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Floristic and Phytoclimatic Study of an Indigenous Small Scale Natural Landscape Vegetation of Jhargram District, West Bengal, India

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Abstract

Sacred groves are distinctive examples of biotic components as genetic resources being preserved in situ and serve as secure heavens for many endangered and endemic taxa. From this point of view, the biological spectrum, leaf spectrum and conservation status of the current sacred grove vegetation, SBT (*Swarga Bauri Than*) in Jhargram district of West Bengal, India, have been studied. The area's floristic study revealed that SBT's angiosperms were varied and consisted of 307 species belonging to 249 genera, distributed under 79 families of 36 orders as per APG IV. Fabales (12.05%) and Fabaceae (11.73%) are the dominant order and family in terms of species wealth. Biological spectrum indicates that the region enjoys "thero-chamae-cryptophytic" type of phytoclimate. With respect to the spectrum of the leaf size, mesophyll (14.05%) was found to be high followed by notophyll (7.84%), microphyll (7.19%), macrophyll (7.84%), nanophyll (6.86%), leptophyll (6.21%), and megaphyll (2.29%). The study area, being a sacred grove, it has a comparatively undisturbed status, and the protection of germplasm in the grove is based on traditional belief in the social system.

Keywords: biodiversity conservation, biological spectrum, leaf spectra, life-form, sacred grove

1. Introduction

Sacred groves are indigenous small scale natural landscape of native vegetation kinds that are traditionally protected and managed by local populations. A range of taboos and prohibitions are used to preserve biodiversity in 'sacred groves' (Colding and Folke, 1997, 2001; Berkes, 2009). Many of them are connected to the premises of tiny temples. These sacred groves comprise plant species that are endemic, rare and endangered. They are therefore natural nursery with rare, threatened and endemic plant species, many of which have vanished outside the groves from the region (Colding and Folke, 1997).

Local communities preserve and protect sacred groves because of their religious convictions and the related traditional rituals that run through several generations. They may consist of multi-species, multitier primary forests or a clump of trees, depending on the history of the vegetation (Gokhale et al., 2011). According to Hughes and Chandran (1998), these groves are landscape segments comprising vegetation and other types of life and geographical characteristics that are delimited and protected by human communities, believing that maintaining them in a comparatively undisturbed state is an expression of human relationship with the divine or nature. Such groves are often situated in biodiversity-rich areas, ranging from a few trees to multi-acre forestland. Adapting a plant to certain ecological circumstances determines a type of life; therefore, it is a significant feature of physiognomy that has been commonly used in vegetation assessment. It shows the macro and microclimate and human disturbances of a certain area (Cain and Castro, 1959).

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The word “biological spectrum” was suggested by Raunkiaer (1934) to describe the distribution of life-form in a flora as well as the phytoclimate under which the prevailing life-forms developed.Under this scheme, plant species can be divided into five primary groups, i.e., phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes.

The percentage of various life form classes put together is called as the biological spectrum. Raunkiaer (1934) built a standard spectrum that could behave as a null model, compared to different spectra of life form. The standard spectrum of Raunkiaer (1934) shows a phanerophytic community, and the deviation (from it) determines the habit's phytoclimate. The occurrence in separate areas of comparable biological spectra shows comparable climatic circumstances. Thus, the differences between normal spectrum and biological spectrum life forms may point out which life form characterises the phytoclimate or vegetation.

Climatic types may be characterised by the prevailing plant life forms in the plant communities under a specific climatic regime (Raunkiaer, 1934; Cain, 1950; Muller and Ellenberg, 1974; Saxena et al., 1982). The Indian region's biological spectrum is linked to particular edaphic, altitude and climatic variables (Meher-Homji, 1964; Rana et al., 2002; Reddy et al., 2011; Sen and Bhakat, 2009, 2012; Singh and Gupta, 2015; Sen, 2016, 2018; Sen and Bhakat, 2018, 2019a, b, c). Studying life-form is therefore a significant component of the description of vegetation, ranking next to floristic structure (Batalha and Martins, 2004). Therefore, the biological spectrum is helpful as an index of forest landscape health status. Biological spectrum may set rules for a community's optimisation and eco-restoration when performed at regular intervals.

Life form may also be categorised using leaf size i.e., leptophylls, nanophyll, microphyll, notophyll, mesophyll, macrophyll and megaphyll. It has some justification for using a leaf size to characterise distinct kinds of vegetation based on percentages of the distinct leaf dimensions present. However, light intensity and soil conditions, especially nitrogen and phosphorus accessible; also have a significant impact on the size of the leaf even within the same genotype (Cunningham et al., 1999).

2. Materials and Methods

2.1 Study site

a) The sacred grove

The study was conducted in a forested sacred grove namely SBT on outer edge of a tribal dominated Chhotopindara, Ranijhor and Dochakhuria villages along the south-western bank of a perennial rivulet Palpala, under Gidni block (latitude $22^{o}26^{/}00.09^{//}$-$22^{o}26^{/}01.48^{//}$ N and longitude $86^{o}50^{/}00.90^{//}$-$86^{o}50^{/}01.56^{//}$ E, average altitude 86.7 m asl) in Jhargram district of West Bengal, India (Figure. 1, 2, 3). The grove houses a brick-made small temple and is spread over a 3.5 acre public land. The grove is located about 38 km southeast from district headquarters at Jhargram town, located in the southern part of West Bengal, India (Figure. 1).

It represents a 400-450-year-old relict forest patch consisting of evergreen, deciduous and semi-deciduous plants. After the eight days of annual Paus Sankranti (a ritual celebrated on the last day of the Bengali Month Paus or middle of January) and every Tuesday and Saturday local people, both tribal and non-tribal of Gidni and adjoining blocks, visit the grove and worship the deity. Since the grove is an abode of deity, the entire area along with plants and other life forms is considered sacred. Owing to this socio-cultural tag on the grove, local people do not cut or disturb the grove flora, thus strictly adhering to the taboos and ethics.

Jhargram district covers an area of 3,037.64 km^2 and had a population of 1,136,548 in the 2011 census. 96.52% of the total population were rural and only 3.48% were urban population. 20.11% of the total population belonged to scheduled castes and 29.37% belonged to scheduled tribes. Its population growth rate over the decade 2001-2011 was 10.9%. The literacy rate was 72% in 2011, where the male literacy rate was 81% and female at 64%. The sex ratio was 979 females per 1,000 males (Anon, 2011).

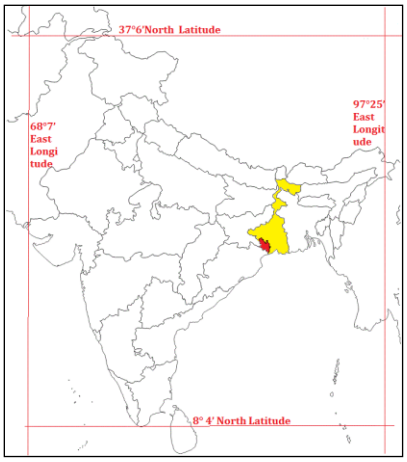

Figure 1. Location of the study area.

Figure 2. Google earth image showing SBT

Figure 3. Small temple in SBT sacred grove.

2.2 Field survey and data collection

During the period from December 2012 to January 2019, the study area was carefully surveyed in various seasons to explore the botanical and social wealth. A short floristic study was conducted on the grounds of "spot identification". Samples of plants with flowers or fruits have been gathered for unknown plants. The samples were processed, maintained, poisoned and assembled on herbarium sheets using conventional and modern herbarium methods after collection (Jain and Rao, 1977). In the sacred grove, photographs were taken of some prevalent, locally rare, endemic and valuable plant species. Herbarium sheets have been recognised by matching properly annotated materials available at Vidyasagar University's Herbarium. For identification purpose, different relevant catalogue (Anderson, 1862), regional floras (Hooker, 1872-1897; Prain, 1903; Haines, 1921-1925; Bennet, 1979; Sanyal, 1994), monographs (Mitra, 1958), revisionary works (Datta and Majumdar, 1966) and other literature were consulted. The socio-cultural functions surrounding the grove were recorded through information collected by interviewing and cross-interviewing the local people.

