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# Quantitative Analysis of Floristic Composition, Biological Spectrum and Leaf Spectrum of a Sacred Grove in Jhargram District, West Bengal, India

Uday Kumar Sen*, Ram Kumar Bhakat
Laboratory of Ecology and Taxonomy, Department of Botany and Forestry, Vidyasagar University
Vidyasagar University Rd, Rangamati, Midnapore, West Bengal 721102, India
*Email: uudaysen@gmail.com

**ABSTRACT.** Sacred Groves are tracts of virgin forests, left untouched and protected by local people, because of culture and religious beliefs. These tracts are remnants of the once-dominant flora, reservoirs of the rich biodiversity, and the last refuge for preserving the rich indigenous culture and traditions. For these reasons, the biological and leaf spectra, as well as the conservation status of the current sacred grove vegetation, Maa Mongalmoyee Than (MMT) in Jhargram district of West Bengal, India, have been studied. Data were collected during different seasons. The floristic list is taxonomically arranged based on clade, order, and family. In addition, photographs of some common, locally uncommon, endemic and valuable plant species within the sacred grove were taken. The herbarium sheets were then described by matching properly annotated materials available at the Herbarium Section of Vidyasagar University as well as the Botanical Survey of India. The results of floristic studies showed 217 MMT's angiosperm species, belonging to 196 genera, distributed under 59 families of 27 orders. Furthermore, Poales (13.82%) and Fabaceae (12.44%) are the dominant order and family, respectively, in terms of species population. Meanwhile, the biological spectrum showed the grove enjoys a "thero-chamaephyte" phytoclimate form, as well as a comparatively undisturbed status, being a sacred grove. Also, the preservation of germplasm within the grove is based on traditional belief in the social system.

**Keywords**: APG IV; biodiversity conservation; biological spectrum; leaf spectra; sacred grove

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## INTRODUCTION

According to Khan *et al.* (2008), a classic example of culturally responsive community-based natural small-scale resource management, are sacred groves. These are small patches of forests devoted to deities and ancestral spirits, with socio-cultural, spiritual and political significance for the indigenous communities caring for them. All around the world, sacred groves have also provided a rich bio-diverse ecosystem, preserved culture, created awareness for bio-diversity conservation, and fostered mutual respect between people and nature within these communities, over the centuries (Verschuuren *et al*., 2012). Meanwhile, international organizations, including the UNESCO, the IUCN and the WWF are attracting increasing interest in the role of these natural sacred sites. The IUCN treats sacred groves as natural religious places, in addition to areas recognized as sacred by indigenous and traditional communities, or as places of worship and remembrance by religions or faiths. Natural sacred sites are highly diverse in biology and culture, and are the oldest protected areas in the world.

A study by Hughes & Chandran (1998) stated immemorial sacred groves have been preserved and revered by numerous people, in the name of indigenous God or Goddess, within Africa, Asia, Autro-Pacific region, North and South America, as well as Europe, throughout history, while Kent (2013) reported the existence of forest areas where supernatural entities were claimed to live and immoral practices, including tree felling, wood poaching, plant or leaf collection, hunting, domestic animal grazing, were forbidden.

India has the highest number of sacred groves in the entire world, estimated at over 100000 (Khan *et al.*, 2008), as a result of high ethno-cultural diversity. These groves occur in many regions, with a variety of cultural practices (Rath & Ormsby, 2020). Indigenous communities across India have protected forest patches as indigenous sacred groves, for generations (Bhagwat & Rutte, 2006).

However, these forests, along with the sacred groves are currently disappearing due to cultural change, industrialization, agricultural land encroachment, and exotic weed invasions.

Berkes (2017) reported sacred forests as islands of biodiversity protecting a large number of plant and animal species, including some rare, endangered and endemic taxa, although called by different names in different states of India, and controlled by local people for various reasons. Generally, sacred groves are repositories and nurseries of many local tribal and other folk medicines, and these are the original sources gradually entering modern medicine, after careful screening (Sen, 2018). This article therefore, provides an insight on how human beliefs, norms, social practices, and ethics, help conserve plants in a tribal area of Jhargram district in West Bengal, through sacred groves.

## MATERIALS AND METHODS

The sacred grove studied (latitude 22º35´51.39´´N - 22º35´50.27´´ N and longitude 86º51´57.82´´E-86º 51´57.39´´E; average altitude 103 masl) consists of mixed deciduous, semi-deciduous and evergreen flora species, the present sacred grove, is popularly known as MMT (named the adjacent village as well as the presiding deity, Mongalmoyee). According to Fig. 1, the grove neighbours Malabati village, under Binpur II block, in Jhargram district, along the Jharkhand state's border, and is bordered on the north by Purulia and Bankura districts, on the east by the district of West Midnapore. In addition, the grove has widespread borders with the state of Orissa on the south, and with Jharkhand state, on the south. The region is also extremely humid and tropical. Temperatures are as high as 46°C, during the hot, dry days of May and June, and as low as 8°C in the chilly nights of December and January.

