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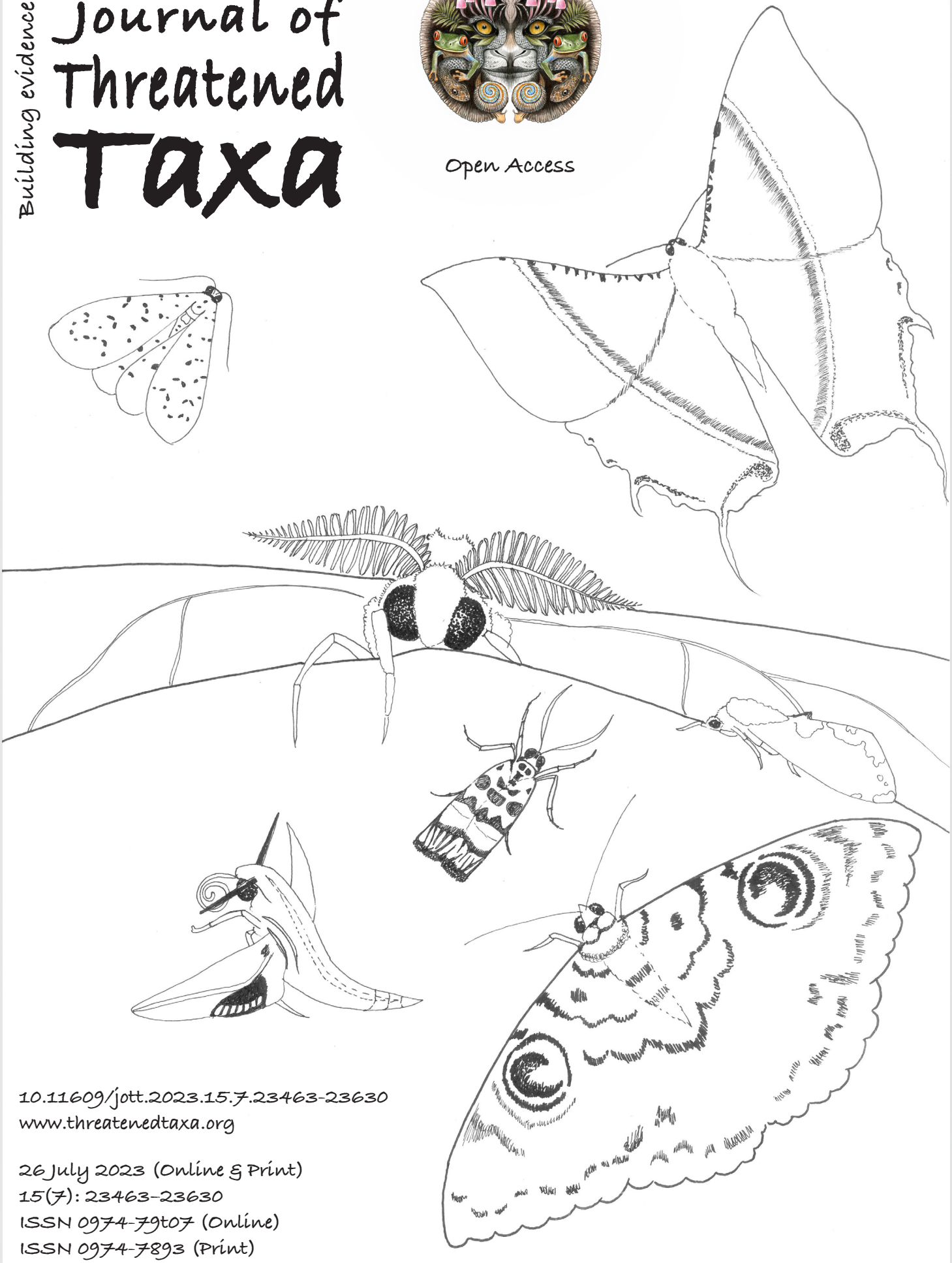

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Registered Office: 3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Ph: +91 9385339863 | www.threatenedtaxa.org
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Cover: Celebrating the unsung heroes—moths, our nocturnal pollinators. © Priyanka Iyer.

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COMMUNICATION

Checklist of the genus *Dendrobium* Sw. (Orchidaceae) in Manipur, India

Hidangmayum Bishwajit Sharma [1] & **Debjyoti Bhattacharyya** [2]

[1,2] Plant Taxonomy and Biosystematics Laboratory, Department of Life Science & Bioinformatics, Assam University, Silchar, Assam 788011, India.