2.3 Analysis of vegetation

In the systematic enumeration of the taxa; clade, order, family, species along with habit, life-span, flowering and fruiting time, Raunkiaer's life-form with sub-type, leaf spectra, IUCN status (IUCN, 2020) and distribution of the plants in the grove have been arranged according to Angiosperm Phylogeny Group IV classification (Chase et al., 2016) (Table 1). All the species were categorised into various Raunkiaer's life form categories depending on the position of regenerating parts or propagules in all the collected species. Thus a biological spectrum was prepared for the grove that was subsequently compared with the Raunkiaer's normal spectrum to determine the phytoclimate of the grove (Raunkiaer, 1934; Muller and Ellenberg, 1974). The knowledge of leaf size helped us understand the physiological status of plants and the plant communities were useful in classifying the associations of plants. Plants were divided into (a) leptophyll (<25 mm^2), (b) nanophyll (25-225 mm^2), (c) microphyll (225-2,025

mm^2), (d) notophyll (2,025-4,500 mm^2), (e) mesophyll (4,500-18,225 mm^2), (f) macrophyll (18,225-164,025 mm^2) and (g) megaphyll (>164,025 mm^2) (Raunkiaer, 1934).

3. Results and Discussion

3.1 Different plant taxa

In the present study, a total of 307 species belonging to 249 genera distributed over 79 families under 36 orders (APG IV, 2016) were recorded from the sacred grove. The top two clades are Rosids and Asterids. More than 81% of the flora is represented by orders of Eudicot and Core Eudicot, of which the major contributions in terms of descending species number (≥10 species) are from Fabales 37 (12.05%), Lamiales 36 (11.73%), Gentianales 28 (9.12%), Poales 28 (9.12%), Malvales 20 (6.51%), Asterales 17 (5.54%), Malpighiales 17 (5.54%), Myrtales 15 (4.89%), Solanales 14 (4.56%), Sapindales 13 (4.23%) and Caryophyllales 12 (3.91%) (Table 1, Figure. 4). Similar types of distribution of orders were highlighted by Gnanasekaran et al., 2012; Sen, 2016, 2018 and Sen and Bhakat, 2018, 2019a, b, c.

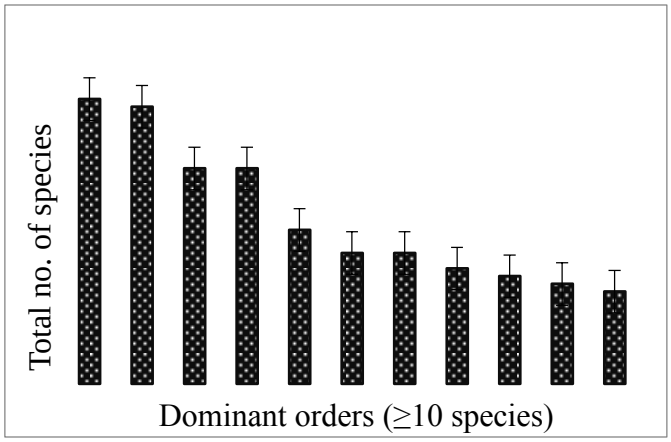

Figure 4. Major contribution of orders (≥10 species) in the SBT.

The fourteen well represented families in species (≥6 species), are: Fabaceae 36 (11.73%), Poaceae 20 (6.51%), Malvaceae 19 (6.19%), Apocynaceae 18 (5.86%), Asteraceae 17 (5.54%), Lamiaceae 15 (4.89%), Acanthaceae 12 (3.91%), Euphorbiaceae 9 (2.93%), Rubiaceae 9 (2.93%), Cyperaceae 8 (2.61%), Solanaceae 8 (2.61%), Amaranthaceae 6 (1.95%), Combretaceae 6 (1.95%) and Convolvulaceae 6 (1.95%) (Table 1, Figure. 5). Cucurbitaceae, Moraceae and Phyllanthaceae comprised 5 (1.62%) species each. Four families contained 4 (1.30%), eight families contained 3 (0.98%) and thirteen families covered 2 (0.65%) species. Another 37 families each had only a single species (Table 1).

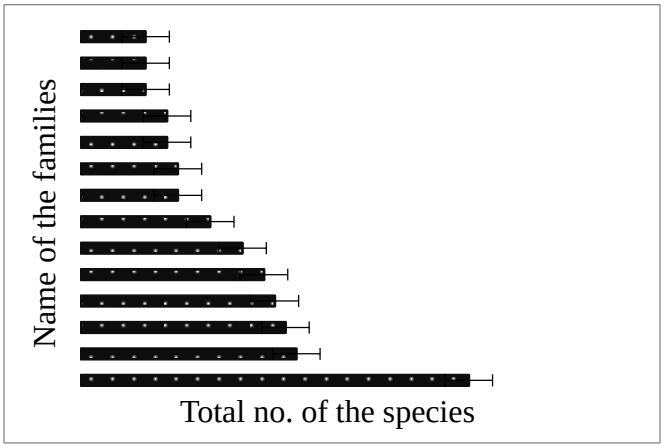

Figure 5. Major contribution of families (≥6 species) in the SBT.

Same type dominant families of sacred groves in India were observed by Rajendraprasad et al., 1998; Ghildiyal et al., 2016; Sen, 2016 etc. In the global context, such family dominance was shown by Batalha and Martins, 2004; Badshah et al., 2016; Chigani et al., 2017 etc. Asteraceae, Fabaceae and Poaceae emerged as the common families in the investigated area. Mendez (2005) also stated that the abundance of the same families in Laguna (Mendoza, Argentina). The members of Fabaceae and Poaceae were dominant due to their distribution with wide ecological amplitude.

3.2 Species diversity in different growth forms

The present floristic study of the sacred grove showed that it harboured a total of 307 plant species [dicots 249 (81.11%) and monocots 58 (18.89%)] belonging to 249 genera [dicots 203 (81.53%) and monocots 46 (18.47%)] of 79 families [dicots 62 (78.48%) and monocots 17 (21.52%)] under 36 orders [dicots 27 (75%) and monocots 9 (25%)]. Among these, 119 (38.76%) of the reported species were herbs followed by shrubs 63 (20.52%), trees 76 (24.76%) and climbers 49 (15.96%) respectively. Amongst the total dicots 249 (81.11%) and monocots 58 (18.89%), herbs, shrubs, trees and climbers represented 79, 59, 70, 41 and 40, 4, 6, 8 species respectively, representing 25.73%, 19.22%, 22.80%, 13.36% and 13.03%, 1.30%, 1.95%, 2.61% of the total species (Table 2, Figure 6).

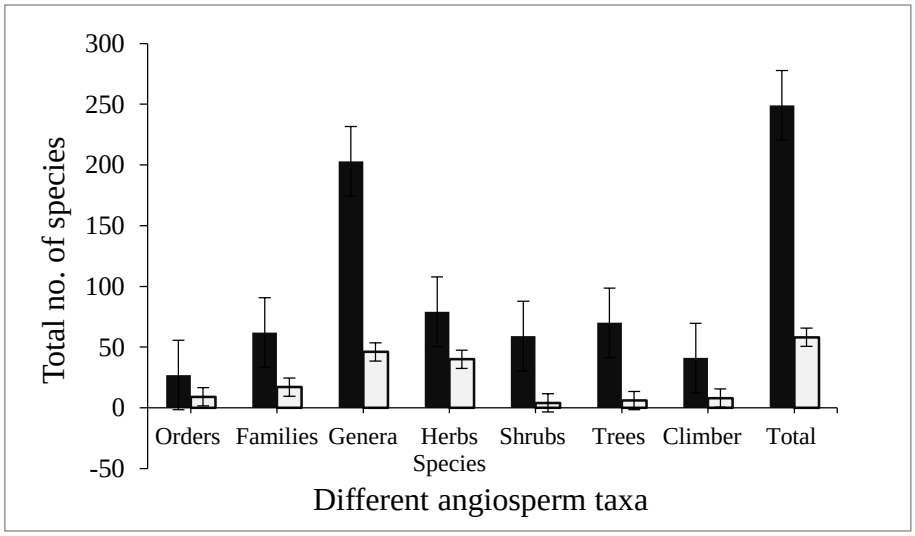

Figure 6. Total angiosperm taxa.

Table 1: Floristic list of SBT sacred grove.

Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Piperales Bercht. and J. Presl							
Aristolochiaceae Juss.							
Aristolochia indica L.	C	A	Jul.-Jan.	Cr	-	No	NE
Magnoliales Juss. ex Bercht. and J. Presl							
Annonaceae Juss.							
Annona reticulata L.	T	P	JuL.-Dec.	Ph	N	Me	NE
Annona squamosa L.	T	P	Mar.-Sep.	Ph	N	Me	LC
Laurales Juss. ex Bercht. and J. Presl							
Lauraceae Juss.							
Litsea glutinosa (Lour.) C. B. Rob.	T	P	Apr.-Sep.	Ph	M	Ma	LC
INDEPENDENT LINEAGE: UNPLACED TO MORE INCLUSIVE CLADE							
Alismatales R. Br. ex Bercht. and J. Presl							
Araceae Juss.							
Alocasia macrorrhizos (L.) G. Don	H	P	Apr.-May	Cr	-	Me	NE
Amorphophallus paeoniifolius (Dennst.) Nicolson	H	A	Jun.-Dec.	Cr	-	Mg	LC
Colocasia esculenta (L.) Schott	H	A	Jul.-Oct.	Cr	-	Mg	LC
Scindapsus officinalis (Roxb.) Schott	C	P	-	Cr	-	Mg	NE
Hydrocharitaceae Juss.							
Hydrilla verticillata (L. f.) Royle	H	A	Nov.-Mar.	Cr	-	Le	LC
Dioscoreales Mart.							
Dioscoreaceae R. Br.							
Dioscorea alata L.	C	P	Aug.-Dec.	Cr	-	Ma	NE
Dioscorea bulbifera L.	C	P	Aug.-Dec.	Cr	-	Ma	NE
Dioscorea pentaphylla L.	C	P	Sep.-Feb.	Cr	-	Me	NE
Pandanales R. Br. ex Bercht. and J. Presl							
Pandanaceae R. Br.							
Pandanus odorifer (Forssk.) Kuntze	S	P	Jul.-May	Ph	N	Ma	LC
Liliales Perleb							
Colchicaceae DC.							
Gloriosa superba L.	C	P	Jul.-Sep.	Cr	-	No	LC
Smilacaceae Vent.							
Smilax ovalifolia Roxb. ex D. Don	C	P	Jun.-Dec.	Ch	-	Me	NE
Asparagales Link							
Orchidaceae Juss.							
Vanda tessellata (Roxb.) Hook. ex G. Don	H	P	Apr.-Jul.	Ph	N	No	LC

Hypoxidaceae R. Br.							
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Curculigo orchioides Gaertn.	H	P	Aug.-Oct.	Cr	-	Mi	NE
Xanthorrhoeaceae							
Aloe vera (L.) Burm.f.	H	P	Dec.-Feb.	Cr	-	Me	NE
Amaryllidaceae J. St.-Hil.							
Crinum asiaticum L.	H	P	Aug.-Oct.	Cr	-	Mg	NE
Asparagaceae Juss.							
Agave americana L.	S	P	Sep.-Mar.	Cr	-	Mg	NE
Asparagus racemosus Willd.	C	P	Aug.-Dec.	Cr	-	Le	NE
Yucca gloriosa L.	S	P	Nov.-Jun.	Cr	-	Me	NE
Arecales Bromhead							
Arecaceae Bercht. and J. Presl							
Borassus flabellifer L.	T	P	Mar.-Oct.	Ph	MM	Mg	EN
Phoenix acaulis Roxb.	S	P	Feb.-Jun.	Ch	-	Me	NE
Phoenix sylvestris (L.) Roxb.	T	P	Feb.-Jun.	Ph	M	Me	NE
Commelinales Mirb. ex Bercht. and J. Presl							
Commelinaceae Mirb.							
Commelina benghalensis L.	H	A	Aug.-Nov.	Th	-	Mi	LC
Murdannia nudiflora (L.) Brenan	H	A	Jul.-Nov.	Th	-	Na	NE
Zingiberales Griseb.							
Costaceae Nakai							
Cheilocostus speciosus (J. Koenig) C. D. Specht	H	P	Jul.-Sep.	Cr	-	Ma	NE
Zingiberaceae Martinov							
Curcuma aromatica Salisb.	H	P	May-Jun.	Cr	-	Ma	NE
Kaempferia galanga L.	H	P	May-Jun.	Cr	-	Ma	NE
Poales Small							
Cyperaceae Juss.							
Cyperus difformis L.	H	P	Jul.-Nov.	He	-	Le	LC
Cyperus dubius Rottb.	H	p	Sep.-Dec.	He	-	Le	LC
Cyperus platystylis R. Br.	H	P	May-Jun.	He	-	Le	NE
Cyperus rotundus L.	H	P	Sep.-Dec.	He	-	Le	LC
Fimbristylis cymosa R. Br.	H	p	Feb.-May	He	-	Le	LC
Fimbristylis dichotoma (L.) Vahl	H	P	Aug.-Oct.	He	-	Le	LC
Fimbristylis quinquangularis (Vahl) Kunth	H	P	Aug.-Nov.	He	-	Le	LC
Rhynchospora colorata (L.) H. Pfeiff.	H	P	May-Oct.	He	-	Le	NE
Poaceae Barnhart							
Aristida setacea Retz.	H	P	Aug.-Dec.	He	-	Le	NE

Bambusa bambos (L.) Voss	T	P	Jul.-Feb.	Ph	M	Me	LC
Brachiaria reptans (L.) C. A. Gardner and C. E.	H	A	Aug.-Oct.	He	-	Mi	LC
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Chloris barbata (L.) Sw.	H	P	Aug.-Nov.	He	-	Le	NE
Chrysopogon aciculatus (Retz.) Trin.	H	P	Sep.-Dec.	He	-	Le	NE
Chrysopogon zizanioides (L.) Roberty	H	P	Jun.-Oct.	He	-	Le	NE
Coix lacryma-jobi L.	H	A	Aug.-Jan.	He	-	No	NE
Cymbopogon citratus (DC.) Stapf.	H	A	Oct.-Dec.	He	-	Le	NE
Cynodon dactylon (L.) Pers.	H	P	All	He	-	Le	NE
Digitaria sanguinalis (L.) Scop.	H	P	Mar.-Jun.	He	-	Le	NE
Echinochloa crusgalli (L.) P. Beauv.	H	A	Aug.-Nov.	He	-	Na	LC
Echinochloa frumentacea Link	H	A	Aug.-Nov.	He	-	Na	LC
Eleusine indica (L.) Gaertn.	H	P	Aug.-Nov.	He	-	Le	LC
Eragrostis amabilis (L.) Wight and Am.	H	P	Aug.-Feb.	He	-	Le	NE
Eragrostis ciliaris (L.) R. Br.	H	P	Aug.-Feb.	He	-	Le	NE
Imperata cylindrica (L.) Raeusch.	H	P	Oct.-Dec.	He	-	Na	LC
Paspalum scrobiculatum L.	H	P	Aug.-Nov.	He	-	Na	LC
Pennisetum glaucum (L.) R. Br.	H	P	Aug.-Oct.	He	-	Mi	LC
Setaria glauca (L.) R. Br.	H	P	Aug.-Nov.	He	-	Le	NE
Sporobolus indicus (L.) R. Br.	H	P	Aug.-Nov.	He	-	Na	NE
EUDICOTS							
Ranunculales Juss. ex Bercht. and J. Presl							
Papaveraceae Juss.							
Argemone mexicana L.	H	A	Dec.-Apr.	Th	-	Ma	NE
Menispermaceae Juss.							
Stephania japonica (Thunb.) Mier.	C	P	Jul.-Dec.	Ph	N	Me	NE
Tinospora sinensis (Lour.) Merr.	C	P	Feb.-Jun.	Ph	N	Me	NE
CORE EUDICOTS							
SUPERROSIDS							
Saxifragales Bercht. and J. Presl							
Crassulaceae J. St. -Hil.							
Bryophyllum pinnatum (Lam.) Oken	H	P	Mar.-Jun.	Ch	-	Ma	NE
ROSIDS							
Vitales Juss. ex Bercht. and J. Presl							
Vitaceae Juss.							
Ampelocissus latifolia (Roxb.) Planch.	C	P	Jun.- Sep.	Ph	N	Me	NE
Cayratia trifolia (L.) Domin.	C	P	Aug.-Dec.	Ph	N	No	NE
Cissus quadrangularis L.	C	P	Jul.-Jan.	Ph	N	No	NE