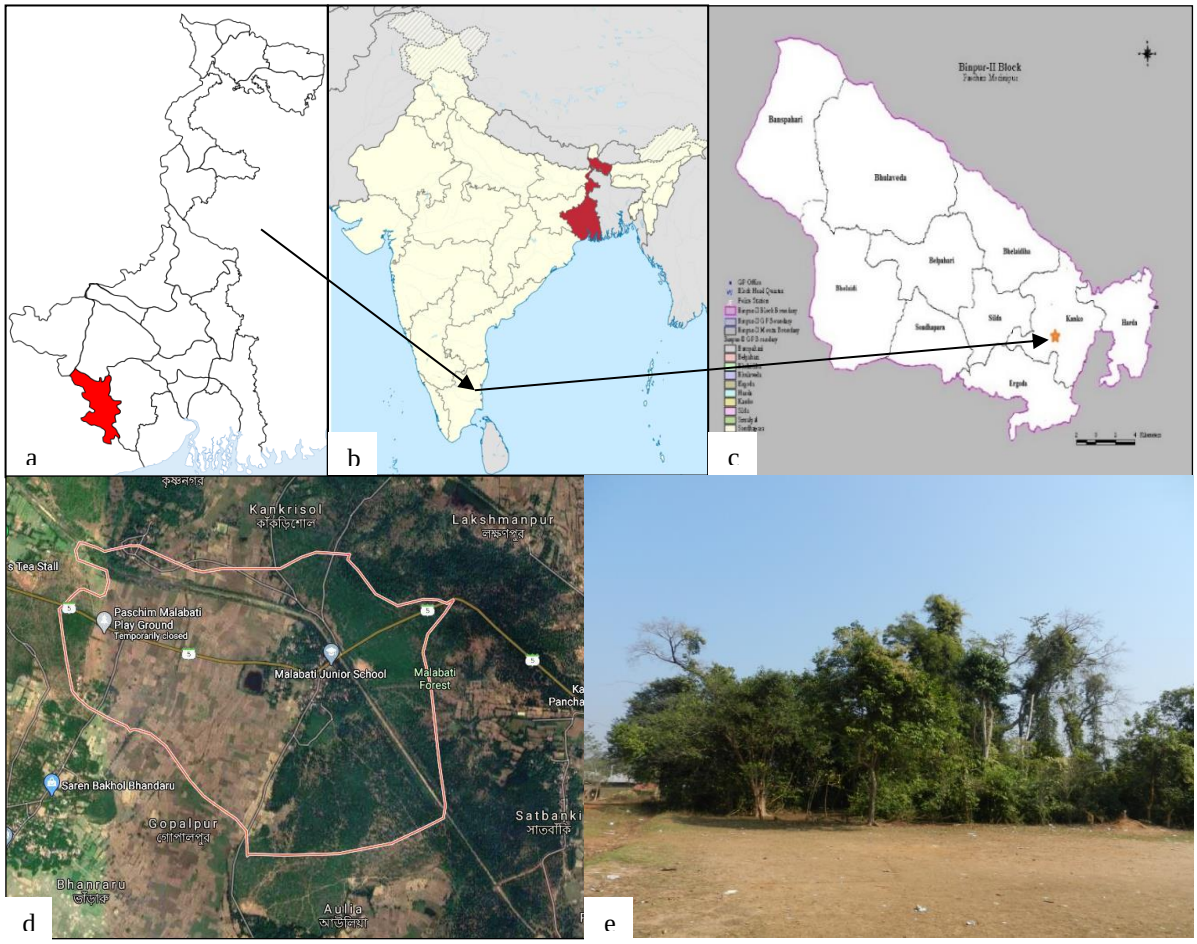


**Fig. 1**. Location of the study area: a. India; b. Jhargram district in West Bengal; c. Binpur II block showing Maa Mongalmoyee Than (MMT); d. Google earth image of MMT; e. MMT sacred grove.

Fig. 1 shows the Chota Nagpur Plateau slowly sloping downwards, and forming an undulating region of infertile rocks/soil laterite. Based on the 2011 census, the district of

Jhargram covers an area of 3037.64 km$^2$ and has a population of 1,136,548. Furthermore, 96.52% of this population was rural, and only 3.48% were urban, while 20.11% and 29.37% belonged to the scheduled castes and tribes, respectively (WBPSPM, 2011).

This 2-acre grove represents an isolated forest patch in near-climax stage and is surrounded by crop fields and forest land. The devotees collect money and other utensils from around the region and neighboring areas, to celebrate worship. Meanwhile, livestock, including goats and chickens, are sacrificed on 4 Magh (18/19$^{th}$ of January) to satisfy the goddess, and this is a deep-rooted custom. Also, an iconic idol of Goddess Mongolmoyee was worshipped within the sacred grove and by the local tribal people, while maintenance and managerial activities are carried out by the local communities.

