

## **NATIVE VASCULAR FLORA OF BEHALI RESERVE FOREST (ASSAM, INDIA) WITH GLOBAL IUCN RED LIST ASSESSMENT OF TWO ENDEMIC SPECIES**

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**Abstract:** The investigations of flora and fauna in Protected Areas provide important contributions to the knowledge on the status of unmanaged natural ecosystems. In 2017–2019, we studied the vascular plant flora of Behali Reserve Forest (Assam, India). The reserve forest covers 140.16 km<sup>2</sup> area of semi-evergreen forest. We investigated the taxonomic composition of the flora and diversity of growth forms of species and habitats. In addition, we conducted global IUCN Red List assessment of two endemic species, *Aristolochia assamica* and *Chlorophytum assamicum*. We found that the vascular plant flora of Behali Reserve Forest consists of 281 taxa, including 272 species, one subspecies and eight varieties. They belong to 206 genera and 79 families. Among them, *Pandanus unguifer* was recorded for the first time for the flora of Assam. In growth form spectrum of vascular plants, trees, vines and shrubs predominated, followed by epiphytes, forbs or herbs, geophytes, annuals and parasites. The largest number of vascular plants was found in dense forests, while open habitats were characterized by the smallest species richness. *Chlorophytum assamicum* is assessed as CR B1ab(iii)+2ab(iii); D, and *Aristolochia assamica* as EN B2ab(iii). At the same time, there is a threat of reduction or disappearance of their populations. This is especially crucial for *C. assamicum*, represented by a single world population. Undoubtedly, further investigations of flora could result in an increase in number of the vascular plant flora of Behali Reserve Forest, as well as providing essential insights into population trends of several other species as per IUCN Red List categories and criteria.

**Keywords:** angiosperms, checklist, foothills, Himalayas, Protected Area, threat status.

### **Introduction**

About 15% of tropical forests play the primary role of biodiversity protection [40] and cover 40% of the world's wooded areas. Similarly, these tropical forests harbour a considerable proportion of global biodiversity [17, 47, 14, 30]. They occupy about 48,295 km<sup>2</sup> (7.72%) of the forests of India [42]. The state of Assam comprises diverse vegetation types, hosting a rich biodiversity. Apart from the tropical semi-evergreen forests, several other forest types such as deciduous forests, evergreen forests and swamp forests are prevalent in the region. The *Flora of Assam* [29] still acts as a comprehensive account for the vascular plants of the entire Northeastern India. However, later it was supplemented by several sporadic publications [16, 37, 3, 2], but there is still a lack of accurate data on plant diversity from numerous sub-regions of Assam, including the Protected Areas.

At present, Protected Areas are considered to be the main tool for *in situ* conservation and restoration [21, 28] of biodiversity around the world. In India, the Protected Area network covers 5.02% of the whole geographical area of country, including 104 national parks, 551 wildlife sanctuaries, 88 conservation reserves and 127 community reserves [35]. Although there are several publications on the biodiversity of Protected Areas in Assam, the understanding of its status and diversity still remains incomplete [36]. Among the Protected Areas network, Reserve Forests are the least protected and are generally under very high anthropogenic pressure. So far, little is known about the biological diversity of these Reserve Forests in India, including in the state of Assam. To date, the biodiversity of the several Protected Areas of India is underestimated and such is the case of Behali Reserve Forest (**BRF**). Recently, three new taxa, *Chlorophytum assamicum* D.Borah & A.P.Das, *Aristolochia assamica* D. Borah & T.V. Do, and *Peliosanthes macrophylla* var. *assamensis* N.Tanaka & D.Borah, were described from BRF and *Tupistra stoliczkan* Kurz was re-discovered after more than a century [8, 9, 10, 11]. In addition, the existence of a wild *Citrus indica* Yu.Tanaka population has been reported in this Protected Area, although it was previously reported to be extinct in the state of Assam [7]. These reports underpin the need for study of these reserve forests and for analysis of their role in protection of several important and endangered biodiversity elements.

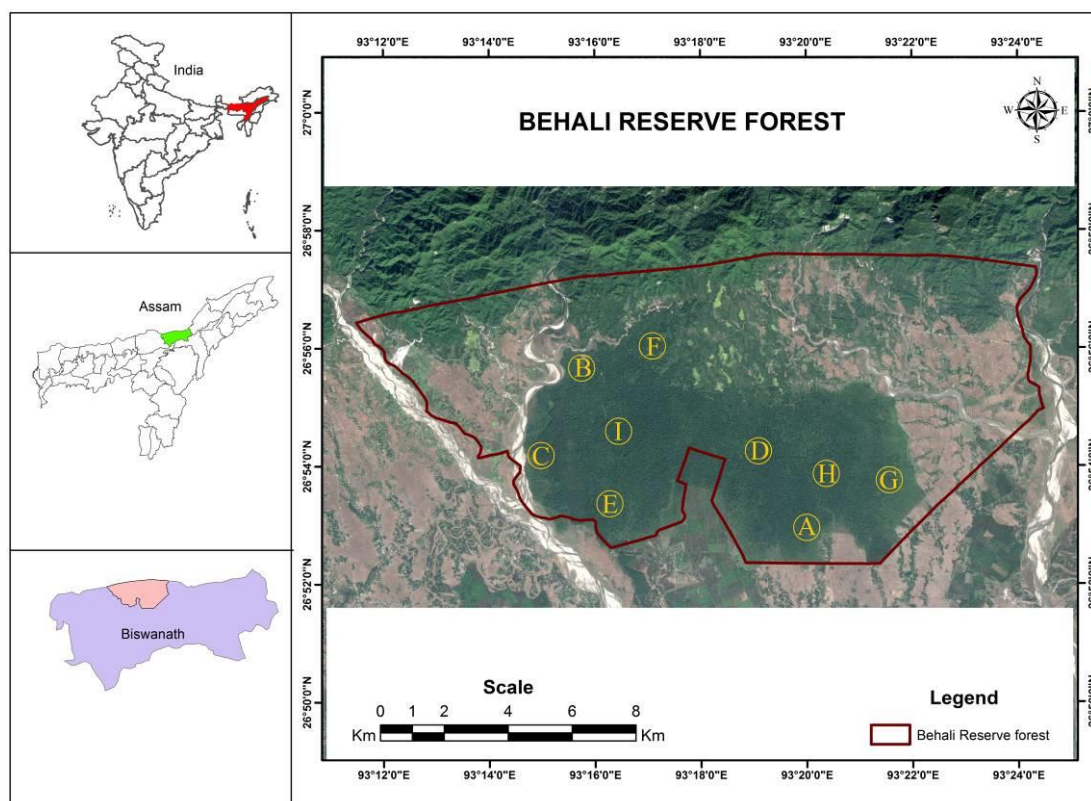
The present study was aimed to study the vascular flora of BRF with special focus on accessing global IUCN Red List status for two endemic plant species.

## Material and Methods

### *Study area*

BRF is located in the outermost foothills of the Eastern Himalaya (Fig. 1). It is a part of the Kameng-Sonitpur Elephant Reserve that also includes other Protected Areas of Assam (Balipara Reserve Forest, Charduar Reserve Forest, Nowduar Reserve Forests, Nameri Tiger Reserve) and Arunachal Pradesh (Eagle Nest Wildlife Sanctuary, Pakke Tiger Reserve, Sessa Orchid Sanctuary and Reserve Forests of Khellong Forest Division, Sonai-Rupai Wildlife Sanctuary) [31]. Together with the Kaziranga National Park on its south, BRF acts as a corridor for different animals to the highlands during floods. So far very few floristic studies have been conducted in the Biswanath district [15, 4, 45] and a general account on the local biodiversity of BRF have been published [44] with no mention of its unique flora.

The area of BRF covers 140.16 km<sup>2</sup> of semi-evergreen forest [46], that falls under the Biswanath district of Assam state, India sharing its boundaries with Buroi River in the East, Borgang river and Singlijan Reserve Forest in the West, Papum Reserve forest in the North, and tea plantations and human habitations in the South [44]. It comprises mostly of plains between 26.866667°–26.950000°N and 93.250000°–93.416667°E and a series of hills on its extreme north. The mean annual temperature is 24.8°C and mean annual precipitation is 1800 mm. The altitude ranges between 90 m a.s.l. to 110 m a.s.l. [44].



**Fig. 1:** Map of Behali Reserve Forest and main study sites (defined by letters).

### *Floristic data sampling and analysis*

Extensive floristic surveys were conducted from April 2017 to August 2019. In total, nine study sites were sampled during the field surveys (Fig. 1, Table 1). The Latin names of plants are based on the database POWO [41]. Collected herbarium specimens were identified using available determinant keys [22, 29]. The confusing taxa were identified with the help of taxonomic group specialists. The voucher specimens collected were later processed and mounted into herbarium sheets following the methods of Jain & Rao [27], and then deposited in HAU (Herbarium of Rajiv Gandhi University, India).