[1] Present address: Nachou Mayai Leikai, Bishnupur District, Manipur 795126, India.

[1] hbishwajitsharma@gmail.com, [2] debjyoti_bsi@yahoo.co.in (corresponding author)

Abstract: An enumeration of the genus *Dendrobium* Sw. (Orchidaceae) in Manipur, India was attempted. Literature review revealed the occurrence of 67 species under the genus from the state. The study was carried out through repeated field explorations in different natural forests of Manipur since 2012. Out of the total taxa reported from the state, only 42 species could be traced in the field. All these taxa are presented here with their flowering phenology and places of occurrence. Twenty-five species were untraceable in the field; however, nine species out of these 25 are represented by authentic herbarium specimens and supported by published documents. The remaining 16 species were reported only in literature, but no live plants or herbarium specimens were found. Out of the 42 species inventoried from the field, many taxa are under threat owing to habitat loss due to felling of trees, deforestation, and 'jhum' cultivation. So, there is an urgent need of conservation of those species through in situ and ex situ means for their sustenance. A photographic plate of some taxa is provided here which might be useful for their easy identification in the field and for taking care of their conservation. Large-scale uses of these species as cut flowers and indoor & outdoor plants may be practised through micropropagation and cultivation in nurseries which may help in revenue generation for the state.

Keywords: conservation, inventorization, northeastern India, orchid, threats.

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Author details: Dr. Hidangmayum Bishwajit Sharma did his research on the morpho-taxonomic studies on the genus *Dendrobium* in Manipur and was awarded PhD under the supervision of Dr. Debjyoti Bhattacharyya. Presently, he is serving as a Government employee under the State Government of Manipur. Dr. Debjyoti Bhattacharyya is an associate professor in the Department of Life Science & Bioinformatics, Assam University, Silchar. He acted as the supervisor of Dr. H. Bishwajit Sharma.

Author contributions: First author (HBS) collected the specimens from the field, worked out, identified, prepared the specimens for the herbarium and drafted the manuscript. Corresponding author (DB) supervised the work, checked the manuscript and communicated it to the journal.

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INTRODUCTION

The members of Orchidaceae Juss. are well known in the world for their beautiful and ineffable flowers of different colours, hues, and forms. Taxonomically, Orchidaceae is one of the most diversified and evolved families of flowering plants (Kumar & Manilal 1994). There is a vast range of diversity in the shape, colour, and size of orchid flowers; yet they are the same in their basic form (Pradhan 2005). Theophrastus (370–285 B.C.) named the group of bizarre plants as 'Orchids' finding resemblance of below-ground paired tubers with male testicles.

Dendrobium Sw. is the second largest genus of the family Orchidaceae after *Bulbophyllum* Thouars. It was established by Olavo (Peter) Swartz in 1799. The name was derived from the Greek words 'dendron' (tree) and 'bios' (life) which means 'one who lives on trees', or essentially 'epiphytes'. The genus is divided into 14 sections, viz.: *Bolbidium*, *Callista*, *Dendrobium*, *Breviflores*, *Formosae*, *Stachyobium*, *Pedilonum*, *Distichophyllum*, *Rhopalanthe*, *Aporum*, *Oxystophyllum*, *Strongyle*, *Grastidium,* and *Conostalix* (Seidenfaden 1985). The genus is sympodial with varying length of pseudobulbs. Most of the species are generally epiphytic or occasionally lithophytic in nature. They have adapted themselves to a wide variety of habitats starting from high altitudes to lowland tropical forests. They remain dormant during winter but quickly grow in summer. In spring, occasionally in autumn, dormant buds come out from the base of the pseudobulb followed by fast growth of new roots. Most of the Dendrobiums flower during the pre-monsoon season (March–May) and a few species blossom in the post-monsoon period. Capsules are produced late in the dry season (August–December).

The genus *Dendrobium* comprises about 3,160 species (Govaerts et al. 2022) with high morphological diversity and is mainly distributed in Sino-Himalayan regions with further extension up to Australia, New Zealand, and Pacific Islands (Wood 2006). In India, the genus is represented by c. 117 species (Rao 2022), of which, about 88 species are found in northeastern India (Rao 2018).

A checklist of the genus *Dendrobium* in Manipur was prepared from different literature (Mukerjee 1953; Deb 1956, 1957, 1960, 1961; Phukan 1996; Chauhan 2001; Kumar & Kumar 2005; Nanda et al. 2012, 2013, 2014; Kishor et al. 2013; Meitei et al. 2014; Khuraijam et al. 2016; Deori et al. 2019), which documents the occurrence of 67 species in the state.

