbarium also vary with respect to the altitudinal zone collected. The altitudinal distribution of orchid specimens recorded more or less follow similar pattern as investigated by Friis *et al.* (2001) for the entire flora. It gradually increased with altitude and show concentration at mid-altitude and gradually decline with further increase in altitude. As true for all orchids of the flora area, endemic orchids are also poorly represented in the National Herbarium collections. The current physical collection representing endemic orchids amounts to nearly 75 with 8 species lacking records. Cribb and Thomas (1997) in their orchid account reported Sidamo (*ca.* 16), Upland Shewa (*ca.*12), Gonder (*ca.* 11), Kefa (*ca.* 10), and Upland Tigray (*ca.* 8) to be floristic regions with relatively highest concentration of orchid endemics. Nevertheless, endemic species in these floristic regions are under-explored and hence poorly represented in the National Herbarium. The study therefore suggests that specialized field studies are most likely to add new species and hence new records of orchids in the flora area as well as in the floristic regions of Ethiopia and Eritrea. Further, a perfect documentation of the orchid specimens together with details of species accounts for both the countries is essentially required in order to better understand the distribution of orchids in relation to their distribution elsewhere in the world.

Conclusions

Orchidaceae is one of the most popular families of the flowering plants because of their horticultural, food, and medicinal value. In many part of the world, orchids have been widely used as educational tool, particularly the showy and rare ones, in raising public awareness to the importance of plant conservation. They are also used as indicator plants to select habitat or area for conservation priority. Despite these, the significance of orchids of the flora area is not well exploited and studied for their value by the community; nor does it reflect in conservation efforts of the country's flora. Herbarium specimens are crucial information source for taxonomic, ecological and conservation researches of plants. However, orchid taxa of the flora area (including the endemics) are poorly represented in the National Herbarium, the most active and sole botanical information center in the country. Similarly, it is also reported in the literature that orchids of the flora area are also poorly represented in other herbaria elsewhere. Their conservation status is not yet assessed. The current threats to their habitats are not well understood and studied. Nevertheless, instant intensive exploration targeted on orchids in the recent years by senior botanists to some of the floristic regions has added new species and new records. These discoveries have allowed a better understanding of some of the species previously known from rather poor and fragmentary collections. Hence, it is important to conduct detailed field surveys to the floristic regions and make collections of orchids in the flora area. These will enable on one hand to have better knowledge of the status and ecology of orchids in these countries and on the other hand to enrich the herbarium collections. It is also expected that such field works will add new species and new records.

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