**Table 1:** Description of the study sites in the Behali Reserve Forest.

Site	Dates of the surveys	Protected Area; study site location	Co-ordinates; altitude
A	July 2017; April 2019	Behali Reserve Forest; Bongaon	26.882361°N, 93.333528°E; 103 m a.s.l.
B	June 2018; April 2019	Behali Reserve Forest; Dikal	26.926944°N, 93.267917°E; 98 m a.s.l.
C	April 2017; August 2018	Behali Reserve Forest; Hatidipu	26.900306°N, 93.253389°E; 101 m a.s.l.
D	March 2018; August 2019	Behali Reserve Forest; Hatimara	26.902472°N, 93.322944°E; 97 m a.s.l.
E	April 2018; June 2019	Behali Reserve Forest; Rangagorha Beat	26.886722°N, 93.267111°E; 92 m a.s.l.
F	June 2017; July 2019	Behali Reserve Forest; Radhasu	26.929583°N, 93.281417°E; 95 m a.s.l.
G	July 2018; April 2019	Behali Reserve Forest; Sialmari	26.895389°N, 93.362028°E; 104 m a.s.l.
H	April 2017; April 2019	Behali Reserve Forest; Serelia	26.896972°N, 93.342167°E; 101 m a.s.l.
I	March 2018; August 2019	Behali Reserve Forest; Siklibandha Tinali	26.906639°N, 93.272417°N; 99 m a.s.l.

To characterize the studied flora, we estimated growth forms of all species and the habitat

types where plants were found. Growth forms were characterised according to IUCN Plant Growth Forms Classification Scheme [24]. To describe habitat diversity, we used the following definitions. 1) Pristine forest (**PF**): unmanaged forest patches with both well-developed canopy and three-tier vegetation. 2) Secondary forests (**SF**): forest patches affected by anthropogenic deforestation, that was resulted in both forest stand and canopy reduction making the illumination intensity as relatively high. 3) Rehabilitated forests (**RF**) are a result of restoration of a degraded forest to its original state by planting native trees. 4) Shrublands (**SH**): shrubby plant community characterized by vegetation dominated by shrubs with participation of grasses, herbs, and geophytes. 5) Riparian habitats (**RH**) are considered as areas along the banks of a permanent or ephemeral water body (river, stream, spring or waterfall). 6) Grasslands (**GR**) are open habitats dominated mainly by grasses, sedges, rushes, being dry or flooded seasonally. The global IUCN Red List categories of each species were indicated following IUCN [26].

### ***IUCN Red List assessment***

Assessments of the conservation status of two endemic species, *Chlorophytum assamicum* and *Aristolochia assamica*, for the IUCN Red List followed the recently revised evaluation criteria adopted by IUCN [23, 25], if any one of the IUCN Red List criteria is met. As we have no detailed and reliable population-level data for these plant species, species conservation assessments have been based on IUCN criteria B [13]: an evaluation of range size measured as either extent of occurrence (EOO, criterion B1) or area of occupancy (AOO, criterion B2) followed by an assessment of population fragmentation. In addition, we used criterion D, as an indicator of a very small or restricted population. The extent of occurrence (EOO) and area of occupancy (AOO) were calculated using GeoCAT tool [1]. To make our assessment in line of high-quality global studies, we used recent publications devoted to global and sub-global IUCN assessments of vascular plants [38, 20, 32].

## **Results**

### ***Flora of vascular plants in the Behali Reserve Forest***

The flora of Assam state consists of a total 2823 vascular plants which belong to 309 genera, and 107 families [29]. However, in a relatively small area of BRF, 281 vascular plant species are reported, which is equal to about 10% of the erstwhile Assam flora.

During field expeditions, about 347 herbarium specimens were collected in the different vegetation types and communities. They represent 281 taxa (to simplify, hereafter – «species»), including 272 species, one subspecies and eight varieties of vascular plants, which belong to 206 genera and 79 families (Table 2). Of these taxa, *Pandanus unguifer* Hook. f. (Fig. 2) is recorded here as a first report for the flora of Assam.

To date, *P. unguifer* was known from South Sikkim district of Central Himalaya and Darjeeling district of upper West Bengal [49]. This species is closely related to the recently described *P. martinianus* Nadaf & Zanan. It can be distinguished by its globular syncarp with 90–110 randomly distributed drupes (vs. ellipsoid syncarp with 140–160 drupes arranged in rows in *P. martinianus*) [48]. Specimen examined: India, Assam, Behali Reserve Forest, Siklibandha Tinali 26°54'23.9" N, 93°16'20.7" E, 99 m a.s.l., 12.03.2018, D. Borah (BRF785) (HAU).

**Table 2: Native vascular flora of Behali Reserve Forest (Assam, India).**

<b>Family</b>	<b>Taxon</b>	<b>Global IUCN Red List status</b>	<b>Voucher No. (Study site)</b>	<b>Habitat</b>	<b>IUCN Growth Form</b>
Fabaceae	<i>Abrus melanospermus</i> Hassk.	NE	BRF828 (E)	PF	Tree
Orchidaceae	<i>Acampe praemorsa</i> var. <i>longepedunculata</i> (Trimen) Govaerts	NE	BRF218 (B)	PF	Epiphyte
Orchidaceae	<i>Acampe praemorsa</i> (Roxb.) Blatt. & Mccann	NE	BRF526 (I)	PF	Epiphyte
Lamiaceae	<i>Achyrospermum wallichianum</i> (Benth.) Benth. ex Hook.f.	NE	BRF833 (E)	SF	Tree
Lauraceae	<i>Actinodaphne obovata</i> (Nees) Blume	NE	BRF519 (C)	PF	Tree
Orchidaceae	<i>Aerides odorata</i> Lour.	NE	BRF837 (F)	PF	Epiphyte
Gesneriaceae	<i>Aeschynanthus micranthus</i> C.B.Clarke	NE	BRF518 (D)	PF, SF	Epiphyte
Meliaceae	<i>Aglaia edulis</i> (Roxb.) Wall.	NT	BRF523 (G)	PF	Tree
Sapindaceae	<i>Allophylus chartaceus</i> (Kurz) Radlk.	NE	BRF801 (E)	RH	Forb or Herb
Zingiberaceae	<i>Alpinia nigra</i> (Gaertn.) Burtt	NE	BRF213 (H)	GR	Geophyte
Zingiberaceae	<i>Alpinia roxburghii</i> Sweet	NE	BRF564 (D)	PF	Geophyte
Lauraceae	<i>Alseodaphne khasyana</i> (Meisn.) Kosterm.	NE	BRF809 (B)	PF	Tree
Lauraceae	<i>Alseodaphnopsis andersonii</i> (King ex Hook.F.) H.W.Li & J.Li	NE	BRF242 (D)	PF	Tree
Primulaceae	<i>Amblyanthus glandulosus</i> (Roxb.) A.DC.	NE	BRF796 (G)	PF	Shrub
Araceae	<i>Amorphophallus bulbifer</i> (Roxb.) Blume	NE	BRF514 (I)	SF	Geophyte
Araceae	<i>Amorphophallus napalensis</i> (Wall.) Bogner & Mayo	NE	BRF521 (B)	PF, SF	Geophyte
Phyllanthaceae	<i>Antidesma acidum</i> Retz.	LC	BRF371 (C)	RF	Shrub
Phyllanthaceae	<i>Antidesma montanum</i> Blume	LC	BRF398 (I)	SF	Shrub
Phyllanthaceae	<i>Antidesma roxburghii</i> Wall. ex Tul.	NE	BRF123 (H)	PF	Shrub
Meliaceae	<i>Aphanamixis polystachya</i> (Wall.) R.Parker	LC	BRF769 (B)	PF	Tree
Phyllanthaceae	<i>Aporosa octandra</i> (Buch.-Ham. ex D.Don) Vickery	LC	BRF126 (E)	SF	Tree
Phyllanthaceae	<i>Aporosa wallichii</i> Hook.F.	NE	BRF134 (A)	PF	Tree
Fabaceae	<i>Archidendron clypearia</i> (Jack) I.C.Nielsen	LC	BRF353 (D)	PF	Tree
Primulaceae	<i>Ardisia colorata</i> G.Lodd.	NE	BRF112 (B)	PF	Shrub
Primulaceae	<i>Ardisia solanacea</i> Roxb.	NE	BRF370 (H)	PF	Shrub