**Field survey and data collection.** The study area was thoroughly investigated during different seasons, between 2012 and 2018. This presented a prospect of the flora composition and field interpretation during the entire flowering and fruiting of the maximum species quantity. Subsequently, phytosociological data were collected by laying 20 × 20 m quadrates for tree species, 5 × 5 m for shrubs as well lianas, and 1 × 1 m for herbs and grasses. A brief floristic survey was carried out through a "spot identification" basis, and the specimens were then processed, preserved, poisoned and mounted on sheets of herbarium (Jain & Rao, 2016). In addition, photographs of some common, locally uncommon, endemic and valuable plant species within the sacred grove were taken. The herbarium sheets were then described by matching properly annotated materials available at the Herbarium Section of Vidyasagar University as well as the Botanical Survey of India. Numerous related catalogues (Anderson, 1862), regional flora (Hooker, 1875; Prain, 1903; Haines, 1926), monographs (Mitra, 1958), revision works (Datta & Majumdar, 1966) and other articles (Paria, 2005; Paria, 2010), were also consulted for identification purposes, while the scientific names were checked using the World Checklist of Vascular Plant (WCVP, 2020) website and confirmed after being deemed acceptable.

**Analysis of vegetation.** The floristic list is taxonomically arranged based on clade, order, and family, according to Angiosperm Phylogeny Group IV classification (Chase *et al*., 2016). Table 1 shows inferred habit, life-span, flowering and fruiting time, Raunkiaer's life-form of each species with sub-type, leaf size, IUCN status and distribution within the grove. The resulting biological spectrum was then compared to the standard Raunkiaer spectrum, to determine the grove's phytoclimate (Raunkiaer, 1934; Muller-Dombois & Ellenberg, 1974). Also, leaf size information was used to assess the plant physiological systems and identify plant associations, while the Raunkiaer (1934) diagram was used to quickly estimate the leaves in the field. Subsequently, a list of invasive alien species was prepared, as described by Reddy (2008).