Leea asiatica (L.) Ridsdale	C	P	Jul.-Sep.	Ph	N	Me	NE
Zygophyllales Link							
Zygophyllaceae R. Br.							
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Tribulus terrestris L.	C	A	Feb.-Sep.	Th	-	Na	LC
Fabales Bromhead							
Fabaceae Lindl.							
Abrus precatorius L.	C	P	Aug.-Mar.	Ph	N	Na	NE
Acacia pennata (L.) Willd.	T	P	Feb.-Oct	Ph	M	Na	LC
Acacia polyacantha Willd.	T	P	Feb.-Oct	Ph	M	Na	LC
Acacia rugata (Lam.) Fawc. and Rendle	T	P	Feb.-Oct	Ph	M	Na	NE
Acacia auriculiformis Benth.	T	P	Feb.-Oct.	Ph	M	Me	LC
Acacia nilotica (L.) Delile	T	P	Jun.-Sep.	Ph	M	Na	LC
Adenanthera pavonina L.	T	P	Mar.-Jan.	Ph	M	No	LC
Albizia lebbeck (L.) Benth.	T	P	Mar.-Feb.	Ph	MM	Mi	NE
Albizia saman (Jacq.) Merr.	T	P	Mar.-Feb.	Ph	MM	Me	NE
Bauhinia vahlii Wight and Arn.	C	P	Apr.-Feb.	Ph	N	Mg	NE
Bauhinia variegate L.	T	P	Feb.-Jun.	Ph	M	Me	LC
Butea superba Roxb.	C	P	Feb.-Jul.	Ph	M	Ma	NE
Caesalpinia pulcherrima (L.) Sw.	T	P	Mar.-Sep.	Ph	M	Mi	LC
Caesalpinia bonduc (L.) Roxb.	C	P	Aug.-Apr.	Ph	N	Mi	LC
Caesalpinia globulorum Bakh. f. and P. Royen	C	P	Mar.-Sep.	Ph	N	Mi	NE
Cajanus scarabaeoides (L.) Thouars	C	A	Sep.-Feb.	Ph	N	Mi	LC
Clitoria ternatea L.	C	A	All	Ph	N	No	NE
Codariocalyx motorius (Houtt.) H. Ohashi	S	A	Aug.-Dec.	Ch	-	Na	NE
Crotalaria pallida Aiton	S	A	Aug.-Jan.	Ch	-	No	NE
Crotalaria prostrata Willd.	H	A	Aug.-Jan.	Th	-	No	NE
Derris indica (Lam.) Bennet	C	P	Jul.-Jan.	Ph	N	Na	NE
Flemingia strobilifera (L.) W. T. Aiton	H	A	Feb.-Sep.	Ch	-	Me	NE
Indigofera tinctoria L.	H	B	Aug.-Nov.	Th	-	Mi	NE
Mimosa pudica L.	H	P	Jul.-Nov.	Th	-	Na	LC
Mimosa rubicaulis Lam.	S	P	Jul.-Nov.	Ch	-	Na	NE
Mucuna pruriens (L.) DC.	C	A	Sep.-May	Ch	-	Le	NE
Parkinsonia aculeate L.	T	P	Oct.-Jun.	Ph	N	Mi	LC
Peltophorum pterocarpum (DC.) K. Heyne	T	P	Mar.-Jan.	Ph	MM	Mi	NE
Pongamia pinnata (L.) Pierre	T	P	Apr.-Feb.	Ph	M	Me	LC
Senna alata (L.) Roxb.	S	A	Aug.-Nov.	Ch	-	Ma	LC
Senna occidentalis (L.) Link	S	P	Aug.-Dec.	Ch	-	No	NE

Senna tora (L.) Roxb.	H	A	Sep.-Dec.	Th	-	Mi	NE
Sesbania sesban (L.) Merr.	S	P	Dec.-Apr.	Ch	-	Ma	LC
Tamarindus indica L.	T	P	Apr.-Jan.	Ph	MM	Na	LC
Tephrosia purpurea (L.) Pers.	H	P	Sep.-Dec.	Th	-	Na	LC
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Zornia gibbosa Span.	H	A	Aug.-Nov.	Th	-	Na	NE
Polygalaceae Hoffmanns. and Link							
Polygala arvensis Willd.	H	A	Jul.-Dec.	Th	-	Me	NE
Rosales Bercht. and J.Presl							
Rhamnaceae Juss.							
Ventilago denticulata Willd.	C	P	Sep.-Jun.	Ph	N	Me	NE
Ziziphus jujube Mill.	T	P	Sep.-Mar.	Ph	M	No	LC
Ziziphus oenopolia (L.) Mill.	C	P	Nov.-Mar.	Ph	N	No	LC
Ulmaceae Mirb.							
Holoptelea integrifolia Planch	T	P	Jan.-Jun.	Ph	MM	Me	NE
Moraceae Gaudich.							
Artocarpus heterophyllus Lamk.	T	P	Jan.-Aug.	Ph	M	Ma	NE
Ficus benghalensis L.	T	P	Mar.-Sep.	Ph	MM	Ma	NE
Ficus religiosa L.	T	P	Jun.-Aug.	Ph	MM	Ma	NE
Ficus racemose L.	T	P	Mar.-Aug.	Ph	M	Ma	LC
Streblus asper Lour.	T	P	Feb.-Jun.	Ph	N	Mi	LC
Cucurbitales Juss. ex Bercht. and J. Presl							
Cucurbitaceae Juss.							
Cayaponia laciniosa (L.) C. Jeffrey	C	A	Jun.-Jan.	Ph	N	Mi	NE
Coccinia grandis (L.) Voigt	C	P	Mar.-Dec.	Ph	N	Me	NE
Momordica dioica Roxb. ex Willd.	C	A	Aug.-Dec.	Ph	N	Me	NE
Trichosanthes cucumerina L	C	P	Aug.-Dec.	Ph	N	Me	NE
Trichosanthes tricuspidata Lour.	C	A	Apr.-Sep.	Ph	N	Me	NE
Celastrales Link							
Celastraceae R. Br.							
Celastrus paniculatus Willd.	C	P	Apr.-Dec.	Ph	N	Me	NE
Oxalidales Bercht. and J. Presl							
Oxalidaceae R.Br.							
Averrhoa carambola L.	T	P	Feb.-Sep.	Ph	N	Ma	NE
Oxalis corniculata L.	H	A	All	Th	-	Na	NE
Malpighiales Juss. ex Bercht. and J. Presl							
Clusiaceae Lindl.							
Garcinia xanthochymus Hook. f. ex T. Anderson	T	P	Mar.-Jan.	Ph	M	No	NE