Aristolochiaceae	<i>Aristolochia acuminata</i> Lam.	NE	BRF201 (A)	PF	Vine
Aristolochiaceae	<i>Aristolochia assamica</i> D.Borah & T.V.Do	EN*	BRF223 (D), BRF978 (D)	SF	Vine
Aristolochiaceae	<i>Aristolochia cathcartii</i> Hook.F.	NE	BRF515 (I)	PF	Vine
Moraceae	<i>Artocarpus chama</i> Buch.-Ham.	NE	BRF524 (A)	PF, SF	Tree
Menispermaceae	<i>Aspidocarya uvifera</i> Hook.F. & Thomson	NE	BRF238 (D)	PF	Vine
Malvaceae	<i>Ayenia grandifolia</i> (DC.) Christenh. & Byng	NE	BRF780 (D)	PF, SF	Vine
Phyllanthaceae	<i>Baccaurea ramiflora</i> Lour.	LC	BRF216 (H)	PF	Tree
Euphorbiaceae	<i>Balakata baccata</i> (Roxb.) Esser	LC	BRF268 (C)	PF	Tree
Balanophoraceae	<i>Balanophora dioica</i> R.Br. ex Royle	NE	BRF578 (B)	PF, SH	Parasite
Apocynaceae	<i>Beaumontia grandiflora</i> Wall.	NE	BRF513 (H)	SF	Vine
Begoniaceae	<i>Begonia silletensis</i> (A.DC.) C.B.Clarke	NE	BRF248 (C)	PF	Forb or Herb
Lauraceae	<i>Beilschmiedia assamica</i> Meisn.	NE	BRF230 (F)	PF	Tree
Lauraceae	<i>Beilschmiedia brandisii</i> Hook.F.	NE	BRF574 (E)	PF	Tree
Lauraceae	<i>Beilschmiedia roxburghiana</i> Nees	NE	BRF375 (I)	PF	Tree
Phyllanthaceae	<i>Bischofia javanica</i> Blume	LC	BRF115 (D)	PF, SF	Tree
Asteraceae	<i>Blumea balsamifera</i> DC.	LC	BRF250 (D)	PF	Forb or Herb
Gesneriaceae	<i>Boeica filiformis</i> C.B.Clarke	NE	BRF547 (I)	RH	Shrub
Phyllanthaceae	<i>Breynia androgyna</i> (L.) Chakrab. & N.P.Balacr.	NE	BRF366 (C)	PF	Shrub
Phyllanthaceae	<i>Breynia retusa</i> (Dennst.) Alston	LC	BRF397 (D)	PF	Shrub
Phyllanthaceae	<i>Bridelia assamica</i> Hook.F.	NE	BRF147 (B)	PF	Shrub
Phyllanthaceae	<i>Bridelia retusa</i> (L.) A.Juss.	NE	BRF387 (H)	PF	Tree
Phyllanthaceae	<i>Bridelia stipularis</i> (L.) Blume	LC	BRF793 (F)	SF	Shrub
Orchidaceae	<i>Bulbophyllum roxburghii</i> (Lindl.) Rchb.F.	NE	BRF399 (G)	PF	Epiphyte
Orchidaceae	<i>Calanthe masuca</i> (D.Don) Lindl.	NE	BRF568 (B)	PF	Geophyte
Lamiaceae	<i>Callicarpa arborea</i> Roxb.	LC	BRF356 (G)	RF	Tree
Burseraceae	<i>Canarium bengalense</i> Roxb.	NE	BRF247 (D), BRF974 (D)	PF	Tree
Burseraceae	<i>Canarium resiniferum</i> Bruce ex. King	NE	BRF209 (G), BRF979 (A)	PF	Tree
Capparaceae	<i>Capparis multiflora</i> Hook.F. & Thomson	NE	BRF263 (C)	SH	Shrub

Rhizophoraceae	<i>Carallia brachiata</i> (Lour.) Merr.	NE	BRF531 (E)	SF	Tree
Fagaceae	<i>Castanopsis lanceifolia</i> (Oerst.) Hickel & A.Camus	NE	BRF837 (F)	PF	Tree
Rubiaceae	<i>Catunaregam spinosa</i> (Thunb.) Tirveng.	NE	BRF389 (D)	PF	Shrub
Rubiaceae	<i>Chassalia curviflora</i> (Wall.) Thwaites	NE	BRF536 (A)	PF	Shrub
Meliaceae	<i>Chisocheton cumingianus</i> subsp. <i>balansae</i> (C.DC.) Mabb.	LC	BRF206 (A)	PF, RF	Tree
Asparagaceae	<i>Chlorophytum assamicum</i> D.Borah & A.P.Da	CR*	BRF262 (E)	PF	Forb or Herb
Orchidaceae	<i>Chrysoglossum ornatum</i> Blume	NE	BRF527 (G)	PF	Forb or Herb
Rutaceae	<i>Citrus indica</i> Yu.Tanaka	NE	BRF34 (F)	PF	Shrub
Rutaceae	<i>Citrus medica</i> L.	NE	BRF390 (I)	RH	Shrub
Euphorbiaceae	<i>Claoxylon longipetiolatum</i> Kurz	NE	BRF805 (C)	SF	Forb or Herb
Orchidaceae	<i>Cleisocentron pallens</i> (Cathcart ex Lindl.) N.Pearce & P.J.Cribb	NE	BRF383 (E)	PF	Epiphyte
Orchidaceae	<i>Cleisostoma subulatum</i> Blume	NE	BRF382 (D)	PF	Epiphyte
Orchidaceae	<i>Cleisostoma tenuifolium</i> (L.) Garay	NE	BRF789 (H)	PF	Epiphyte
Lamiaceae	<i>Clerodendrum colebrookeanum</i> Walp.	NE	BRF357 (E)	SF	Shrub
Lamiaceae	<i>Clerodendrum bracteatum</i> Wall. ex Walp.	NE	BRF559 (C)	PF	Shrub
Lamiaceae	<i>Clerodendrum laevifolium</i> Blume	NE	BRF546 (D)	PF	Shrub
Combretaceae	<i>Combretum acuminatum</i> Roxb.	NE	BRF517 (F)	PF	Vine
Commelinaceae	<i>Connarus paniculatus</i> Roxb.	NE	BRF836 (E)	SH	Vine
Boraginaceae	<i>Cordia myxa</i> L.	NE	BRF573 (H)	SF	Tree
Orchidaceae	<i>Corymborkis veratrifolia</i> (Reinw.) Blume	NE	BRF575 (A)	PF	Geophyte
Capparaceae	<i>Crateva religiosa</i> G.Forst.	LC	BRF766 (B)	PF, SF	Tree
Amaryllidaceae	<i>Crinum amoenum</i> Ker Gawl. ex Roxb.	NE	BRF226 (H)	RH	Geophyte
Euphorbiaceae	<i>Croton caudatus</i> Geiseler	NE	BRF577 (I)	SF	Vine
Euphorbiaceae	<i>Croton persimilis</i> Müll.Arg.	NE	BRF267 (A)	PF	Tree
Lauraceae	<i>Cryptocarya amygdalina</i> Nees	NE	BRF520 (C)	PF	Tree
Hypoxidaceae	<i>Curculigo capitulata</i> (Lour.) Kuntze	NE	BRF354 (A)	RH	Forb or Herb
Orchidaceae	<i>Cymbidium aloifolium</i> (L.) Sw.	NE	BRF219 (G)	RF	Epiphyte
Orchidaceae	<i>Cymbidium bicolor</i> Lindl.	NE	BRF235 (I)	PF	Epiphyte
Fabaceae	<i>Dalbergia ramosa</i> Roxb.	LC	BRF548 (G)	PF	Tree