**Table 1**. List of angiosperm plants in Maa Mongalmoyee Than (MMT) sacred grove.

| Name of the Species | Habit | Life span | Fl. & Fr. Time | Raunkiaer's life-form | Sub-type | Leaf spectra | IUCN Red List Status |
|---|---|---|---|---|---|---|---|
| **MESANGIOSPERMS** | | | | | | | |
| **MAGNOLIIDS** | | | | | | | |
| Piperales Bercht. & J. Presl | | | | | | | |
| Piperaceae Giseke | | | | | | | |
| *Peperomia pellucida* (L.) Kunth | H | A | Nov.-Mar. | Th | | Na | NE |
| Aristolochiaceae Juss. | | | | | | | |
| *Aristolochia indica* L. | C | A | Jul.-Jan. | Cr | | Me | NE |
| Magnoliales Juss. ex Bercht. & J. Presl | | | | | | | |
| Annonaceae Juss. | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Artabotrys hexapetalus* (L.f.) Bhandari | C | P | Apr.-Oct. | Ph | N | Me | NE |
| **INDEPENDENT LINEAGE: UNPLACED TO MORE INCLUSIVE CLADE** | | | | | | | |
| **MONOCOTS** | | | | | | | |
| Alismatales R.Br. ex Bercht. & J. Presl | | | | | | | |
| Araceae Juss. | | | | | | | |
| *Pothos scandens* L. | C | P | Feb.-May | Ph | N | No | NE |
| *Scindapsus officinalis* (Roxb.) Schott | C | P | - | Ph | N | Mg | NE |
| Dioscoreales Mart. | | | | | | | |
| Dioscoreaceae R. Br. | | | | | | | |
| *Dioscorea bulbifera* L. | C | P | Aug.-Dec. | Cr | | Ma | NE |
| Asparagales Link | | | | | | | |
| Orchidaceae Juss. | | | | | | | |
| *Habenaria commelinifolia* (Roxb.) Wall. ex Lindl. | H | P | Aug.-Oct. | Cr | | Na | NE |
| *Vanda tessellata* (Roxb.) Hook. ex G. Don | H | P | Apr.-Jul. | Ph | N | No | LC |
| Hypoxidaceae R.Br. | | | | | | | |
| *Curculigo capitulata* (Lour.) Kuntze | H | P | Jun.-Sep. | Cr | | Me | NE |
| Arecales Bromhead | | | | | | | |
| Arecaceae Bercht. & J. Presl | | | | | | | |
| *Phoenix acaulis* Roxb. | S | P | Feb.-Jun. | Ch | | Me | NE |
| *Phoenix sylvestris* (L.) Roxb. | T | P | Feb.-Jun. | Ph | M | Me | NE |
| Poales Small | | | | | | | |
| Cyperaceae Juss. | | | | | | | |
| *Cyperus mindorensis* (Steud.) Huygh | H | P | Nov.-Mar. | He | | Na | LC |
| *Cyperus distans* L.f. | H | P | Jul.-Sep. | He | | Le | LC |
| *Cyperus rotundus* L. | H | P | Sep.-Dec. | He | | Le | LC |
| *Fimbristylis aestivalis* (Retz.) Vahl | H | P | Feb.-May | He | | Le | NE |
| *Fimbristylis dichotoma* (L.) Vahl | H | P | Aug.-Oct. | He | | Le | LC |
| *Fimbristylis eragrostis* (Nees) Hance | H | P | May-Aug. | He | | Le | NE |
| *Schoenoplectiella roylei* (Nees) Lye | H | P | Feb.-Aug. | He | | Le | LC |
| *Scleria annularis* Steud. | H | P | Feb.-Sep. | He | | Mi | NE |
| Poaceae Barnhart | | | | | | | |
| *Apluda mutica* L. | H | P | Sep.-Nov. | He | | Na | NE |
| *Aristida setacea* Retz. | H | P | Aug.-Dec. | He | | Le | NE |
| *Bothriochloa pertusa* (L.) A. Camus | H | A | Jan.-May | He | | Na | NE |
| *Cenchrus ciliaris* L. | H | P | Jun.-Oct. | He | | Na | LC |
| *Chloris barbata* Sw. | H | P | Aug.-Nov. | He | | Le | NE |
| *Chrysopogon aciculatus* (Retz.) Trin. | H | P | Jun.-Oct. | He | | Le | NE |
| *Cynodon dactylon* (L.) Pers. | H | P | All | He | | Le | NE |
| *Dichanthium foveolatum* (Delile) Roberty | H | P | All | He | | Le | NE |
| *Digitaria sanguinalis* (L.) Scop. | H | P | Mar.-Jun. | He | | Le | NE |
| *Eleusine indica* (L.) Gaertn. | H | P | Aug.-Nov. | He | | Le | LC |
| *Eragrostis cilianensis* (All.) Vignolo ex Janch. | H | P | Jul.-Nov. | He | | Le | NE |
| *Eragrostis unioloides* (Retz.) Nees ex Steud. | H | P | Oct.-Jan | He | | Le | LC |
| *Heteropogon contortus* (L.) P. Beauv. ex Roem. & Schult. | H | P | Sep.-Jan. | He | | Na | NE |