MATERIALS AND METHODS

Study area

The state of Manipur, a part of Indo-Burma Biodiversity Hotspot, is bounded by Nagaland in the north, Mizoram in the south, Assam in the west, and Myanmar (Burma) in the east as well as in the south (Image 1). The state lies between the coordinates $23^0 83'$–$25^0 68'$ N and $93^0 03'$–$94^0 78'$ E. The total geographical area covered by the state is 22,327 km^2. The total forest cover of Manipur is 17,219 km^2, which is 77.12% of the total geographical area of the state. The state lies in a unique geographical position between the virtual meeting point of India and southeastern Asia (Singh 2014) with a total boundary of 854 km length. The altitude varies 50–3,000 m.

Based on the topography, structure, geology, the location's relief, and other geographical conditions, Manipur can be divided into two major natural physiographic divisions, viz.: (i) The Manipur hills and mountains and (ii) The Manipur valleys. Five major types of forests are prevalent in the state. These are: 1. Subtropical semi-evergreen forests, 2. Subtropical deciduous forests, 3. Montane wet temperate forests, 4. Subtropical pine forests, and 5. Subtropical dry temperate forests (Singh 2014).

Field survey and data collection

For the present study, several field explorations were conducted in different places of Manipur since 2012 (Table 1). Field surveys were made covering all seasons, although pre-monsoon and post-monsoon are the best collection seasons for the orchids especially for the genus *Dendrobium*. Locations were noted with their altitudes and geographical coordinates. A total of 58 sites were visited (Table 1). Surveys were conducted for at least 3–5 days at each location.

Identification of species

After collection, identification of species was done using standard methods of morpho-taxonomic studies. Flowers were dissected and critically studied under Stereo Zoom dissecting microscope (Olympus SZ61). Species without flowering were collected in a vegetative stage and grown in the nursery of the orchidarium of Centre for Orchid Gene Conservation of Eastern Himalayan Region (COGCEHR), Hengbung, Kangpokpi district, Manipur. These species were studied after they bloomed in the orchidarium. Morphological attributes were noted and identification of the species for all taxa were made using primary and secondary sources of