Staphyleaceae	<i>Dalrympelea pomifera</i> Roxb.	LC	BRF391 (C)	PF, SF	Tree
Orchidaceae	<i>Dendrobium aphyllum</i> (Roxb.) C.E.C.Fisch.	LC	BRF101 (G)	RF	Epiphyte
Orchidaceae	<i>Dendrobium lituiflorum</i> Lindl.	NE	BRF538 (H)	RF	Epiphyte
Orchidaceae	<i>Dendrobium mannii</i> Ridl.	NE	BRF102 (B)	PF	Epiphyte
Orchidaceae	<i>Dendrobium moschatum</i> (Banks) Sw.	NE	BRF791 (G)	PF	Epiphyte
Orchidaceae	<i>Dendrolirium lasiopetalum</i> (Willd.) S.C.Chen & J.J.Wood	NE	BRF364 (F)	PF	Epiphyte
Fabaceae	<i>Derris scandens</i> (Roxb.) Benth.	LC	BRF353 (A)	RH	Vine
Acanthaceae	<i>Dicliptera chinensis</i> (L.) Juss.	NE	BRF261 (A)	SF	Forb or Herb
Orchidaceae	<i>Didymoplexis pallens</i> Griff.	NE	BRF137 (D)	SH	Geophyte
Dilleniaceae	<i>Dillenia indica</i> L.	NE	BRF264 (D)	PF, SF, RH	Tree
Apocynaceae	<i>Dischidia bengalensis</i> Colebr.	NE	BRF579 (F)	PF, SF	Epiphyte
Asparagaceae	<i>Dracaena petiolata</i> Hook.f.	NE	BRF814 (G)	PF	Forb or Herb
Putranjivaceae	<i>Drypetes assamica</i> (Hook.F.) Pax & K.Hoffm.	NE	BRF566 (I)	PF	Tree
Lythraceae	<i>Duabanga grandiflora</i> (Roxb. ex DC.) Walp.	LC	BRF544 (B)	RF	Tree
Meliaceae	<i>Dysoxylum excelsum</i> Blume	NE	BRF773 (I)	PF	Tree
Meliaceae	<i>Dysoxylum gotadhora</i> (Buch.-Ham.) Mabb.	NE	BRF775 (E)	PF	Tree
Boraginaceae	<i>Ehretia wallichiana</i> Hook.f. & Thomson ex C.B.Clarke	NE	BRF822 (E)	PF	Shrub
Elaeagnaceae	<i>Elaeagnus pyriformis</i> Hook.f.	NE	BRF827 (G)	RH	Shrub
Elaeocarpaceae	<i>Elaeocarpus angustifolius</i> Blume	LC	BRF227 (G)	PF	Tree
Elaeocarpaceae	<i>Elaeocarpus rugosus</i> Roxb. ex G.Don	VU	BRF207 (C)	PF	Tree
Elaeocarpaceae	<i>Elaeocarpus varunua</i> Buch.-Ham. ex Mast.	NE	BRF228 (F), BRF976 (D)	PF	Tree
Araliaceae	<i>Eleutherococcus trifoliatus</i> (L.) S.Y.Hu var. <i>trifoliatus</i>	NE	BRF804 (C)	RH	Shrub
Fabaceae	<i>Entada phaseoloides</i> (L.) Merr.	NE	BRF229 (C)	PF	Vine
Orchidaceae	<i>Epipogium roseum</i> (D.Don) Lindl.	NE	BRF837 (F)	PF	Geophyte
Oleaceae	<i>Erythralum scandens</i> Blume	LC	BRF381 (B)	SF	Vine
Moraceae	<i>Ficus auriculata</i> Lour.	LC	BRF378 (G)	PF, SF	Tree
Moraceae	<i>Ficus benjamina</i> L.	LC	BRF569 (B)	PF, SF	Tree
Moraceae	<i>Ficus drupacea</i> Thunb.	LC	BRF233 (I)	PF, SF	Tree
Moraceae	<i>Ficus elastica</i> Roxb. ex Hornem.	NE	BRF774 (B)	PF, SF	Tree



Moraceae	<i>Ficus hederacea</i> Roxb.	NE	BRF237 (E)	PF, SF	Vine
Moraceae	<i>Ficus heterophylla</i> L.F.	NE	BRF541 (C)	RH	Vine
Moraceae	<i>Ficus heteropleura</i> Blume	NE	BRF363 (E)	PF, SF	Vine
Moraceae	<i>Ficus hispida</i> L.F.	LC	BRF108 (H)	SF	Tree
Moraceae	<i>Ficus nervosa</i> B.Heyne ex Roth	LC	BRF119 (A)	PF, SF	Tree
Moraceae	<i>Ficus semicordata</i> Buch.-Ham. ex Sm.	LC	BRF141 (D)	RH	Tree
Moraceae	<i>Ficus subincisa</i> Buch.Ham. ex Sm.	LC	BRF407 (B)	PF	Vine
Moraceae	<i>Ficus subulata</i> Blume	NE	BRF205 (B)	PF	Vine
Moraceae	<i>Ficus tinctoria</i> G.Forst.	LC	BRF151 (I)	PF	Vine
Annonaceae	<i>Fissistigma bicolor</i> (Roxb.) Merr.	NE	BRF258 (C)	SF	Vine
Annonaceae	<i>Fissistigma polyanthum</i> (Hook.f. & Thomson) Merr.	NE	BRF225 (H)	SF	Vine
Annonaceae	<i>Friesodielsia fornicata</i> (Roxb.) D.Das	NE	BRF767 (C), BRF977 (D)	PF	Vine
Clusiaceae	<i>Garcinia xanthochymus</i> Hook.F. ex T.Anderson	NE	BRF580 (F)	PF	Tree
Orchidaceae	<i>Gastrochilus obliquus</i> var. <i>suavis</i> (Seidenf.) Z.H.Tsi	NE	BRF528 (C)	PF	Epiphyte
Zingiberaceae	<i>Globba multiflora</i> Wall. ex Baker	NE	BRF534 (B)	GR	Geophyte
Phyllanthaceae	<i>Glochidion zeylanicum</i> var. <i>arborescens</i> (Blume) Chakrab. & M.Gangop.	NE	BRF794 (E)	SF	Tree
Lamiaceae	<i>Gomphostemma niveum</i> Hook.F.	NE	BRF358 (F)	PF	Forb or Herb
Annonaceae	<i>Goniothalamus simonsii</i> Hook.f. & Thomson	LC	BRF784 (E)	PF	Shrub
Rhamnaceae	<i>Gouania leptostachya</i> DC.	NE	BRF121 (F)	SF	Vine
Malvaceae	<i>Grewia serrulata</i> DC.	NE	BRF558 (E)	SF	Shrub
Achariaceae	<i>Gynocardia odorata</i> R.Br.	NE	BRF512 (F)	PF	Tree
Zingiberaceae	<i>Hedychium coccineum</i> Buch.-Ham. ex Sm.	NE	BRF212 (C)	SF, SH	Geophyte
Zingiberaceae	<i>Hedychium stenopetalum</i> G.Lodd.	NE	BRF837 (F)	OF	Geophyte
Loranthaceae	<i>Helixanthera ligustrina</i> (Wall.) Danser	NE	BRF106 (C)	PF	Parasite
Orchidaceae	<i>Hetaeria affinis</i> (Griff.) Seidenf. & Ormerod	NE	BRF384 (I)	PF	Geophyte
Apocynaceae	<i>Heterostemma alatum</i> Wight & Arn.	NE	BRF202 (G)	PF	Vine
Malvaceae	<i>Hibiscus fragrans</i> Roxb.	NE	BRF779 (B)	PF	Vine
Malpighiaceae	<i>Hiptage benghalensis</i> (L.) Kurz	LC	BRF361 (H)	PF	Vine

Cucurbitaceae	Hodgsonia macrocarpa (Blume) Cogn.	NE	BRF208 (C), BRF975 (D)	PF	Vine
Araceae	Homalomena aromatica (Spreng.) Schott	NE	BRF210 (G)	SF	Geophyte
Myristicaceae	Horsfieldia kingii (Hook.f.) Warb.	NE	BRF781 (C)	PF	Tree
Apocynaceae	Hoya verticillata (Vahl) G.Don	NE	BRF254 (D)	PF, SF	Epiphyte
Menispermaceae	Hypserpa nitida Miers ex Benth.	NE	BRF542 (H)	PF	Vine
Rubiaceae	Ixora nigricans R.Br. ex Wight & Arn.	NE	BRF395 (G)	PF	Shrub
Oleaceae	Jasminum coarctatum Roxb.	NE	BRF400 (I)	SF, SH	Vine
Oleaceae	Jasminum laurifolium Roxb. ex Hornem.	NE	BRF234 (D)	SF, SH	Vine
Myristicaceae	Knema angustifolia (Roxb.) Warb.	NE	BRF450 (I)	PF	Tree
Malvaceae	Kydia calycina Roxb.	LC	BRF373 (A)	RF	Tree
Zingiberaceae	Larsenianthus careyanus (Benth. & Hook.F.) W.J.Kress & Mood	NE	BRF554 (E)	SF, SH	Geophyte
Araceae	Lasia spinosa (L.) Thwaites	LC	BRF252 (D)	RH	Forb or Herb
Vitaceae	Leea compactiflora Kurz	NE	BRF392 (A)	SF	Geophyte
Opiliaceae	Lepionurus sylvestris Blume	NE	BRF539 (B)	PF	Shrub
Sapindaceae	Lepisanthes senegalensis (Poir.) Leenh.	NE	BRF535 (H)	PF	Shrub
Lauraceae	Lindera reticulata (Blume) Benth. & Hook.F. ex Fern.-Vill.	NE	BRF571 (G)	PF	Tree
Altingiaceae	Liquidambar excelsa (Noronha) Oken	NE	BRF211 (E)	PF	Tree
Fagaceae	Lithocarpus listeri (King) Grierson & D.G.Long	NE	BRF835 (B)	PF	Tree
Lauraceae	Litsea albescens (Hook.f.) D.G.Long	NE	BRF768 (I)	PF	Tree
Lauraceae	Litsea assamica Hook.F.	NE	BRF360 (F)	PF	Tree
Lauraceae	Litsea chartacea Hook.F.	NE	BRF103 (A)	PF	Tree
Lauraceae	Litsea glutinosa (Lour.) C.B.Rob.	LC	BRF104 (I)	PF	Tree
Lauraceae	Litsea hookeri (Meisn.) D.G.Long	NE	BRF545 (G)	RH	Shrub
Lauraceae	Litsea khasyana Meisn.	NE	BRF576 (D)	RH, RH	Shrub
Lauraceae	Litsea laeta (Nees) Trimen	LC	BRF770 (E)	PF	Tree
Lauraceae	Litsea monopetala (Roxb.) Pers.	NE	BRF241 (I)	PF, SF	Tree
Lauraceae	Litsea sericea (Wall. ex Nees) Hook.F.	LC	BRF105 (A)	PF	Tree
Campanulaceae	Lobelia alsinoides Lam.	LC	BRF246 (I)	RH, SF	Forb or Herb
Campanulaceae	Lobelia zeylanica L.	LC	BRF516 (E)	RH, SF	Forb or Herb