| *Imperata cylindrica* (L.) P.Beauv. | H | P | Oct.-Dec. | He | | Na | LC |
| *Oplismenus compositus* (L.) P. Beauv. | H | P | Sep.-Dec. | He | | Mi | NE |
| *Paspalum scrobiculatum* L. | H | A | Aug.-Nov. | He | | Na | LC |
| *Perotis indica* (L.) Kuntze | H | P | Jul.-Nov. | He | | Le | NE |
| *Rottboellia cochinchinensis* (Lour.) Clayton | H | P | Aug.-Oct. | He | | Mi | NE |
| *Sacciolepis myosuroides* (R.Br.) Chase ex E.G.Camus & A.Camus | H | P | Sep.-Dec. | He | | Na | LC |
| *Setaria flavida* (Retz.) Veldkamp | H | P | Aug.-Nov. | He | | Na | NE |
| *Sporobolus diandrus* (Retz.) P. Beauv. | H | P | Nov.-Jun. | He | | Na | NE |
| *Tragus mongolorum* Ohwi | H | P | Aug.-Oct. | He | | Le | NE |
| **EUDICOTS** | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ranunculales Juss. ex Bercht. & J. Presl | | | | | | | |
| Papaveraceae Juss. | | | | | | | |
| *Argemone mexicana* L. | H | A | Dec.-Apr. | Th | | Ma | NE |
| Menispermaceae Juss. | | | | | | | |
| *Cissampelos pareira* L. | C | P | Jul.-Jan. | Ph | N | Me | NE |
| *Cocculus hirsutus* (L.) W. Theob. | C | P | Aug.-Nov. | Ph | N | No | NE |
| *Stephania japonica* (Thunb.) Miers | C | P | Jul.-Dec. | Ph | N | Me | NE |
| *Tiliacora acuminata* (Lam.) Miers | C | P | Nov.-May | Ph | N | Me | NE |
| *Tinospora sinensis* (Lour.) Merr. | C | P | Feb.-Jun. | Ph | N | Me | NE |
| **CORE EUDICOTS** | | | | | | | |
| **SUPERROSIDS** | | | | | | | |
| Saxifragales Bercht. & J. Presl | | | | | | | |
| Crassulaceae J.St.-Hil. | | | | | | | |
| *Kalanchoe pinnata* (Lam.) Pers. | H | P | Mar.-Jun. | Ch | | Ma | NE |
| **ROSIDS** | | | | | | | |
| Vitales Juss. ex Bercht. & J. Presl | | | | | | | |
| Vitaceae Juss. | | | | | | | |
| *Causonis trifolia* (L.) Mabb. & J.Wen | C | P | Aug.-Dec. | Ph | N | No | NE |
| *Cayratia pedata* (Lam.) Gagnep. | C | P | Aug.-Feb. | Ph | N | Me | VU |
| *Cissus quinquangularis* Chiov. | C | P | Aug.-Dec. | Ph | N | No | NE |
| Fabales Bromhead | | | | | | | |
| Fabaceae Lindl. | | | | | | | |
| *Abrus precatorius* L. | C | P | Aug.-Mar. | Ph | N | Na | NE |
| *Bauhinia acuminata* L. | T | P | Sep.-Mar. | Ph | M | Ma | LC |
| Brachypterum scandens (Roxb.) Miq. | C | P | Jul.-Jan. | Ph | N | Na | NE |
| *Cajanus scarabaeoides* (L.) Thouars | C | A | Sep.-Feb. | Ph | N | Mi | LC |
| *Cassia fistula* L. | T | P | Feb.-Dec. | Ph | N | Me | LC |
| *Chamaecrista absus* (L.) H. S. Irwin & Barneby | H | A | Aug.-Dec. | Th | | Mi | LC |
| *Crotalaria prostrata* Rottler ex Willd. | H | A | Aug.-Jan. | Th | | No | NE |
| *Dicliptera bupleuroides* Nees | H | A | Jun.-Oct. | Th | | No | NE |
| *Erythrina variegata* L. | T | P | Feb.-Jul. | Ph | M | Ma | LC |
| *Flemingia chappar* Buch.-Ham. ex Benth. | S | P | Nov.-Feb. | Ch | | Me | NE |
| *Gliricidia sepium* (Jacq.) Steud. | T | P | Feb.-May | Ph | N | Me | LC |
| *Grona triflora* (L.) H.Ohashi & K.Ohashi | H | P | Jul.-Feb. | Th | | Me | NE |
| *Guilandina bonduc* L. | C | P | Aug.-Apr. | Ph | N | Mi | LC |
| *Indigofera linnaei* Ali | 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 | | Me | NE |
| *Peltophorum pterocarpum* (DC.) Backer ex K. Heyne | T | P | Mar.-Jan. | Ph | MM | Mi | NE |
| *Phanera vahlii* (Wight & Arn.) Benth. | C | P | Apr.-Feb. | Ph | N | Mg | NE |
| *Pleurolobus gangeticus* (L.) J.St.-Hil. ex H.Ohashi & K.Ohashi | H | P | Jun.-Oct. | Th | | Na | NE |
| *Senna obtusifolia* (L.) H. S. Irwin & Barneby | H | A | Mar.-Oct. | Th | | Mi | LC |
| *Senna sophera* (L.) Roxb. | S | A | Apr.-Sep. | Ch | | No | NE |
| *Senna tora* (L.) Roxb. | H | A | Sep.-Dec. | Th | | Mi | NE |