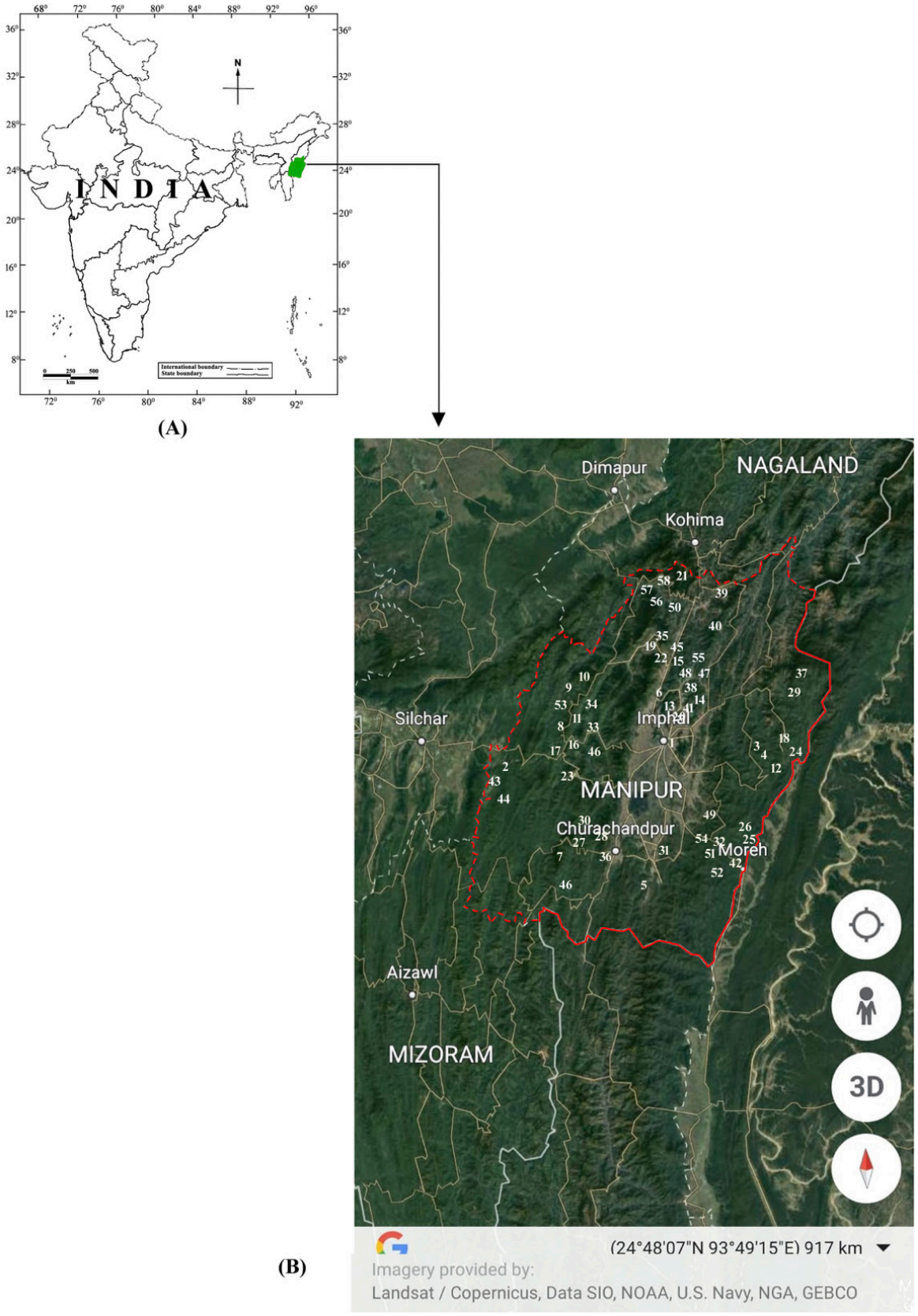

Image 1. A—Map of India showing study area | B—A Google Earth map (Data SIO, NOAA, U.S.Navy, NGA, GEBCO © 2017 Google) showing specific collection sites in the study area Manipur (Image taken on 08 April 2023 at 1405 h). (Corresponding Table 1 is referred for locality names).

Table 1. List of localities with their elevational range. Locality number corresponds to numbers in Image 1. (partly reproduced from Sharma, 2019).

	Sites of occurrence	Elevation range (in m)
1.	Baruni Hills	1100–1400
2.	Bidyanagar	50–60
3.	Bungpa Khullen	1100–1400
4.	Bungpa Khunou	1100–1400
5.	Chakpikarong	700–900
6.	Changoubung Nepali Khul	1250–1750
7.	Chiru	1000–1300
8.	Chiulon	1000–1328
9.	Dailong Cemetery	950–1260
10.	Dailong Rangan	900–1200
11.	Duigailong	1050–1350
12.	Grihang	1000–1300
13.	Haipi	1100–1500
14.	Hengbung	950– 1168
15.	Injolum	970–1200
16.	Kahulong	950–1260
17.	Kaikao	700–1000
18.	Kamjong	1230–1500
19.	Kapung Hill	1540–1752
20.	Keithelmanbi	900–1100
21.	Kenelu	1741–1832
22.	Khajinglok	1200–1450
23.	Khongsang	400–700
24.	Kongkan	1000–1300
25.	Kwatha	400–540
26.	Kwatha khulen	450–590
27.	Laimaton	1100–1600
28.	Lamdan	900–1300
29.	Langli	1500–2000
30.	Leimatak	450–600
31.	Litan Village	800–1010
32.	Lokchao	400–500
33.	Longchum	500–800
34.	Longku	1000–1250
35.	Lungdi Hill	1580–1942
36.	Majuron	900–1400
37.	Maku	1200–1500
38.	Malingli	1450–1600
39.	Mao	1200–1798
40.	Maram Khunuo	900–1345
41.	Mayangkhang	900–1150
42.	Moreh	400–550
43.	New Alipur	50–70
44.	Ningshingkhul	50–70
45.	Oklong	1350–1760
46.	Rangkhung	800–1100
47.	Sadim Pukhri	1300–1570
48.	Sadim Village	1250–1450
49.	Saivom Village	1300–1450
50.	Sangkungmai	990–1779
51.	Sinam Village	1350–1550
52.	Songpiyang	420–500
53.	Tamenglong	1000–1450
54.	Tengnoupal	1050–1400
55.	Tringalung	1420–1512
56.	Willong	955–1756
57.	Willong Khunou	850–1028
58.	Yangkhulen	970–1800