Orchidaceae	<i>Luisia trichorrhiza</i> (Hook.) Blume	NE	BRF385 (H)	PF	Epiphyte
Solanaceae	<i>Lycianthes biflora</i> (Lour.) Bitter	NE	BRF214 (A)	SF	Shrub
Lauraceae	<i>Machilus duthiei</i> King ex Hook.f.	NE	BRF771 (D)	PF	Tree
Lauraceae	<i>Machilus gamblei</i> King ex Hook.F.	LC	BRF401 (E)	PF	Tree
Moraceae	<i>Maclura cochinchinensis</i> (Lour.) Corner	NE	BRF525 (E)	SF	Shrub
Araliaceae	<i>Macropanax dispermus</i> (Blume) Kuntze	LC	BRF826 (I)	PF	Tree
Loranthaceae	<i>Macrosolen cochinchinensis</i> (Lour.) Tiegh.	NE	BRF231 (A)	PF	Parasite
Primulaceae	<i>Maesa indica</i> (Roxb.) Sweet	LC	BRF110 (C)	SF	Shrub
Magnoliaceae	<i>Magnolia griffithii</i> Hook.F. & Thomson	DD	BRF376 (G)	PF	Tree
Magnoliaceae	<i>Magnolia hodgsonii</i> (Hook.F. & Thomson) H.Keng	LC	BRF240 (E)	PF, SF	Tree
Magnoliaceae	<i>Magnolia kingii</i> (Dandy) Figlar	DD	BRF777 (D)	PF	Tree
Euphorbiaceae	<i>Mallotus philippensis</i> (Lam.) Müll.Arg.	LC	BRF269 (G)	SF	Tree
Euphorbiaceae	<i>Mallotus roxburghianus</i> Müll.Arg.	NE	BRF351 (D)	SF	Shrub
Melastomataceae	<i>Melastoma malabathricum</i> L.	NE	BRF107 (A)	SF	Shrub
Sabiaceae	<i>Meliosma pinnata</i> (Roxb.) Maxim.	NE	BRF797 (G)	PF	Tree
Sabiaceae	<i>Meliosma simplicifolia</i> (Roxb.) Walp.	NE	BRF565 (D)	SF	Tree
Calophyllaceae	<i>Mesua ferrea</i> L.	NE	BRF550 (F)	PF	Tree
Fabaceae	<i>Mezoneuron cucullatum</i> (Roxb.) Wight & Arn.	NE	BRF831 (I)	SH	Vine
Fabaceae	<i>Mezoneuron enneaphyllum</i> (Roxb.) Wight & Arn. ex Voigt	NE	BRF244 (A)	SH	Vine
Malvaceae	<i>Microcos paniculata</i> L.	LC	BRF776 (I)	PF	Tree
Rutaceae	<i>Micromelum integerrimum</i> (Roxb. ex DC.) Wight & Arn. ex M.Roem.	LC	BRF532 (B)	SF	Tree
Annonaceae	<i>Milusa dioeca</i> (Roxb.) Chaowasku & Kessler	NE	BRF257 (F), BRF973 (D)	PF	Tree
Icacinaceae	<i>Miquelia assamica</i> (Griff.) Mast. ex B.D.Jacks.	NE	BRF355 (I)	PF	Vine
Annonaceae	<i>Mitrephora tomentosa</i> Hook.F. & Thomson	NE	BRF572 (B)	PF	Tree
Moraceae	<i>Morus alba</i> L.	NE	BRF782 (G)	SF	Shrub
Moraceae	<i>Morus macroura</i> Miq.	NE	BRF783 (E)	PF	Tree
Commelinaceae	<i>Murdannia japonica</i> (Thunb.) Faden	NE	BRF832 (G)	SF	Forb or Herb
Musaceae	<i>Musa velutina</i> H.Wendl. & Drude	NE	BRF379 (D)	GR	Geophyte

Rubiaceae	<i>Mussaenda glabra</i> Vahl	NE	BRF396 (D)	PF	Shrub
Rubiaceae	<i>Mussaenda roxburghii</i> Hook.F.	NE	BRF369 (C)	SF	Shrub
Rubiaceae	<i>Mycetia nutans</i> (R.Br. ex Kurz) Razafim. & B.Bremer	NE	BRF128 (I)	PF	Shrub
Nyssaceae	<i>Nyssa javanica</i> (Blume) Wangerin	NE	BRF380 (I)	PF	Tree
Apiaceae	<i>Oenanthe javanica</i> (Blume) DC.	NE	BRF255 (D)	RH	Forb or Herb
Asparagaceae	<i>Ophiopogon micranthus</i> Hook.f.	NE	BRF818 (F)	PF, SH	Forb or Herb
Rubiaceae	<i>Ophiorrhiza ochroleuca</i> Hook.F.	NE	BRF114 (E)	PF	Shrub
Urticaceae	<i>Oreocnide integrifolia</i> (Gaudich.) Miq.	NE	BRF368 (C)	PF, RH, RH	Tree
Melastomataceae	<i>Osbeckia nepalensis</i> Hook.F.	NE	BRF362 (I)	SF	Shrub
Pandanaceae	<i>Pandanus unguifer</i> Hook.f.	NE	BRF785 (E)	RH	Shrub
Orchidaceae	<i>Papilionanthe teres</i> (Roxb.) Schltr.	NE	BRF567 (F)	RF	Epiphyte
Menispermaceae	<i>Parabaena sagittata</i> Miers ex Hook.F. & Thomson	NE	BRF221 (B)	PF, SF	Vine
Rubiaceae	<i>Pavetta indica</i> L.	NE	BRF132 (H)	PF	Shrub
Anacardiaceae	<i>Pegia nitida</i> Colebr.	NE	BRF259 (I)	SF	Vine
Asparagaceae	<i>Peliosanthes macrophylla</i> var. <i>assamensis</i> N.Tanaka & D.Borah	NE	BRF837 (F)	PF	Forb or Herb
Orchidaceae	<i>Phalaenopsis deliciosa</i> Rchb.F.	NE	BRF217 (C)	PF	Epiphyte
Orchidaceae	<i>Phalaenopsis lobbii</i> (Rchb.F.) H.R.Sweet	NE	BRF372 (G)	PF	Epiphyte
Orchidaceae	<i>Phalaenopsis mannii</i> Rchb.F.	NE	BRF131 (E)	PF	Epiphyte
Lauraceae	<i>Phoebe attenuata</i> (Nees) Nees	NE	BRF521 (C)	PF	Tree
Orchidaceae	<i>Pholidota imbricata</i> Hook.	NE	BRF418 (I)	PF	Epiphyte
Marantaceae	<i>Phrynium pubinerve</i> Blume	NE	BRF232 (B)	RH	Forb or Herb
Phyllanthaceae	<i>Phyllanthus assamicus</i> Müll.Arg.	LC	BRF149 (G)	PF	Tree
Simaroubaceae	<i>Picrasma javanica</i> Blume	NE	BRF803 (A)	PF	Tree
Orchidaceae	<i>Pinalia bractescens</i> (Lindl.) Kuntze	NE	BRF787 (A)	PF	Epiphyte
Piperaceae	<i>Piper betleoides</i> C.DC.	NE	BRF411 (D)	PF, SF	Vine
Piperaceae	<i>Piper sylvaticum</i> Roxb.	NE	BRF530 (I)	PF, SF	Vine
Urticaceae	<i>Poikilospermum suaveolens</i> (Blume) Merr.	NE	BRF795 (D)	PF, SF	Vine
Commelinaceae	<i>Pollia subumbellata</i> C.B.Clarke	NE	BRF560 (B)	PF	Forb or Herb
Annonaceae	<i>Polyalthia suberosa</i> (Roxb.) Thwaites	NE	BRF256 (G)	PF	Shrub