| *Smithia sensitiva* Aiton | H | A | Oct.-Jan. | Th | | Na | LC |
| *Tephrosia purpurea* (L.) Pers. | H | P | Sep.-Dec. | Th | | Na | LC |
| *Teramnus labialis* (L. f.) Spreng. | C | A | Aug.-Dec. | Ph | N | Mi | NE |
| *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb. | T | P | Jun.-Sep. | Ph | M | Na | LC |
| *Zornia gibbosa* Span. | H | A | Aug.-Nov. | Th | | Na | NE |
| Polygalaceae Hoffmanns. & Link | | | | | | | |
| *Polygala arvensis* Willd. | H | A | Jul.-Dec. | Th | | Me | NE |
| Rosales Bercht. & J. Presl | | | | | | | |
| Rhamnaceae Juss. | | | | | | | |
| *Gouania tiliifolia* Lam. | C | P | Apr.-Oc. | Ph | N | Me | NE |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Ventilago denticulata* Willd. | C | P | Sep.-Jun. | Ph | N | Me | NE |
| *Ziziphus oenopolia* (L.) Mill. | C | P | Nov.-Mar. | Ph | N | No | LC |
| Cannabaceae Martinov | | | | | | | |
| *Cannabis sativa* L. | S | A | Oct.-Feb. | Ch | | Mg | NE |
| Moraceae Gaudich. | | | | | | | |
| Streblus asper Lour. | T | P | Feb.-Jun. | Ph | N | Mi | LC |
| Cucurbitales Juss. ex Bercht. & J. Presl | | | | | | | |
| Cucurbitaceae Juss. | | | | | | | |
| *Cayaponia laciniosa* (L.) C. Jeffrey | C | P | Mar.-Dec. | Ph | N | Me | NE |
| *Coccinia grandis* (L.) Voigt | C | P | Mar.-Dec. | Ph | N | Me | NE |
| *Diplocyclos palmatus* (L.) C. Jeffrey | C | P | Aug.-Oct. | Ph | N | Me | NE |
| *Solena amplexicaulis* (Lam.) Gandhi | C | P | Jul.-Jan. | 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. & J. Presl | | | | | | | |
| Oxalidaceae R. Br. | | | | | | | |
| *Oxalis corniculata* L. | H | A | All | Th | | Na | NE |
| Malpighiales Juss. ex Bercht. & J. Presl | | | | | | | |
| Violaceae Batsch | | | | | | | |
| *Afrohybanthus enneaspermus* (L.) Flicker | H | P | Jul.-Nov. | Th | | Na | NE |
| Salicaceae Mirb. | | | | | | | |
| *Flacourtia indica* (Burm. f.) Merr. | S | P | Sep.-May | Ch | | No | LC |
| Euphorbiaceae Juss. | | | | | | | |
| *Acalypha indica* L. | H | A | All | Th | | No | NE |
| *Baliospermum solanifolium* (Burm.) Suresh | S | A | Aug.-Mar. | Th | | Me | LC |
| *Chrozophora plicata* (Vahl) A. Juss. ex Spreng. | H | A | Feb.-Apr. | Th | | No | NE |
| *Croton bonplandianus* Baill. | H | P | All | Th | | No | NE |
| *Euphorbia hirta* L. | H | A | Feb.-Dec. | Th | | Na | NE |
| *Euphorbia thymifolia* L. | H | P | All | Th | | No | NE |
| *Jatropha gossypiifolia* L. | S | P | Apr.-Aug. | Ch | | Ma | LC |
| *Tragia involucrata* L. | C | P | Mar.-Jan. | Ph | N | Me | NE |
| Phyllanthaceae Martinov | | | | | | | |
| *Breynia vitis-idaea* (Burm.f.) C. E. C. Fisch. | S | P | Apr.-Dec. | Ph | N | Mi | LC |
| *Phyllanthus lanceolarius* (Roxb.) Müll.Arg. | S | A | Mar.-Dec. | Th | | Me | LC |
| Myrtales Juss. ex Bercht. & J. Presl | | | | | | | |
| Combretaceae R. Br. | | | | | | | |
| *Combretum decandrum* Jacq. | C | P | Nov.-May | Ph | N | Me | NE |
| Lythraceae J. St.-Hil. | | | | | | | |
| *Woodfordia fruticosa* (L.) Kurz | S | P | Feb.-May | Ph | N | Me | LC |
| Sapindales Juss. ex Bercht. & J. Presl | | | | | | | |
| Sapindaceae Juss. | | | | | | | |
| *Allophylus serratus* (Roxb.) Kurz | C | P | Jul.-Oct. | Ph | N | Me | NE |
| *Cardiospermum halicacabum* L. | C | A | Jul.-Dec. | Ph | N | No | LC |
| Rutaceae Juss. | | | | | | | |
| *Aegle marmelos* (L.) Corrêa | T | P | May-Jul. | Ph | M | Me | NE |
| Meliaceae Juss. | | | | | | | |
| Azadirachta indica A. Juss. | T | P | Mar.-Jul. | Ph | M | No | LC |
| Malvales Juss. ex Bercht. & J. Presl | | | | | | | |
| Malvaceae Juss. | | | | | | | |
| *Abelmoschus crinitus* Wall. | S | A | Mar.-Sep. | Ch | | Ma | LC |