information, i.e., flora, monographs, articles, and books (Hooker 1890; Seidenfaden 1985; Kumar & Kumar 2005; Wood 2006; Lucksom 2007). Identity of the species was further confirmed by matching the specimens with the types and authentic herbarium specimens housed in the Central National Herbarium, Botanical Survey of India, Howrah (CAL) and Eastern Regional Centre, Botanical Survey of India, Shillong (ASSAM). Online databases, viz., The International Plant Names Index (IPNI 2022), Plants of the World Online (POWO 2022), Tropicos (2022), and The World Flora Online (WFO 2023) were consulted for updated nomenclature. Global Biodiversity Information Facility (GBIF 2023) was also browsed for digital images of species. Jain & Rao (1977) and Singh & Subramaniam (2008) were followed for preparation of herbarium sheets. Specimens were deposited in the Central Herbarium of Assam University, Silchar (AUSCH), Assam.

RESULTS

Out of the 14 sections of the genus *Dendrobium* (Seidenfaden 1985), species occurring in the state of Manipur are represented by eight sections (Table 2). In the field, the authors could locate only 42 species out of the 67 species recorded earlier from the state. Among these, 25 species could not be found in the wild, nine species are represented by herbarium specimens and

Table 2. List of species of *Dendrobium* located in their natural wild habitats in Manipur with flowering phenology, occurrence, and exsicata.

	Sections	Scientific name	Phenology	Voucher specimen(s)	Occurrence*
1.	Callista (Lour.) Schltr.	*Dendrobium chrysotoxum* Lindl.	April–June	H. Bishwajit Sharma 001,041,056	25, 47, 50
2.		*Dendrobium densiflorum* Lindl.	April–June	H. Bishwajit Sharma 002,010,011,080	57, 8, 17, 37
3.		*Dendrobium jenkinsii* Wall. ex Lindl.	March–June	H. Bishwajit Sharma 003,051,052,057	56, 26, 2, 43
4.		*Dendrobium lindleyi* Steud.	March–April	H. Bishwajit Sharma 012	31
5.	Formosae (Benth. & Hook.f.) Hook.f.	*Dendrobium draconis* Rchb.f.	June–July	H. Bishwajit Sharma 071	51
6.		*Dendrobium formosum* Roxb. ex Lindl.	August–September	H. Bishwajit Sharma 023	16
7.		*Dendrobium infundibulum* Lindl.	March–April	H. Bishwajit Sharma 072	54
8.		*Dendrobium longicornu* Lindl.	August–September	H. Bishwajit Sharma 008	58
9.		*Dendrobium tamenglongense* R.Kishor, Y.N.Devi, H.B.Sharma, J.Tongbram & S.P.Vij	July–September	Nanda 00510	16
10.		*Dendrobium williamsonii* Day & Rchb.f.	March–April	H. Bishwajit Sharma 045,049,088	47, 6, 24
11.	Breviflores Hook.f.	*Dendrobium bicameratum* Lindl.	July–August	H. Bishwajit Sharma 022,040,048	27, 14, 23
12.		*Dendrobium stuposum* Lindl.	June–July	H. Bishwajit Sharma 087	4
13.	Dendrobium	*Dendrobium amoenum* Wall ex Lindl.	May–June	H. Bishwajit Sharma 081	18
14.		*Dendrobium aphyllum* (Roxb.) C.E.C.Fisch.	March–April	H. Bishwajit Sharma 013,014,047,076	6, 53,11,1
15.		*Dendrobium bensoniae* Rchb.f.	June–July	H. Bishwajit Sharma 058	25
16.		*Dendrobium brymerianum* Rchf.f.	July–August	H. Bishwajit Sharma 027	45
17.		*Dendrobium capillipes* Rchb.f.	April–May	H. Bishwajit Sharma 034,035	36, 7
18.		*Dendrobium chrysanthum* Wall. ex Lindl.	August–September	H. Bishwajit Sharma 077,082	1, 12
19.		*Dendrobium crepidatum* Lindl. & Paxton.	April–May	H. Bishwajit Sharma 015,028,036,083	22, 3, 7, 19
20.		*Dendrobium crystallinum* Rchb.f.	April–May.	H. Bishwajit Sharma 059,060	42, 52
21.		*Dendrobium denneanum* Kerr.	May–June	H. Bishwajit Sharma 061,062,063	25, 49, 32
22.		*Dendrobium devonianum* Paxton.	April–May	H. Bishwajit Sharma 016,029,042	47, 46, 40
23.		*Dendrobium falconeri* Hook.	May–June	H. Bishwajit Sharma 030,043,064	55, 48, 52
24.		*Dendrobium fimbriatum* Hook.	April–May	H. Bishwajit Sharma 004,005,017	35, 33, 21
25.		*Dendrobium gibsonii* Paxton.	July–August	H. Bishwajit Sharma 018,084	34, 3
26.		*Dendrobium heterocarpum* Wall. ex Lindl.	April–May	H. Bishwajit Sharma 065,066,067	26, 54, 49
27.		*Dendrobium lituiflorum* Lindl.	April–May	H. Bishwajit Sharma 006,053,085	56, 4, 44
28.		*Dendrobium moschatum* (Buch.-Ham.) Sw.	June–July	H. Bishwajit Sharma 068,069	25, 42
29.		*Dendrobium nobile* Lindl.	March–April	H. Bishwajit Sharma 031,078,090,091	1, 13, 20, 39
30.		*Dendrobium ochreatum* Lindl.	April–May	H. Bishwajit Sharma 019,032,037,054	9, 2, 28, 39
31.		*Dendrobium parishii* Rchb.f.	May–June	H. Bishwajit Sharma 086	18
32.		*Dendrobium polyanthum* Lindl.	March–April	H. Bishwajit Sharma 007,020,038,044,079	57, 38, 1, 30, 17
33.		*Dendrobium pulchellum* Roxb. ex Lindl.	May–June	H. Bishwajit Sharma 070	26
34.		*Dendrobium transparens* Wall. ex Lindl.	May –June	H. Bishwajit Sharma 021,055	2, 5
35.		*Dendrobium wardiamum* R.Warner	April–May	H. Bishwajit Sharma 039	27
36.	Stachyobium Lindl.	*Dendrobium denudans* D.Don.	September–October	H. Bishwajit Sharma 009,024	58, 16
37.		*Dendrobium eriiflorum* Griff.	September–October	H. Bishwajit Sharma 073,089	29, 51
38.		*Dendrobium sinominutiflorum* S.C.Chen, J.J.Wood & H.P.Wood.	September–October	H. Bishwajit Sharma 033	45
39.	Pedilonum (Bl.) Lindl.	*Dendrobium cumulatum* Lindl.	July–August	H. Bishwajit Sharma 074	25
40.		*Dendrobium parcum* Rchb.f.	March–April	H. Bishwajit Sharma 025,050	10, 41
41.	Aporum (Bl.) Lindl.	*Dendrobium spatella* Rchb.f.	August–September	H. Bishwajit Sharma 026,075	25, 53
42.	Grastidium (Bl.) J.J.Smith	*Dendrobium salaccense* (Blume) Lindl.	March–April	H. Bishwajit Sharma 046	15