Orchidaceae	<i>Pomatocalpa spicatum</i> Breda	NE	BRF386 (A)	PF	Epiphyte
Orchidaceae	<i>Pomatocalpa undulatum</i> (Lindl.) J.J.Sm.	NE	BRF145 (A)	PF	Epiphyte
Urticaceae	<i>Pouzolzia sanguinea</i> (Blume) Merr.	NE	BRF799 (F)	SF	Vine
Lamiaceae	<i>Premna bengalensis</i> C.B.Clarke	NE	BRF243 (I)	PF	Tree
Lamiaceae	<i>Premna esculenta</i> Roxb.	NE	BRF359 (A)	PF	Tree
Burseraceae	<i>Protium serratum</i> (Wall. ex Colebr.) Engl.	NE	BRF829 (I)	PF	Tree
Acanthaceae	<i>Pseuderanthemum latifolium</i> (Vahl) B.Hansen	NE	BRF553 (F)	SF	Forb or Herb
Poaceae	<i>Pseudostachyum polymorphum</i> Munro	NE	BRF798 (D)	GR	Forb or Herb
Rubiaceae	<i>Psychotria denticulata</i> Wall.	NE	BRF837 (F)	PF	Forb or Herb
Malvaceae	<i>Pterospermum acerifolium</i> (L.) Willd.	NE	BRF374 (B)	PF	Tree
Malvaceae	<i>Pterospermum lanceifolium</i> Roxb. ex DC.	NE	BRF239 (I)	PF	Tree
Menispermaceae	<i>Pycnarrhena pleniflora</i> Miers ex Hook.F. & Thomson	NE	BRF204 (H)	PF	Vine
Theaceae	<i>Pyrenaria khasiana</i> var. <i>lakhimpurensis</i> N. Odyuo & D.K. Roy	NE	BRF393 (F)	PF	Tree
Rhamnaceae	<i>Rhamnus napalensis</i> (Wall.) M.A.Lawson	LC	BRF215 (B)	GR	Tree
Orchidaceae	<i>Rhynchostylis retusa</i> (L.) Blume	NE	BRF537 (F)	RF	Epiphyte
Rosaceae	<i>Rubus moluccanus</i> L.	NE	BRF800 (G)	SF	Shrub
Sabiaceae	<i>Sabia lanceolata</i> Colebr.	NE	BRF555 (C)	PF	Vine
Actinidiaceae	<i>Saurauia armata</i> Kurz	NE	BRF260 (C)	PF	Tree
Actinidiaceae	<i>Saurauia napaulensis</i> DC.	LC	BRF563 (B)	SF	Tree
Marantaceae	<i>Schumannianthus benthamianus</i> (Kuntze) Veldkamp & I.M.Turner	NE	BRF543 (I)	GR	Forb or Herb
Elaeocarpaceae	<i>Sloanea sterculiacea</i> var. <i>assamica</i> (Benth.) Coode	NE	BRF266 (E)	PF	Tree
Smilacaceae	<i>Smilax orthoptera</i> A.DC.	NE	BRF367 (D)	SH	Vine
Rubiaceae	<i>Spiradielis bifida</i> Kurz	NE	BRF790 (F)	PF	Forb or Herb
Stachyuraceae	<i>Stachyurus himalaicus</i> Hook.f. & Thomson ex Benth.	LC	BRF786 (I)	PF	Shrub
Gesneriaceae	<i>Stauranthera umbrosa</i> (Griff.) C.B.Clarke	NE	BRF810 (C)	RH	Forb or Herb
Stemonaceae	<i>Stemona tuberosa</i> Lour.	NE	BRF533 (H)	SF	Vine
Menispermaceae	<i>Stephania rotunda</i> Lour.	NE	BRF377 (I)	SF	Vine
Malvaceae	<i>Sterculia lanceolata</i> var. <i>coccinea</i> (Jack) Phengklai	NE	BRF522 (C)	PF	Shrub
Malvaceae	<i>Sterculia villosa</i> Roxb. ex Sm.	NE	BRF570 (E)	RF	Tree

Resedaceae	<i>Stixis suaveolens</i> (Roxb.) Baill.	NE	BRF388 (A)	PF, SF	Vine
Acanthaceae	<i>Strobilanthes paniculiformis</i> J.R.I.Wood	NE	BRF766 (G)	RH	Forb or Herb
Apocynaceae	<i>Strophanthus wallichii</i> A.DC.	NE	BRF224 (C)	PF	Vine
Styracaceae	<i>Styrax hookeri</i> C.B.Clarke	NE	BRF788 (E)	PF	Tree
Styracaceae	<i>Styrax serrulatus</i> Roxb.	NE	BRF125 (B)	RH	Tree
Myrtaceae	<i>Syzygium aqueum</i> (Burm.F.) Alston	NE	BRF220 (B)	PF	Tree
Myrtaceae	<i>Syzygium balsameum</i> (Wight) Wall. ex Walp.	NE	BRF236 (E)	PF, SF	Tree
Myrtaceae	<i>Syzygium oblatum</i> (Roxb.) Wall. ex A.M.Cowan & Cowan	NE	BRF772 (A)	PF	Tree
Combretaceae	<i>Terminalia bellirica</i> (Gaertn.) Roxb.	NE	BRF549 (D)	PF	Tree
Combretaceae	<i>Terminalia citrina</i> (Gaertn.) Roxb.	LC	BRF834 (I)	PF	Tree
Dilleniaceae	<i>Tetracera sarmentosa</i> (L.) Vahl	NE	BRF265 (B)	PF, SF	Vine
Loranthaceae	<i>Tolypanthus maclurei</i> (Merr.) Danser	NE	BRF203 (H)	PF, SF	Parasite
Orchidaceae	<i>Tropidia angulosa</i> (Lindl.) Blume	NE	BRF778 (H)	PF	Forb or Herb
Orchidaceae	<i>Tropidia curculigoides</i> Lindl.	NE	BRF529 (B)	PF	Forb or Herb
Asparagaceae	<i>Tupistra stoliczana</i> Kurz	NE	BRF249 (C)	PF	Forb or Herb
Apocynaceae	<i>Urceola rosea</i> (Hook. & Arn.) D.J. Middleton	NE	BRF552 (I)	PF	Vine
Apocynaceae	<i>Vallis solanacea</i> (Roth) Kuntze	NE	BRF253 (E)	PF	Vine
Lamiaceae	<i>Vitex glabrata</i> R.Br.	LC	BRF830 (F)	PF	Tree
Lamiaceae	<i>Vitex pinnata</i> L.	LC	BRF807 (I)	PF	Tree
Lamiaceae	<i>Vitex quinata</i> (Lour.) F.N.Williams	LC	BRF808 (B)	PF	Tree
Campanulaceae	<i>Wahlenbergia marginata</i> (Thunb.) A.DC.	NE	BRF245 (H)	RH, SF	Forb or Herb
Apocynaceae	<i>Wrightia arborea</i> (Dennst.) Mabb.	NE	BRF562 (H)	PF	Tree
Cucurbitaceae	<i>Zanonia indica</i> L.	NE	BRF222 (A)	SF	Vine
Rutaceae	<i>Zanthoxylum oxyphyllum</i> Edgew.	NE	BRF802 (D)	PF	Vine
Rutaceae	<i>Zanthoxylum rhetsa</i> (Roxb.) DC.	LC	BRF792 (I)	PF	Tree
Orchidaceae	<i>Zeuxine nervosa</i> (Wall. ex Lindl.) Benth. ex Trimen	NE	BRF365 (D)	PF	Geophyte
Rhamnaceae	<i>Ziziphus funiculosa</i> Buch.-Ham. ex M.A.Lawson	NE	BRF556 (G)	PF	Vine

**Legend: IUCN Red List categories:** CR\* - Critically Endangered, EN\* - Endangered, VU – Vulnerable, NT - Near Threatened, LC – Least Concern, DD - Data Deficient, NE - Not Evaluated, \* - "asterisk" marks taxa evaluated at present study; **Habitat types:** PF- Pristine forests, SF - Secondary forests, RF - Rehabilitated forests, SH – Shrublands, RH - Riparian habitats, GR – Grasslands.



Fig. 2: *Pandanus unguifer* in Behali Reserve Forest (India); inset: syncarp.

The families with highest species number were Orchidaceae (34 species), Lauraceae (20), Moraceae (17), Phyllanthaceae (14) and Lamiaceae (11 species). The richest genera by number of species were *Ficus* and *Litsea* with 13 and 9 species, respectively.

Analysis of vascular plant flora in terms of growth forms demonstrated the predominance of trees (37.0%), followed by vines (18.1%) and shrubs (16.4%), and so on (Fig. 3).