| *Abroma augusta* (L.) L. f. | S | P | Jan.-Mar. | Ph | N | Ma | NE |
| *Abutilon indicum* (L.) Sweet | S | A | Jun.- Dec. | Ch | | Ma | NE |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Azanza lampas* (Cav.) Alef. | S | A | Sep.-Dec. | Ch | | Ma | NE |
| *Grewia asiatica* L. | T | P | Jun.-Aug. | Ph | N | Ma | LC |
| *Corchorus aestuans* L. | H | A | Jul.-Nov. | Th | | Me | NE |
| *Helicteres isora* L. | S | P | Sep.- Feb. | Ph | N | Me | NE |
| *Malvastrum coromandelianum* (L.) Garcke | H | A | Jul.-Nov. | Th | | No | NE |
| *Melochia corchorifolia* L. | H | A | May-Jun. | Th | | No | LC |
| *Sida cordata* (Burm. f.) Borss. Waalk. | H | A | Aug.-Feb. | Th | | No | NE |
| *Sida cordifolia* L. | S | A | Aug.-Dec. | Th | | No | NE |
| *Sida rhombifolia* L. | H | P | Sep.-Dec. | Th | | No | NE |
| *Urena lobata* L. | S | A | Sep.-Dec. | Ch | | No | LC |
| Capparaceae Juss. | | | | | | | |
| *Capparis zeylanica* L. | C | P | Mar.-Oct. | Ph | M | No | NE |
| Cleomaceae Bercht. & J. Presl | | | | | | | |
| *Cleome viscosa* L. | H | A | Sep.-Apr. | Th | | No | NE |
| **SUPERASTERIDS** | | | | | | | |
| Santalales R.Br. ex Bercht. & J. Presl | | | | | | | |
| Santalaceae R.Br. | | | | | | | |
| *Viscum cruciatum* Sieber ex Boiss. | S | P | Jan.-Jun. | Ph | N | Le | NE |
| *Viscum multinerve* (Hayata) Hayata | S | P | Mar.-Jul. | Ph | N | Le | NE |
| Loranthaceae Juss. | | | | | | | |
| *Dendrophthoe falcata* (L. f.) Ettingsh. | S | A | Nov.-Mar. | Ph | N | No | NE |
| *Scurrula cordifolia* (Wall.) G.Don | S | A | Jul.-Nov. | Ph | N | No | NE |
| Caryophyllales Juss. ex Bercht. & J. Presl | | | | | | | |
| Plumbaginaceae Juss. | | | | | | | |
| *Plumbago zeylanica* L. | H | A | Sep.-Feb. | Th | | Mi | NE |
| Polygonaceae Juss. | | | | | | | |
| *Antigonon leptopus* Hook. & Arn. | C | A | Aug.-Jan. | Ph | N | Me | NE |
| Amaranthaceae Juss. | | | | | | | |
| *Achyranthes aspera* L. | H | A | Sep.-Feb. | Th | | Mi | 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 |
| *Dysphania ambrosioides* (L.) Mosyakin & Clemants | H | A | Apr.-Jul. | Th | | Mi | NE |
| *Gomphrena celosioides* Mart. | H | A | Apr.-Aug. | Th | | No | NE |
| *Ouret lanata* (L.) Kuntze | H | A | Nov.-Jan. | Th | | Le | NE |
| *Pupalia lappacea* (L.) Juss. | H | P | Sep.-Jan. | Th | | No | LC |
| Aizoaceae Martinov | | | | | | | |
| *Trianthema portulacastrum* L. | H | A | Apr.-Oct. | Th | | Mi | NE |
| Nyctaginaceae Juss. | | | | | | | |
| *Boerhavia erecta* L. | H | A | Jul.-Sep. | Th | | Mi | NE |
| Molluginaceae Bartl. | | | | | | | |
| *Trigastrotheca pentaphylla* (L.) Thulin | H | A | Aug.-Nov. | Th | | Na | NE |
| Cactaceae Juss. | | | | | | | |
| *Cereus hexagonus* (L.) Mill. | S | P | Jun.-Jul. | Ch | | Le | LC |
| **ASTERIDS** | | | | | | | |
| Cornales Link | | | | | | | |
| Cornaceae Bercht. & J. Presl | | | | | | | |
| *Alangium salviifolium* (L. f.) Wangerin | T | P | Mar.-Jul. | Ph | N | Me | LC |
| Ericales Bercht. & J. Presl | | | | | | | |
| Sapotaceae Juss. | | | | | | | |
| *Madhuca longifolia* var. latifolia (Roxb.) A. Chev. | T | P | Mar.-Jul. | Ph | MM | Ma | NE |
| Ebenaceae Gurke | | | | | | | |
| *Diospyros melanoxylon* Roxb. | T | P | Apr.-Jul. | Ph | MM | Ma | NE |
| *Diospyros montana* Roxb. | T | P | Apr.-Jan. | Ph | MM | Ma | NE |
| Gentianales Juss. ex Bercht. & J. Presl | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rubiaceae Juss. | | | | | | | |
| *Adina cordifolia* (Roxb.) Brandis | T | P | Jun.-Dec. | Ph | MM | Me | NE |