*For locality identification, refer to Table 1 and Image 1

Table 3. *Dendrobium* species represented only by herbarium specimens

	Scientific name	Locality	Voucher specimen
1.	*Dendrobium bellatulum* Rolfe	Senapati Hills, Senapati district, Manipur	A. A. Mao & R. Gogoi 111162 (ASSAM !)
2.	*Dendrobium cariniferum* Rchb.f.	Sirohi forests, Ukhrul District, Manipur	G. Watt 6500 (CAL !).
3.	*Dendrobium delacouri* Guillaumin	Yangoupokpi Lokchao Wildlife Sanctuary, Chandel district, Manipur	N.N. Rabha & L.R. Meitei 131115 (ASSAM !)
4.	*Dendrobium dickasonii* L.O.Williams	1500 m, Manipur	U.C.Pradhan 27 (K, Digital Image !)
5.	*Dendrobium kentrophyllum* Hook.f.	Sangaithel, Senapati district, Manipur	J.S. Khuraijam 302107 (LWG, Photo !)
6.	*Dendrobium moniliforme* (L.) Sw.	Phungum, Manipur	S. K. Mukerjee-2855 (CAL !)
7.	*Dendrobium monticola* P.F.Hunt & Summerh.	Karong, 3500 ft., Manipur	Thakur Rup Chand 3730 (MICH, Digital Image !)
8.	*Dendrobium porphyrochilum* Lindl.	Ukhrul, Ukhrul district, Manipur	S. K. Mukerjee 3420 (CAL !)
9.	*Dendrobium wattii* (Hook.f.) Rchb.f.	*s.l., s.d*, Manipur	G. Watt 5944 (CAL !)

authenticated by published documents (Table 3) and 16 species were mentioned in literature without any representative specimens from Manipur (Table 4).