Violaceae Batsch							
Hybanthus enneaspermus (L.) F. Muell.	H	P	Jul.-Nov.	Th	-	Na	NE
Salicaceae Mirb.							
Flacourtia indica (Burm. f.) Merr.	S	P	Sep.-May.	Ch	-	Mi	LC
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Euphorbiaceae Juss.							
Acalypha indica L.	H	A	All	Th	-	No	NE
Croton bonplandianus Baill.	H	P	All	Th	-	No	NE
Euphorbia antiquorum L.	T	P	Jan.-Apr.	Ph	N	Le	NE
Euphorbia hirta L.	H	A	Feb.-Dec.	Th	-	Na	NE
Euphorbia neriifolia L.	S	P	Oct.-Feb.	Ch	-	Le	NE
Jatropha curcas L.	S	P	Mar.-Aug.	Ch	-	Ma	NE
Jatropha gossypifolia L.	S	P	Mar.-Aug.	Ch	-	Ma	NE
Ricinus communis L.	S	P	Jan.-Apr.	Ph	N	Mg	NE
Tragia involucrata L.	C	P	Mar.-Jan.	Ph	N	Me	NE
Phyllanthaceae Martinov							
Antidesma acidum Retz.	T	P	Jun.-Dec.	Ph	N	Me	LC
Breynia vitis-idaea (Burm. f.) C. E. C. Fisch.	S	P	Apr.-Dec.	Ph	N	Mi	LC
Bridelia retusa (L.) A. Juss.	T	P	Mar.-Dec.	Ph	N	Me	LC
Phyllanthus amarus Schumach. and Thonn.	H	A	Apr.-Sep.	Th	-	Na	NE
Phyllanthus virgatus G. Forst.	H	A	Apr.-Sep.	Th	-	Na	NE
Myrtales Juss. ex Bercht. and J. Presl							
Combretaceae R. Br.							
Combretum album Pers.	C	P	Nov.-May	Ph	N	Me	NE
Combretum decandrum Jacq.	C	P	Nov.-May	Ph	N	Me	NE
Combretum indicum (L.) De Filipps	C	P	All	Ph	N	Me	NE
Terminalia arjuna (Roxb. ex DC.) Wight and Arn.	T	P	Apr.-Feb.	Ph	MM	Ma	NE
Terminalia bellirica (Gaertn.) Roxb.	T	P	Apr.-Feb.	Ph	MM	Ma	NE
Terminalia tomentosa (Roxb.) Wight and Arn.	T	P	Apr.-May	Ph	MM	Ma	NE
Lythraceae J.St.-Hil.							
Ammannia baccifera L.	H	A	Sep.-Feb.	Th	-	Le	LC
Lawsonia inermis L.	S	P	Oct.-Dec.	Ph	N	Na	NE
Punica granatum L.	S	P	Mar.-Oct.	Ph	N	Na	LC
Rotala densiflora (Roth) Koehne	H	A	Aug.-Nov.	Th	-	Le	LC
Onagraceae Juss.							
Ludwigia octovalvis (Jacq.) P. H. Raven	H	A	Sep.-Jan.	Th	-	Mi	LC
Myrtaceae Juss.							

Eucalyptus tereticornis Sm.	T	P	Mar.-Jul.	Ph	MM	Me	NE
Psidium guajava L.	T	P	Apr.-Oct.	Ph	N	Me	LC
Syzygium cumini (L.) Skeels	T	P	Mar.-Jul.	Ph	MM	Me	LC
Melastomataceae Juss.							
Melastoma malabathricum L.	S	P	May-Jan.	Ch	-	Me	NE
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Sapindales Juss. ex Bercht. and J. Presl							
Anacardiaceae R. Br.							
Lannea coromandelica (Houtt.) Merr.	T	P	Feb.-Jun.	Ph	M	Mg	NE
Mangifera indica L.	T	P	Feb.-Jun.	Ph	M	Ma	DD
Semecarpus anacardium L. f.	T	P	Jul.-Dec.	Ph	M	Mg	NE
Sapindaceae Juss.							
Cardiospermum halicacabum L.	C	A	Jul.-Dec.	Ph	N	No	NE
Sapindus emarginatus Vahl	T	P	Dec.-May	Ph	M	Me	NE
Schleichera oleosa (Lour.) Merr.	T	P	Mar.-Jul.	Ph	MM	Ma	LC
Rutaceae Juss.							
Aegle marmelos (L.) Corrêa	T	P	May-Jul.	Ph	M	Me	NE
Glycosmis pentaphylla (Retz.) DC.	T	P	Sep.-Feb.	Ph	N	Me	LC
Limonia acidissima Groff	T	P	Jan.-Dec.	Ph	M	Na	NE
Murraya koenigii (L.) Spreng.	T	P	Apr.-Jun.	Ph	N	Na	NE
Simaroubaceae DC.							
Ailanthus excelsa Roxb.	T	P	Jan.-Jun.	Ph	MM	Ma	NE
Meliaceae Juss.							
Azadirachta indica A. Juss.	T	P	Mar.-Jul.	Ph	M	No	LC
Melia azedarach L.	T	P	Feb.-Nov.	Ph	M	No	LC
Malvales Juss. ex Bercht. and J. Presl							
Malvaceae Juss.							
Abelmoschus crinitus Wall.	S	A	Mar.-Sep.	Ch	-	No	NE
Abelmoschus moschatus Medik.	S	A	Mar.-Aug..	Ch	-	No	NE
Abutilon indicum (L.) Sweet	S	A	Jun.-Dec.	Ch	-	Ma	NE
Ambroma augusta L. f.	S	P	Jan.-Mar.	Ph	N	Ma	NE
Azanza lampas (Cav.) Alef.	S	A	Sep.-Dec.	Ch	-	Ma	NE
Corchorus aestuans L.	H	A	Jul.-Nov.	Th	-	Me	NE
Gossypium arboreum L.	S	P	Aug.-Feb.	Ch	-	Ma	NT
Gossypium barbadense L.	S	P	Dec.-Apr.	Ch	-	Ma	LC
Grewia helicterifolia Wall, ex G. Don	T	P	Jun.-Sep.	Ph	N	Ma	NE
Grewia asiatica L.	T	P	Jun.-Aug.	Ph	N	Me	LC
Helicteres isora L.	S	P	Sep.-Feb.	Ph	N	Me	NE
Hibiscus rosa-sinensis L.	S	P	All	Ch	-	Me	NE

Hibiscus vitifolius L.	S	A	Oct.-Feb.	Ch	-	Me	NE
Pterospermum acerifolium (L.) Willd.	T	P	Jan.-Aug.	Ph	MM	Ma	NE
Sida acuta Burm. f.	S	A	Aug.-Dec.	Th	-	No	NE
Sida cordata (Burm.f.) Borss. Waalk.	H	A	Aug.-Feb.	Th	-	No	NE
Sida cordifolia L.	S	A	Aug.-Dec.	Th	-	No	NE
Triumfetta rhomboidea Jacq.	S	A	Sep.-Jan.	Th	-	Me	NE
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Urena sinuata L.	S	A	Sep.-Dec.	Ch	-	No	NE
Bixaceae Kunth							
Bixa orellana L.	T	P	Oct.-Mar.	Ph	N	Me	LC
Brassicales Bromhead							
Capparaceae Juss.							
Capparis zeylanica L.	C	P	Mar.-Oct.	Ph	M	No	NE
Crateva nurvala Buch.-Ham.	T	P	Mar.-Jul.	Ph	M	Me	NE
Cleomaceae Bercht. and J. Presl							
Cleome gynandra L.	H	A	Jul.-Sep.	Th	-	No	NE
Cleome viscosa L.	H	A	Sep.-Apr.	Th	-	No	NE
SUPERASTERIDS							
Santalales R. Br. ex Bercht. and J. Presl							
Santalaceae R. Br.							
Viscum cruciatum Sieber ex Boiss.	S	P	Jan.-Jun.	Ph	N	Le	NE
Loranthaceae Juss.							
Loranthus cordifolius Wall.	S	A	Jul.-Nov.	Ph	N	No	NE
Scurrula atropurpurea (Blume) Danser	S	A	Nov.-Mar.	Ph	N	No	NE
Caryophyllales Juss. ex Bercht. and J. Presl							
Droseraceae Salisb.							
Drosera burmanni Vahl	H	A	Nov.-Apr.	Th	-	Le	LC
Amaranthaceae Juss							
Achyranthes aspera L.	H	A	Sep.-Feb.	Th	-	Mi	NE
Aerva lanata (L.) Juss.	H	A	Nov.-Jan.	Th	-	Le	NE
Alternanthera sessilis (L.) R. Br. ex DC.	H	A	Jul.-Feb.	Th	-	Mi	LC
Amaranthus spinosus L.	H	A	All	Th	-	Na	NE
Amaranthus viridis L.	H	A	All	Th	-	Na	NE
Celosia argentea L.	H	A	Sep.-Feb.	Th	-	Na	NE
Aizoaceae Martinov							
Trianthema portulaccastrum L.	H	A	Apr.-Oct.	Th	-	Mi	NE
Nyctaginaceae Juss.							
Boerhavia diffusa L.	H	A	Jun.-Dec.	Th	-	Mi	NE