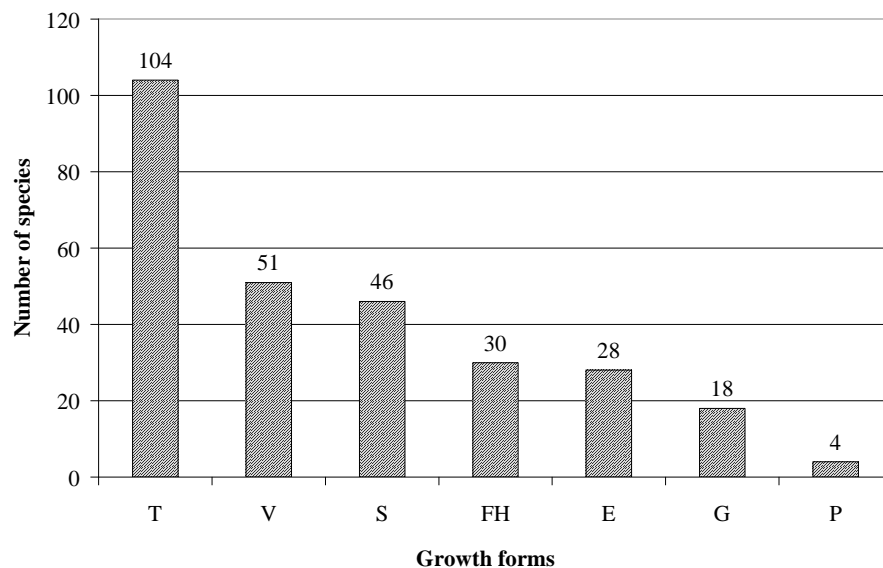
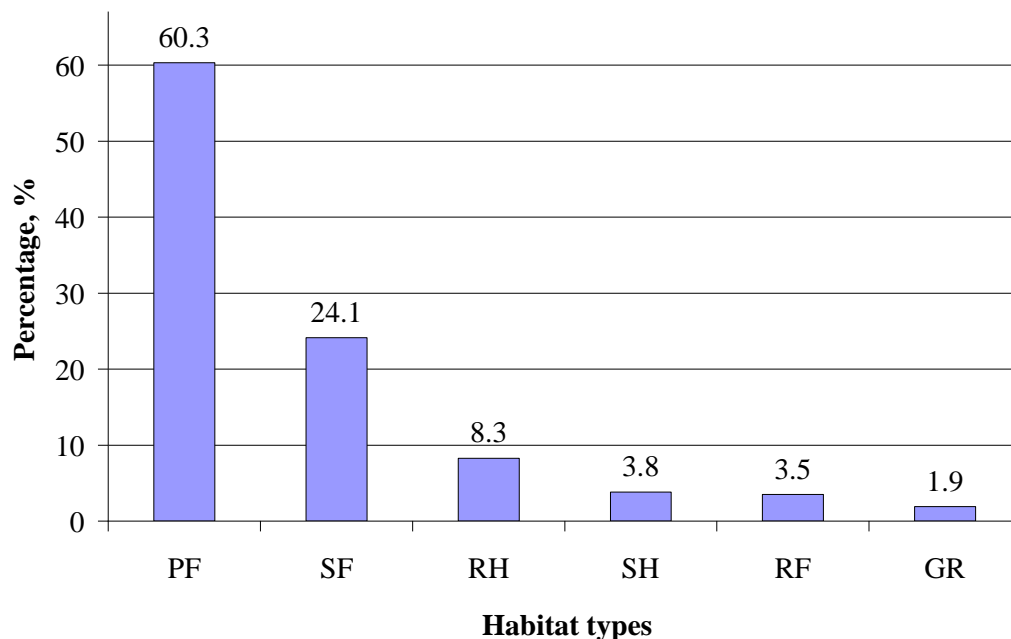


Fig. 3: Distribution of vascular plant species along growth forms. Designations: T – tree, V – vine, S – shrub, E – epiphyte, FH – forb or herb, G – geophyte, P – parasite.

In the present study, we estimated the habitat diversity where the vascular plants grow in the BRF (Fig. 4). We found that the highest number of species was registered in pristine forests (190 taxa) followed by secondary forests (76 taxa) and rehabilitated forests (26 taxa). At the same time, open habitats (e.g. grasslands) were characterized by the lowest species richness.



**Fig. 4: The proportion of species number per habitat in the Behali Reserve Forest.** Designations: PF – Pristine forests, SF – Secondary forests, RF – Rehabilitated forests, SH – Shrublands, RH – Riparian habitats, GR – Grasslands.

#### ***Global IUCN Red List assessment of two endemic species***

Of 281 taxa in BRF, 58 plants species have global IUCN status [26]. Of these, 54 species are reported as Least Concern (Appendix), two species (*Magnolia kingii* (Dandy) Figlar and *Magnolia griffithii* Hook. f. & Thomson) as Data Deficient, *Elaeocarpus rugosus* Roxb. ex G. Don as Vulnerable, and *Aglaia edulis* (Roxb.) Wall. as Near Threatened. In this paper, we carried out the global IUCN Red List of two more plant species on the basis of data obtained in North-east India (Fig. 5) during the present study.

##### *IUCN status of Chlorophytum assamicum*

**Criterion B:** There is a single location (Fig. 5C). AOO: 4 km<sup>2</sup> calculated with a 2 × 2 km-cell fixed grid by GeoCAT programme [1]. Decline in extent and quality of the habitat (iii) has been directly observed and expected to continue in the future.

**Criterion D:** Number of mature individuals is less than 50.

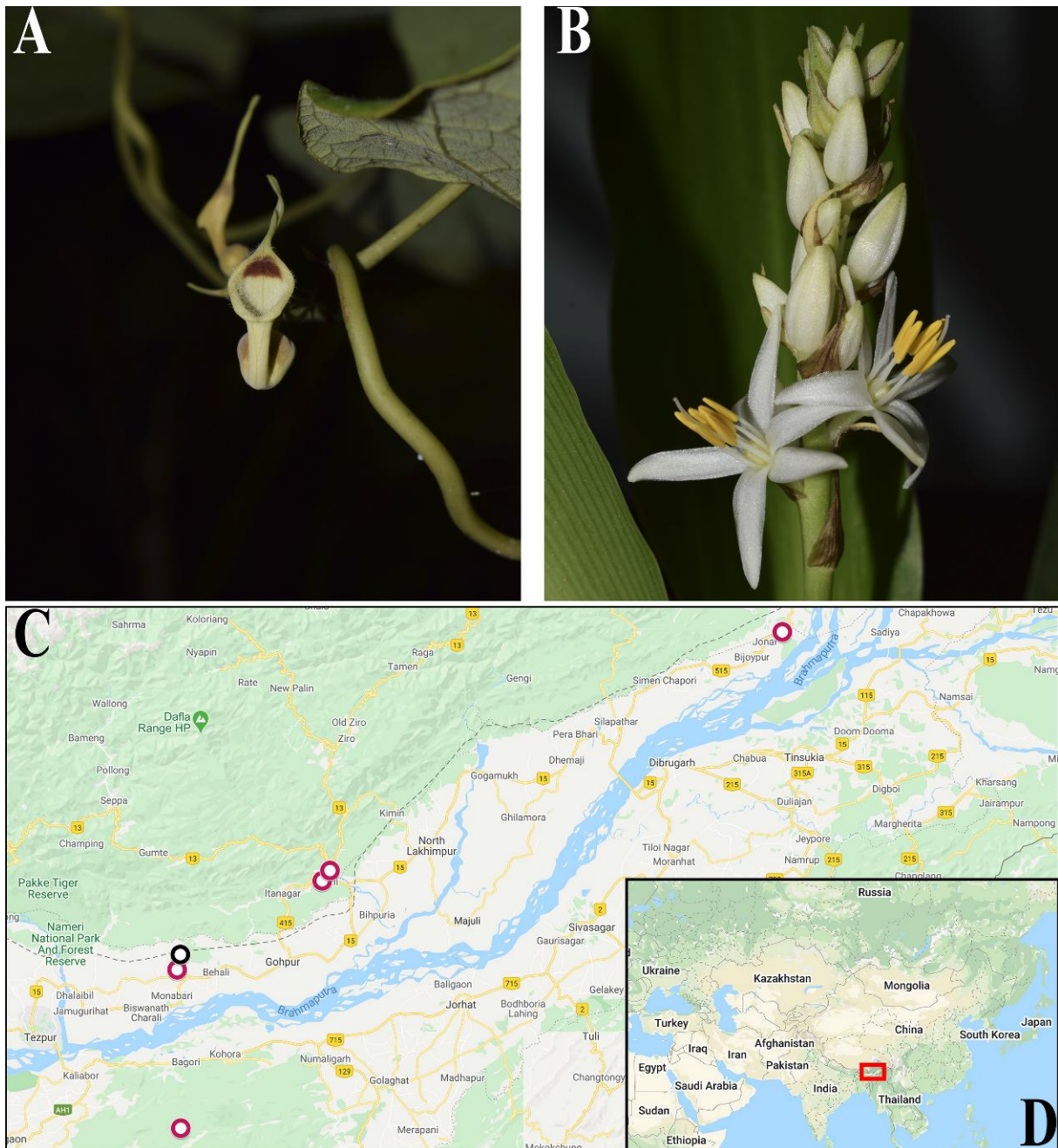
**Category:** CR B1ab(iii)+2ab(iii); D.