All the collected species by the authors are presented here with their scientific and vernacular names, phenology, distribution in the state (Table 2). Photographs of the species which are very rare in the field are provided to ease the identification of the taxa.

Among the 42 collected species from the state under eight sections, the dominant section was *Dendrobium* which was represented by 23 species. It was followed by the section *Formosae* (6 spp.), *Callista* (4 spp.), *Stachyobium* (3 spp.), *Breviflores* (2 spp.), and *Pedilonum* (2 spp.). Sections *Aporum* and *Grastidium* were found to be represented by a single species each. Some species like *D. chrysanthum*, *D. chrysotoxum*, and *D. crepidatum* were very common throughout the state. In contrast, *D. bensoniae, D. capillipes, D. lindleyi, D. salaccense,* and *D. tamenglongense* were rare in the study area in some localized pockets.

Table 4. List of reported *Dendrobium* species not traced in the field condition as well as in the herbaria; only known from earlier literature.

	Scientific name	Reference of the report
1.	*Dendrobium acinaciforme* Roxb.	Deori et al. (2019)
2.	*Dendrobium aduncum* Lindl.	Deori et al. (2019)
3.	*Dendrobium anceps* Sw.	Deori et al. (2019); Kumar & Kumar (2005)
4.	*Dendrobium dantaniense* Guillaumin	Deori et al. (2019)
5.	*Dendrobium farmeri* Paxton	Deori et al.(2019); Kumar & Kumar (2005)
6.	*Dendrobium gratiosissimum* Rchb.f.	Deori et al. (2019); Kumar & Kumar (2005)
7.	*Dendrobium hookerianum* Lindl.	Deori et al. (2019)
8.	*Dendrobium jaintianum* Sabap.	Deori et al. (2019)
9.	*Dendrobium khasianum* Deori	Deori et al. (2019)
10.	*Dendrobium linguella* Rchb.f.	Deori et al. (2019); Kumar & Kumar (2005)
11.	*Dendrobium mannii* Ridl.	Deori et al. (2019)
12.	*Dendrobium numaldeorii* C.Deori, Hynn. & Phukan	Deori et al. (2019)
13.	*Dendrobium peguanum* Lindl.	Deori et al. (2019)
14.	*Dendrobium pendulum* Roxb.	Deori et al. (2019); Kumar & Kumar (2005)
15.	*Dendrobium sulcatum* Lindl.	Deori et al. (2019)
16.	*Dendrobium thyrsiflorum* B.S.Williams	Deori et al. (2019); Kumar & Kumar (2005)

DISCUSSION

Manipur, a part of the Indo-Burma Biodiversity Hotspot (Myers et al. 2000), is one of the orchid rich states in northeastern India. Owing to its geographical location, serene forest cover, and humid climatic conditions, the state is blessed with rich plant genetic resources including orchids. Out of the 67 species reported from the state, only 42 species were seen in the field during this study. Further field surveys are needed to confirm the occurrence of the rest of the 25 species in the state.

Epiphytic *Dendrobium* species are found growing on trunks of small and large trees in tropical and sub-tropical forests in association with other orchid species viz. *Bulbophyllum candidum, B. careyanum, B. cariniflorum, B. gamblei, B. sunipia, Coelogyne corymbosa, C. griffithii, C. nitida, Cymbidium aloifolium, C. erythraeum, Pholidota articulata, P. imbricata, Pinalia acervata*, and *P. amica*.

Few *Dendrobium* species, viz., *Dendrobium aphyllum*, *D. crepidatum, D. devonianum, D. fimbriatum* and *D. nobile* grew as epiphytic as well as lithophytic conditions in tropical and sub-tropical forests.