Portulacaceae Juss.							
Portulaca oleracea L.	H	A	Jun.-Dec.	Th	-	Mi	NE
Cactaceae Juss.							
Cereus pterogonus Lam.	S	P	Jun.-Jul.	Ch	-	Le	NE
Opuntia stricta (Haw.) Haw.	S	P	Apr.-Aug.	Ch	-	Le	LC
ASTERIDS							
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Cornales Link							
Cornaceae Bercht. and J. Presl							
Alangium salviifolium (L. f.) Wangerin	T	P	Mar.-Jul.	Ph	N	Me	NE
Ericales Bercht. and J. Presl							
Lecythidaceae A. Rich.							
Careya arborea Roxb.	T	P	Jan.-Apr.	Ph	M	Mg	NE
Sapotaceae Juss.							
Madhuca longifolia var *latifolia* (Roxb.) A. Chev.	T	P	Mar.-Jul.	Ph	MM	Ma	NE
Mimusops elengi L.	T	P	Apr.-Sep.	Ph	MM	Me	LC
Ebenaceae Gurke							
Diospyros melanoxylon Roxb.	T	P	Apr.-Jul.	Ph	MM	Ma	NE
Gentianales Juss. ex Bercht. and J. Presl							
Rubiaceae Juss.							
Gardenia gummifera L. f.	T	P	Mar.-Aug.	Ph	N	No	LC
Gardenia resinifera Roth	S	P	Feb.-Jun.	Ph	N	No	NE
Haldina cordifolia (Roxb.) Ridsdale	T	P	Jun.-Dec.	Ph	MM	Ma	NE
Hedyotis neesiana Arn.	H	A	Jun.-Nov.	Th	-	Na	NE
Meyna spinose Roxb. ex Link	S	P	Mar.-Jun.	Ch	-	Me	NE
Morinda citrifolia L.	T	P	Feb.-May	Ph	N	Ma	NE
Neolamarckia cadamba (Roxb.) Bosser	T	P	Jul.-Nov.	Ph	MM	Ma	NE
Oldenlandia corymbosa L.	H	A	Aug.-Feb.	Th	-	Le	LC
Spermacoce articularis L. f.	H	A	All	Th	-	Na	NE
Loganiaceae R.Br. ex Mart.							
Strychnos nux-vomica L.	T	P	Mar.-Jan.	Ph	MM	Me	NE
Apocynaceae Juss.							
Alstonia scholaris (L.) R. Br.	T	P	Nov.-Aug.	Ph	MM	Me	LC
Calotropis gigantean (L.) Dryand.	S	P	Mar.-Feb.	Ch	-	Ma	NE
Carissa spinarum A. DC.	C	P	Mar.-Oct.	Ph	N	No	NE
Cascabela thevetia (L.) Lippold	T	P	All	Ph	N	Mi	LC
Catharanthus roseus (L.) G. Don.	S	P	All	Th	-	No	NE

Cryptolepis dubia (Burm.f.) M.R.Almeida	C	P	Apr.-Mar.	Ph	N	No	NE
Gymnema sylvestre (Retz.) R.Br. ex Sm.	C	P	Apr.-Mar.	Ph	N	Mi	NE
Hemidesmus indicus (L.) R. Br. ex Schult.	C	P	Aug.-Jan.	Ph	N	Mi	NE
Holarrhena pubescens Wall. ex G. Don	T	P	Apr.-Feb.	Ph	N	Ma	LC
Ichnocarpus frutescens (L.) W. T. Aiton	S	P	Sep.-Mar.	Ph	N	No	NE
Marsdenia sylvestris (Retz.) P. l. Forst.	C	P	Apr.-Mar.	Ph	N	Mi	NE
Nerium oleander (L.)	S	P	Jul.-Apr.	Ph	N	No	LC
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Pergularia daemia (Forssk.) Chiov.	C	P	Sep.-Jan.	Ph	N	Me	NE
Plumeria rubra (L.)	T	P	Oct.-May	Ph	M	No	LC
Rauvolfia serpentina (L.) Benth. ex Kurz	S	P	Mar.-Dec.	Th	-	Me	NE
Rauvolfia tetraphylla L.	S	P	Feb.-Dec.	Ch	-	No	NE
Tylophora indica (Burm. f.) Merr.	C	A	Apr.-Oct.	Ph	N	No	NE
Vallaris solanacea (Roth) Kuntze	C	P	Apr.-Jan.	Ph	N	Me	NE
Boraginales Juss. ex Bercht. and J. Presl							
Boraginaceae Juss.							
Heliotropium indicum L.	H	A	Oct.-Jan.	Th	-	No	NE
Solanales Juss. ex Bercht. and J. Presl							
Convolvulaceae Juss.							
Cuscuta reflexa Roxb.	C	P	Nov.-Mar.	Ph	N	Ap	NE
Evolvulus alsinoides (L.) L.	H	A	Jul.-Feb.	Th	-	Na	NE
Ipomoea aquatica Forssk.	H	P	All	Th	-	No	LC
Ipomoea mauritiana Jacq,	C	P	Aug.-Dec.	Ph	N	Ma	NE
Jacquemontia paniculata (Burm. f.) Hallier f.	T	P	Sep.-Jan.	Ph	N	Mi	NE
Rivea hypocrateriformis Choisy	C	P	Aug.-Oct.	Ph	N	No	NE
Solanaceae Juss.							
Datura metel L.	S	P	Aug.-May	Ch	-	Ma	NE
Datura stramonium L.	S	P	Jul.-Oct.	Ch	-	Ma	NE
Physalis minima L.	H	A	Aug.-Dec.	Ch	-	Ma	NE
Solanum americanum Mill.	H	A	Dec.-Jun.	Th	-	Ma	NE
Solanum rudepannum Dunal	H	A	Dec.-Jun.	Th	-	Ma	LC
Solanum surattense Burm. f.	H	A	Aug.-Dec.	Th	-	Ma	NE
Solanum torvum Sw.	H	P	Jul.-Mar.	Ch	-	Ma	NE
Solanum virginianum L.	H	A	Dec.-Jun.	Th	-	Ma	NE
Lamiales Bromhead							
Oleaceae Hoffmanns. and Link							
Nyctanthes arbor-tristis L.	T	P	Sep.-Jan.	Ch	-	Mi	NE
Plantaginaceae Juss.							

Bacopa monnieri (L.) Pennell	H	A	Apr.-Jan.	Th	-	Na	LC
Limnophila indica (L.) Druce	H	A	Sep.-Jan.	Th	-	Na	LC
Scoparia dulcis L.	H	A	May-Dec.	Th	-	Na	NE
Martyniaceae Horan.							
Martynia annua L.	H	A	Aug.-Dec.	Ch	-	Me	NE
Acanthaceae Juss.							
Andrographis echioides (L.) Nees	H	A	Jul.-Oct.	Th	-	No	NE
Andrographis paniculata (Burm. f.) Nees	H	A	Sep.-Apr.	Th	-	No	NE
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Barleria lupulina Lindl.	S	P	Dec.-Apr.	Ch	-	Mi	NE
Barleria prionitis (L.)	S	P	Dec.-Apr.	Ch	-	Mi	NE
Dicliptera bupleuroides Nees	H	A	Jun.-Oct.	Th	-	No	NE
Ecbolium viride (Forsk.) Alston	H	P	Dec.-Apr.	Ch	-	Mi	NE
Hemigraphis hirta T. Anders.	H	A	Aug.-Nov.	Th	-	Mi	NE
Hygrophila auriculata (Schumach.) Heine	H	A	Sep.-Jan.	Th	-	Mi	LC
Justicia adhatoda L.	S	P	Feb.-Apr.	Ch	-	Me	NE
Justicia gendarussa Burm.f.	S	P	Feb.-Apr.	Ch	-	Me	NE
Ruellia tuberosa L.	H	A	Aug.-Nov.	Th	-	Mi	NE
Rungia pectinata (L.) Nees	H	A	All	Th	-	Mi	NE
Bignoniaceae Juss.							
Tecoma stans (L.) Juss. ex Kunth	T	P	Nov.-Mar.	Ph	N	Me	NE
Stereospermum chelonoides (L. f.) DC.	T	P	Aug.-Feb.	Ph	M	Me	NE
Verbenaceae J. St. Hil.							
Lantana camara (L.)	S	P	Nov.-Feb.	Ch	-	No	NE
Lippia javanica (Burm. f.) Spreng.	S	P	Sep.-Apr.	Ch	-	Mi	NE
Lamiaceae Martinov							
Anisochilus carnosus (L. f.) Wall.	S	A	Sep.-Jan.	Ch	-	No	NE
Anisomeles indica (L.) Kuntze	H	A	Sep.-Jan.	Ch	-	Mi	NE
Clerodendrum infortunatum L.	S	P	Feb.-Jul.	Ch	-	Ma	NE
Hyptis suaveolens (L.) Poit.	S	A	Sep.-Jan.	Ch	-	Me	NE
Leonotis nepetifolia (L.) R. Br.	S	A	Apr.-Jul.	Th	-	Me	NE
Leonurus sibiricus L.	S	A	Sep.-Feb.	Ch	-	Mi	NE
Leucas cephalotes (Roth) Spreng.	H	A	Sep.-Dec.	Th	-	Mi	NE
Mentha longifolia (L.) L.	S	A	Apr.-Jul.	Th	-	Mi	LC
Ocimum americanum L.	S	P	All	Ch	-	Na	NE
Ocimum basilicum L.	H	P	May-Jul.	Ch	-	Na	NE
Ocimum tenuiflorum L.	S	P	Aug.-Jan.	Ch	-	Na	NE
Plectranthus amboinicus (Lour.) Spreng.	H	A	May-Sep.	Th	-	Mi	NE