##### *IUCN status of Aristolochia assamica*

**Criterion B:** AOO: 20 km<sup>2</sup> calculated with a 2 × 2 km-cell fixed grid by GeoCAT [1]. EOO: 5769 km<sup>2</sup> calculated with minimum convex hull by GeoCAT [1]. There are five location within the distribution range. Decline in extent and quality of the habitat (iii) has been directly observed and expected to continue in the future.

**Category:** EN B2ab(iii).





**Fig. 5:** A – *Aristolochia assamica* (red dots at map C); B – *Chlorophytum assamicum* (black dot at map C); their locations at map of Northeast India (C) and in South Asia (D).

### Discussion

The data recorded indicates the presence of a rich floristic diversity in BRF as compared to other forests of Assam state. Though forest has been experiencing tremendous pressure for last few decades, through timber extraction, firewood collection, extension of human settlements, land encroachment and other such destructive activities, still some dense patches have been left in the core regions. The species list obtained is comparable to the studies of Majumdar & Datta [34], Sarkar & Devi [43], Borah et al. [6], Mipun et al. [36] in terms of number of species. At the same time, species richness in BRF is higher than Dutta & Devi [18, 19], Bora & Bhattacharya [5], Borogayary et al. [12], demonstrated in other forests of similar environment within the state of

Assam. Concerning separate families, the predominant Orchidaceae makes the main contribution to epiphyte richness. Perhaps, the relatively lower proportion of orchids in taxonomic spectra is a result of underestimation of epiphytic floras.

In the studied flora, woody plants are predominated with the highest number of trees (104 taxa), vines (51 taxa) and shrubs (46 taxa). It is typical for tropical forests, where trees and shrubs make the most contribution to carbon stock [39]. This is in line with the highest species richness in pristine, secondary and rehabilitated forests. At the same time, we clearly found that the species richness decreased as both openness and disturbance level of a habitat increased. Our results are consistent with data that disturbances and plantation or rehabilitation of forests alter and decline the species composition in a plant community [33].

Results of the conducted IUCN Red List assessments of two endemic species, *Aristolochia assamica* and *Chlorophytum assamicum*, made it possible to continue the search and monitoring of their new locations and future re-assessment of IUCN status. Moreover, now, Critically Endangered *A. assamica* is the 14<sup>th</sup> species in world and 1<sup>st</sup> species in South and South-east Asia of the genus *Aristolochia*, which are estimated globally [26]. Finally, it is the 3<sup>rd</sup> Critically Endangered *Aristolochia* species, while other ten species were previously assessed as Endangered (four taxa), Vulnerable (six taxa), Least Concern (one taxon). *Chlorophytum assamicum* is the 20<sup>th</sup> species of the genus *Chlorophytum* estimated globally. It is the 3<sup>rd</sup> globally assessed *Chlorophytum* species in both India and the whole of South and South-east Asia. Finally, *C. assamicum* is a 4<sup>th</sup> Critically Endangered *Chlorophytum* species assessed at a global scale, while three more *Chlorophytum* taxa were globally estimated as Endangered, one species is Vulnerable, one species is Data Deficient, and, finally, 11 *Chlorophytum* have Least Concern status [26]. Taking into account the high level of species endemism in the tropics and, in particular, in India, we propose a need to estimate more number of plant species according to IUCN Red List categories and criteria in order to fill gaps in knowledge on threats to plant species in the world.

### Conclusions

The BRF flora in the state of Assam demonstrates a high habitat diversity represented mainly by forests (pristine, secondary, rehabilitated), which reflects the predominance of woody plants in growth form spectrum. Although the present checklist is not an exhaustive inventory of the BRF (higher sampling effort is necessary to capture total local plant diversity), it serves as a starting point for future floristic and ecological studies in this and the nearest protected and managed areas in North-east Asia. Because during the present studies in BRF, three new species were described, one species was rediscovered after a century, as well as one new record obtained for the flora of Assam state [8, 9]. And at the same time, several such new records of plant species for India and for science are highly possible in future. The global IUCN Red List assessment conducted of two endemic plant species highlights an opportunity to obtain further data on populations of other plant species and throws light on the need for conservation programmes for species recovery through populations built up in native habitats.

**Acknowledgments:** This research was supported by the Department of Botany, Rajiv Gandhi University, Arunachal Pradesh. The authors are thankful to Altafhusain Nadaf (University of Pune, India), Ankur Upadhaya (Rajiv Gandhi University, India), Biswajit Das (North Eastern Regional Institute of Science and Technology, India), David J. Middleton (Singapore Botanic Gardens, Singapore), Dilip Kumar Roy (Botanical Survey of India, India), Do Van Truong (Vietnam National Museum of Nature, Vietnam), Felipe Moreira (Rio de Janeiro, Brazil), Hussain Barbhuiya

(Bhabha Atomic Research Centre, India), Hyeok Jae Choi (Changwon National University, Korea), J.R.I. Wood (University of Oxford, United Kingdom), Jana V Sudhakar (Dr. SRK Govt. Arts College, India), Jayanta Thakur (Gauhati University, India), Suhas Kadam Department of Environment & Forests, India), Khyanjeet Gogoi (Regional Orchids Germplasm Conservation and Propagation Centre, India), Leonid Averyanov (Komarov Botanical Institute of RAS, Russia), Michele Rodda (Singapore Botanic Gardens, Singapore), Mark Hughes (Royal Botanic Garden Edinburgh, Scotland), Martin Calamander (Missouri Botanical Garden, Missouri), Mipun Puranjay (BN College, India), Momang Taram (Rajiv Gandhi University, India), Munna Gorh (Biswanath College, India), N. Balachandran (French Institute of Pondicherry, India), Noriyuki Tanaka (Tokyo, Japan), Navendu Page (Indian Institute of Science, India), Nazir Ahmed Bhatt (North Eastern Hill University, India), Neelam Gap (North Eastern Regional Institute of Science and Technology, India), Nidhan Singh (IB College, India), Niku Das (Biswanath College, India), Padmaraj Gajurel (North Eastern Regional Institute of Science and Technology, India), Purna Tokbi (Biswanath, India), Rajeev Kumar Singh (Botanical Survey of India, India), Rajiv Barman (Biswanath College, India), Ritesh Kumar Choudhary (Agharkar Research Institute, India), Robert Dahanga (Tripura University, India), Rupam Bhujel (Gauhati University, India), Sabir Ahmed (Biswanath College, India), Sanjib Baruah (Bodoland University, India), Santanu Dey (Nagaland University, India), Santosh Nampy (Calicut University, India), Suman Kondha (Biswanath, India), Tapas Chakraborty (Kolkata, India), Todd J. Barkman (Western Michigan University, USA) for their cooperation in the field studies, identification, and drafting of this paper.

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**FLORA VASCULARĂ NATIVĂ DIN REZERVAȚIA PĂDUREA BEHALI (ASSAM, INDIA) CU  
EVALUAREA GLOBALĂ ÎN LISTELE ROȘII IUCN A DOUĂ SPECII ENDEMICE**

**(Rezumat)**

Investigarea florei și faunei din ariile protejate aduce contribuții importante la cunoașterea statutului ecosistemelor naturale neadministrare. În perioada 2017-2019, am studiat flora vasculară din Rezervația Pădurea Behali (Assam, India). Rezervația are o suprafață de 140,16 km<sup>2</sup> și este o pădure semi-sempervirescentă. Am investigat compoziția taxonomică a florei și diversitatea formelor de creștere a speciilor și habitatelor. În plus, am evaluat două

specii endemice (*Aristolochia assamica* și *Chlorophytum assamicum*) din punctul de vedere al criteriilor din Listelor Roșii IUCN. Rezultatele noastre au arătat că flora vasculară a Rezervației Pădurea Behali cuprinde 281 taxoni, cu 272 specii, o subspecie și opt varietăți. Acestea aparțin la 206 genuri și 79 familii. Printre acestea, *Pandanus unguifer* a fost menționat pentru prima dată în flora din Assam. În ceea ce privește spectrul formelor de creștere, au predominat arborii, lianele și tufărișurile, urmate de epifite, specii ierboase, geofite, anuale și parazite. Cel mai mare număr de specii de plante s-a înregistrat în zonele dense ale pădurii, în timp ce habitatele deschise s-au caracterizat prin cel mai mic număr de specii. *Chlorophytum assamicum* este evaluat ca CR B1ab(iii)+2ab(iii); D, iar *Aristolochia assamica* ca EN B2ab(iii). De asemenea, există o amenințare privind reducerea sau dispariția populațiilor acestor specii. Acest aspect este foarte important mai ales pentru *Chlorophytum assamicum*, reprezentat de o singură populație la nivel global. Cu siguranță studiile ulterioare ar putea pune în evidență un număr mai mare de specii floricole vasculare din Rezervația Pădurea Behali, precum și tendința de dezvoltare a populațiilor altor specii importante din punctul de vedere al categoriilor și criteriilor din Listele Roșii IUCN.

*Received: 16.09.2020; Accepted: 19.11.2020.*