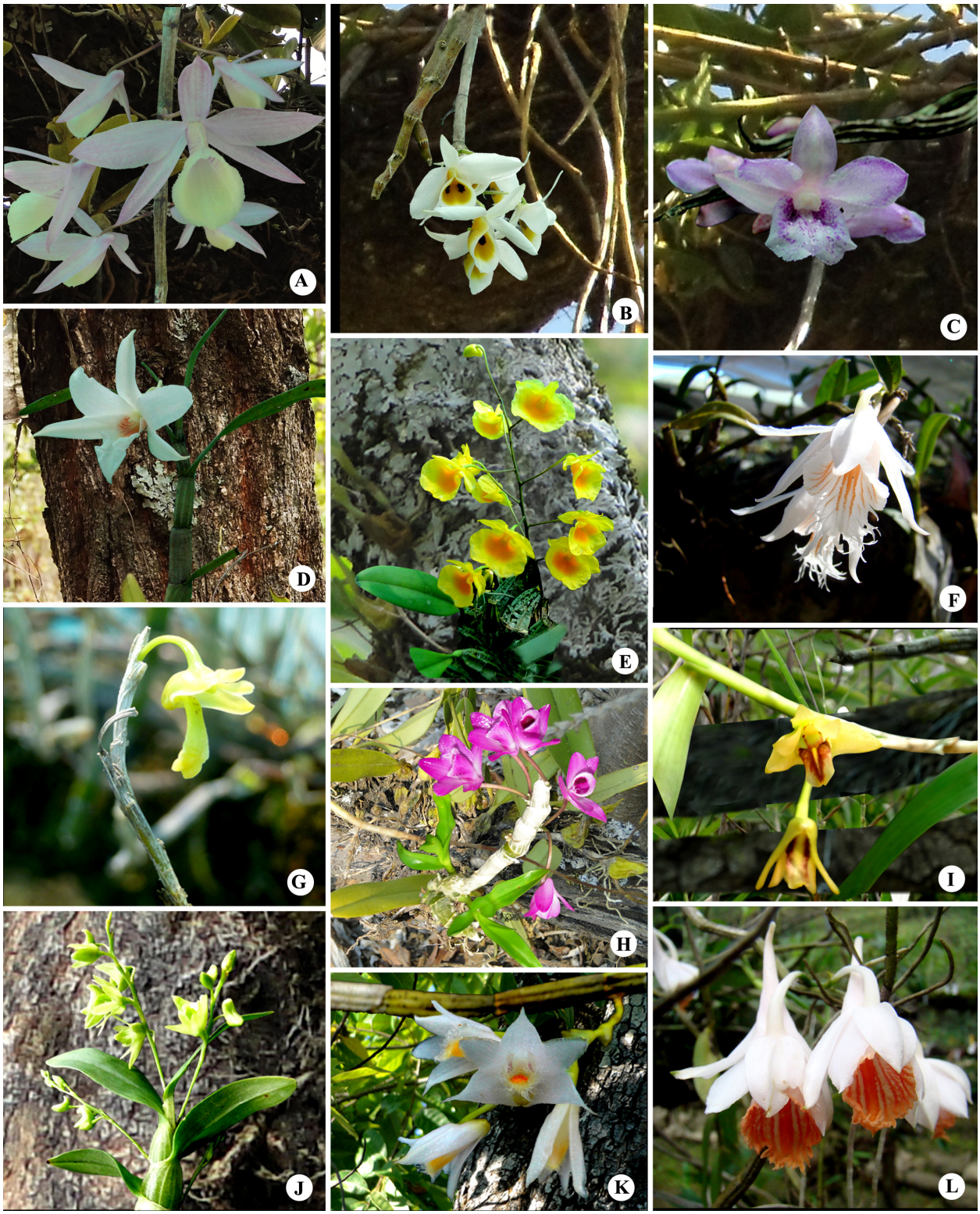

Image 2. A—*Dendrobium aphyllum* | B—*Dendrobium bensoniae* | C—*Dendrobium cumulatum* | D—*Dendrobium draconis* | E—*Dendrobium lindleyi* | F—*Dendrobium longicornu* | G—*Dendrobium parcum* | H—*Dendrobium parishii* | I—*Dendrobium salaccense* | J—*Dendrobium sinominutiflorum* | K—*Dendrobium stuposum* | L—*Dendrobium tamenglongense*. © H. Bishwajit Sharma.

Some of the host tree species of *Dendrobium*s in Manipur are *Artocarpus chaplasha*, *Bauhinia purpurea*, *Mangifera indica*, *Michelia champaca*, *Quercus serreta*, *Schima wallichii, Terminalia elliptica*, and *Toona ciliata*.

Loss of natural habitats particularly due to tree felling, shifting (Jhum) cultivation practices, construction of hydro-electric dam, railway tracks, and other urbanization practices cause rapid loss of plant genetic resources. As most of the species are epiphytic, illegal trade of timber species also affect their natural habitats resulting in their extermination from the field. So, for survival of the species, continuous monitoring is mandatory at regular interval. As most of the species are very showy, ex situ cultivation is suggested for revenue generation.

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