Premna mollissima Roth	T	P	May-Jul.	Ph	M	No	NE
Tectona grandis L. f.	T	P	Jul.-Jan.	Ph	MM	Mg	NE
Vitex negundo L.	T	P	Mar.-Jun.	Ph	N	Mi	LC
Asterales Link							
Asteraceae Bercht. and J.Presl							
Ageratum conyzoides (L.) L.	H	A	Nov.-Mar.	Th	-	Mi	LC
Ayapana triplinervis (Vahl) R. M. King and H. Rob.	H	A	Aug.-Dec.	Th	-	Mi	NE
Name of the species	Habit	Life-span	Fl. and Fr. time	Raunkiaer's life-form	Sub-type	Leaf spectra	IUCN red list status
Baccharoides anthelmintica (L.) Moench	H	A	Sep.-Mar.	Th	-	Me	NE
Blumea lacera (Burm.f.) DC.	H	A	Aug.-Feb.	Th	-	Mi	NE
Chromolaena odorata (L.) R. M. King and H. Rob.	S	A	Mar.-Sep.	Ch	-	Mi	NE
Cyanthillium albicans (DC.) H. Rob.	H	A	Aug.-Mar.	Th	-	Mi	NE
Cyanthillium cinereum (L.) H. Rob.	H	A	Nov.-Feb.	Th	-	Me	NE
Eclipta prostrata (L.) L.	H	A	All	Th	-	Mi	LC
Elephantopus scaber L.	H	A	Sep.-Jan.	Th	-	No	NE
Enydra fluctuans DC.	H	A	Dec.-Mar.	Th	-	Mi	LC
Grangea maderaspatana (L.) Poir.	H	A	Dec.-May	Th	-	Le	LC
Sonchus oleraceus (L.) L.	H	A	Sep.-Jan.	Th	-	Na	NE
Sphaeranthus senegalensis DC.	H	A	Nov.-Apr.	Th	-	Le	LC
Sphagneticola calendulacea (L.) Pruski	H	A	All	Th	-	Me	NE
Synedrella nodiflora (L.) Gaertn.	H	A	Sep.-Jan.	Th	-	No	NE
Tridax procumbens (L.) L.	H	A	All	Th	-	Na	NE
Xanthium strumarium L.	H	A	Sep.-Apr.	Th	-	Me	NE
Apiales Nakai							
Apiaceae Lindl.							
Centella asiatica (L.) Urb.	H	A	Jul.-Jan.	Th	-	No	LC

Abbreviation

In Habit: C-Climber; H-Herb; S-Shrub; T-Tree

In Life-span: A-Annual; B-Biennial; P-Perennial

In Flowering and fruiting time: Jan.-January; Feb.-February; Mar.-March; Apr.-April; Jun.-June; Jul.-July; Aug.-August; Sep.-September; Oct.-October; Nov.-November; Dec.-December; All-All season

In Raunkiaer's life-form and Sub-type: Ch-Chamaephytes; Cr-Cryptophytes; He-Hemicryptophytes; M-Mesophanerophyte; MM-Megaphanerophytes; N-Nanophanerophytes; Ph-Phanerophytes; Th-Therophytes

In Leaf spectra: Ap-Aphyllous; Le-Leptophyll; Na-Nanophyll; Mi-Microphyll; No-Notophyll; Me-Mesophyll; Ma-Macrophyll; Mg-Megaphyll

In IUCN red list status: DD-Data Deficient; LC-Least Concern; NE-Not Evaluated; VU-Vulnerable; NT-Near Threatened

Table 2: Total angiospermic taxa.

Group	Orders	Families	Genera	Species				
				Herbs	Shrubs	Trees	Climber	Total
Dicots	27	62	203	79	59	70	41	249
Monocots	9	17	46	40	4	6	8	58
Total	36	79	249	119	63	76	49	307

3.3 Life span

In the sacred grove, 109 (35.50%) annual plants would go through their life cycle in one growing season. As many as 1 (0.33%) biennial plant whose life cycle spans two years. As many as 197 (64.17%) perennial plants that could survive most unfavorable conditions and stayed alive for more than two years (Table 1).

3.4 Life form and biological spectrum

The biological spectrum shows that phanerophytes 128 (41.69%) was the dominant, followed by therophytes 81 (26.38%), chamaephytes 52 (16.95%), hemicryptophytes 27 (8.79%), and cryptophytes 19(6.19%). Of the phanerophytes, nanophanerophytes 73 (23.78%) was dominant than mesophanerophytes 31 (10.10%) and megaphanerophytes 24 (7.82%) (Table 3, Figure 7). It reveals that therophytes, chamaephytes, and cryptophytes constituted the higher percentage 13.38%, 7.95% and 0.19% respectively than the normal spectrum exhibiting "thero-chamae-cryptophytic" phytoclimate.

Further, the number of hemicryptophytes (17.21%) and phanerophytes (4.31%) was comparatively smaller in percentage than the Raunkiaer's normal spectrum. Of the phanerophytes, nanophanerophytes (8.78%) and megaphanerophytes (4.82%) were somewhat larger and mesophanerophyte (17.9%) was a comparatively smaller value than the Raunkiaer's normal spectrum (Table 3, Figure 7). This result was probably due to the local protection under certain taboos of the sacred grove. The dominant therophytes, chamaephytes, and cryptophytes altogether constituted 49.52% of the life forms proportion. Therophytes showed the maximum divergence of the normal spectrum; other workers had also reported a similar phytoclimatic association for different tracks of vegetation (Misra et al., 1979; Saxena et al., 1982; Rajendraprasad et al., 1998; Sen, 2018). The dominance of therophytes (81 species, 26.38%) indicates that the investigated area was under mild biotic pressure (Sher et al., 2014). Many plant species were decreasing in the area. It would be the moral and ethical duty of the local people to protect the plant resources.

Table 3: Biological spectrum (% of all life forms) of study site and its comparison with Raunkiaer's normal spectrum.

Life forms	Total no. of species	Biological spectrum (%) of the study site	Raunkiaer's normal spectrum (%)	Deviation=(Raunkiaer's normal spectrum-Biological spectrum)
Phanerophytes (Ph)	128	41.69	46.00	-4.31
Megaphanerophytes (MM)	24	7.82	3.00	4.82
Mesophanerophytes (M)	31	10.10	28.00	-17.90
Nanophanerophytes (N)	73	23.78	15.00	8.78
Chamaephytes (Ch)	52	16.95	9.00	7.95
Hemicryptophytes (He)	27	8.79	26.00	-17.21
Cryptophytes (Cr)	19	6.19	6.00	0.19
Therophytes (Th)	81	26.38	13.00	13.38
Total	307	100.00	100.00	

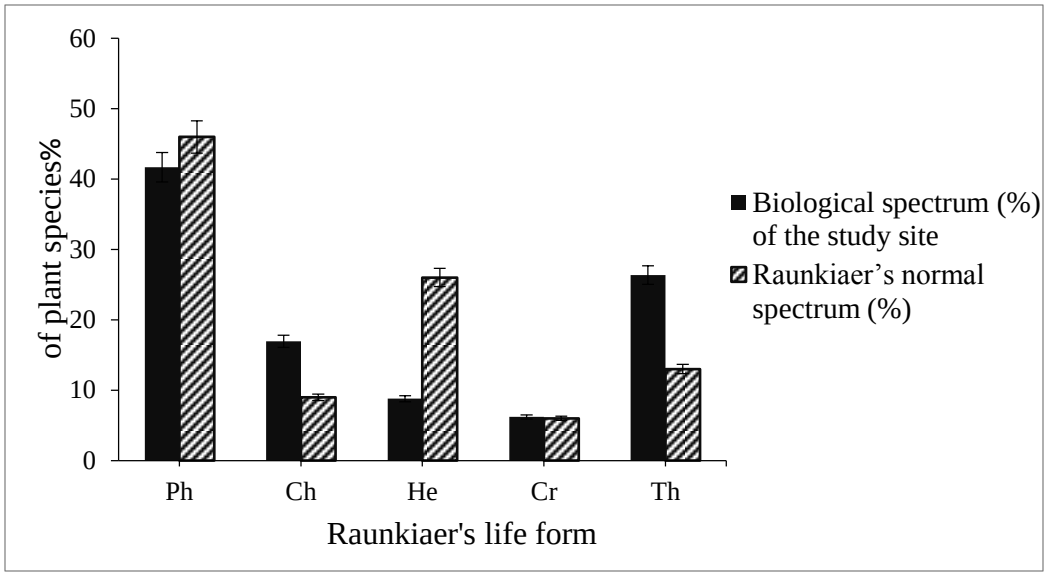

Figure 7. Comparison of biological spectrum with Raunkiaer's normal spectrum.

3.5 Leaf size spectra

The overall leaf size spectra showed that there were leptophyll 34 (11.11%), nanophyll 42 (13.73%), microphyll 50 (16.34%), notophyll 52 (16.99%), mesophyll 67 (21.90%), macrophyll 49 (16.01%) and megaphyll 12 (3.92%). *Cuscuta reflexa* is only aphyllous species. As regards the leaf size spectra, mesophyll was found to be high followed by notophyll, microphyll, macrophyll, nanophyll, leptophyll, and megaphyll (Table 1, 4). In case of leaf spectra, the presence of leptophyll 19 (6.21%), nanophyll 21 (6.86%), microphyll 22 (7.19%), notophyll 24 (7.84%), mesophyll 43 (14.05%), macrophyll 24 (7.84%) and megaphyll 7 (2.29%) have the maximum in comparison to hemicryptophytes, therophytes, therophytes, phanerophytes, phanerophytes, phanerophytes and phanerophytes respectively (Table 4). Cyperaceae 8 (2.61%), Poaceae 5 (1.63%), Fabaceae 9 (2.93%), Apocynaceae 8 (2.61%), Malvaceae 6 (1.95%), Solanaceae 8 (2.61%) and Araceae 3 (0.98%) were dominant families of leptophyll, nanophyll, microphyll, notophyll, mesophyll, macrophyll and megaphyll respectively (Table 4, Figure 8). This result was also similar to other tropical forests in Asia (Bohman, 2004; Gillison, 2018).

Table 4: Life-form analysis with different leaf size.

Raunkiaer's life form	Leaf spectra								Total
	Ap	Le	Na	Mi	No	Me	Ma	Mg	
Ph	1	2	11	16	24	43	24	7	128
MM			1	2		7	12	2	24
M			5	1	8	9	5	3	31
N	1	2	5	13	16	27	7	2	73
Ch		4	5	9	8	11	15		52
He		19	5	2	1				27
Cr		2		1	2	4	5	5	19
Th		7	21	22	17	9	5		81
Total	1	34	42	50	52	67	49	12	307

Abbreviation

In Raunkiaer's life-form: Ch-Chamaephytes; Cr-Cryptophytes; He-Hemicryptophytes; M-Mesophanerophyte; MM-Megaphanerophytes; N-Nanophanerophytes; Ph-Phanerophytes; Th-Therophytes

In Leaf spectra: Ap-Aphyllous; Le-Leptophyll; Na-Nanophyll; Mi-Microphyll; No-Notophyll; Me-Mesophyll; Ma-Macrophyll; Mg-Megaphyll

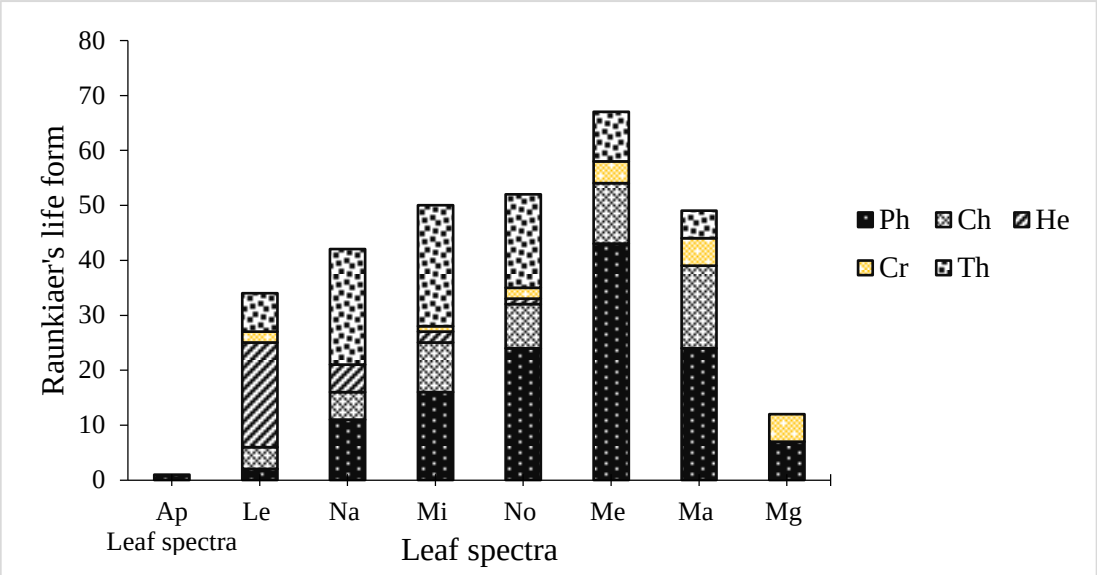

Figure. 8. Analysis of life form with different leaf size.

3.6 Conservation status and IUCN categories

Among these 307 plant species, 220 plants have not been evaluated still now. There were 85 least concerned (LC), 1 data deficient (DD), 1 near threatened (NT) species according to the IUCN (IUCN, 2020) (Table 1).

Based on the above-mentioned phytosociological analysis with ecological information on IUCN Red Listed plants, it is revealed that plants are still present and regenerate in the sacred grove but locally disappear in highly disturbed areas. This study would highlight the status and distribution of the species in the study area, the ecological characteristics necessary for their survival, and the threats to some of the species identified by following the IUCN (2020) criteria. It is because IUCN Red List applications are a global plant diversity barometer (Brummitt et al., 2008). Various factors caused the increase in numbers of threatened species in the area. Grasing was a major cause which led to the destruction of seedlings. The most critical factor that caused the decline of the endemic useful species was human activity, such as pilgrimage, dying of the plant and land use change.

4. Conclusion

The current study indicates the option of using Raunkiaer's strategy to ascertain the notable differences between the populations of angiosperm plants in a forested landscape or biome and their associations, the part of species in the percentage of floristic life-forms that resulted by the existing ecological parameters and environmental gradients. Life-form analysis provides a clear image of the sacred grove's biological spectrum. In the present study therophytes, chamaephytes and cryptophyte share the importance depicting the “thero-chamae-cryptophytic” phytoclimate. It may also be noted that the information acquired from this study will in future serve as a database of life forms for research of change detection and tenacity of bioclimate or phytoclimate (Raju et al., 2014). Comparing and contrasting the neighboring natural strands pattern along the environmental gradients will also be useful, revealing more than the mere forest covers in the ecosystem data; suggesting that biotic variables play a significant part in shaping a landscape's vegetation by guiding succession. This shows the impact in the

sacred grove of anthropogenic disturbances that favor the development of more therophytes. Further disruption to the current sacred grove can therefore promote future changes in its current phytoclimate.

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