| *Cissus quinquangularis* Chiov. | C | P | Feb.-Apr. | Ph | N | Mi | NE |
| *Dentella repens* (L.) J. R. Forst. & G. Forst. | H | A | Feb.-May | Th | | Na | LC |
| *Meyna laxiflora* Robyns | S | P | Mar.-Jun. | Ch | | Me | NE |
| *Morinda citrifolia* L. | T | P | Feb.-May | Ph | N | Ma | NE |
| *Oldenlandia corymbosa* L. | H | A | Aug.-Feb. | Th | | Le | LC |
| *Paederia foetida* L. | C | P | Sep.-Dec. | Ch | | No | NE |
| *Spermacoce lasiocarpa* R. Br. ex Wall. | H | A | All | Th | | Na | NE |
| Gentianaceae Juss. | | | | | | | |
| *Canscora diffusa* (Vahl) R. Br. ex Roem. & Schult. | H | A | Oct.-Jan. | Th | | Le | NE |
| Apocynaceae Juss. | | | | | | | |
| *Aganosma heynei* (Spreng.) I. M. Turner | C | P | Jul.-Nov. | Ph | N | No | NE |
| *Calotropis gigantea* (L.) W.T.Aiton | S | P | Mar.-Feb. | Ch | | Ma | 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. | C | P | Aug.-Jan. | Ph | N | Mi | NE |
| *Ichnocarpus frutescens* (L.) W.T. Aiton | C | P | Sep.-Mar. | Ph | N | No | NE |
| *Pergularia daemia* (Forssk.) Chiov. | C | P | Sep.-Jan. | Ph | N | Me | NE |
| *Rauvolfia tetraphylla* L. | S | P | Feb.-Dec. | Ch | | No | NE |
| *Telosma pallida* (Roxb.) Craib | C | P | Sep.-Feb. | Ph | N | Me | NE |
| *Vallaris solanacea* (Roth) Kuntze | C | P | Apr.-Jan. | Ph | N | Me | NE |
| Solanales Juss. ex Bercht. & J. Presl | | | | | | | |
| Convolvulaceae Juss. | | | | | | | |
| *Argyreia nervosa* (Burm. f.) Bojer | C | P | Jul.-Apr. | Ph | N | Me | NE |
| *Cuscuta reflexa* Roxb. | C | P | Oct.-Feb. | Ph | N | Ap | NE |
| *Erycibe paniculata* Roxb. | S | A | Apr.-Jun. | Ch | | No | NE |
| *Evolvulus alsinoides* (L.) L. | H | A | Jul.-Feb. | Th | | Na | NE |
| *Evolvulus nummularius* (L.) L. | H | A | All | Th | | Na | NE |
| *Ipomoea mauritiana* Jacq. | C | P | Aug.-Dec. | Ph | N | Ma | NE |
| *Merremia emarginata* (Burm. f.) Hallier f. | C | P | Dec.-Apr. | Ph | N | No | LC |
| *Rivea ornata* (Roxb.) Choisy | C | P | Aug.-Oct. | Ph | N | No | NE |
| Solanaceae Juss. | | | | | | | |
| *Datura stramonium* L. | S | P | Jul.-Oct. | Ch | | Ma | NE |
| *Nicotiana plumbaginifolia* Viv. | H | A | May-Sep. | Th | | Ma | NE |
| *Physalis angulata* L. | S | A | Aug.-Dec. | Ch | | Ma | LC |
| *Solanum americanum* Mill. | H | A | Oct.-Apr. | Th | | Mi | NE |
| *Solanum torvum* Sw. | S | P | Jul.-Mar. | Ch | | Ma | NE |
| *Solanum virginianum* L. | H | A | Dec.-Jun. | Th | | Ma | NE |
| Lamiales Bromhead | | | | | | | |
| Oleaceae Hoffmanns. & Link | | | | | | | |
| *Jasminum multiflorum* (Burm. f.) Andrews | C | P | Dec.-Mar. | Ph | N | No | NE |
| Plantaginaceae Juss. | | | | | | | |
| *Scoparia dulcis* L. | H | A | May-Dec. | Th | | Mi | NE |
| *Veronica anagallis-aquatica* L. | H | A | Feb.-Jun. | Th | | Mi | LC |
| Scrophulariaceae Juss. | | | | | | | |
| *Buddleja asiatica* Lour. | S | P | Jan.-Oct. | Ch | | No | LC |
| Acanthaceae Juss. | | | | | | | |
| *Andrographis echioides* (L.) Nees | H | A | Jul.-Oct. | Th | | No | NE |
| *Dicliptera paniculata* (Forssk.) I. Darbysh. | H | A | Dec.-Feb. | Th | | Mi | NE |
| *Hemigraphis hirta* (Vahl) T. Anderson | H | A | Aug.-Nov. | Th | | Mi | NE |
| *Justicia adhatoda* L. | S | P | Feb.-Apr. | Ch | | Me | NE |
| *Justicia gendarussa* Burm.f. | S | P | Feb.-Apr. | Ch | | Me | NE |
| *Rostellularia procumbens* (L.) Nees | H | P | Oct.-Jan. | Th | | Me | NE |
| *Ruellia prostrata* Poir. | H | A | May-Oct. | Th | | Mi | NE |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Ruellia tuberosa* L. | H | A | Aug.-Nov. | Th | | Mi | NE |
| *Rungia pectinata* (L.) Nees | H | A | All | Th | | Mi | NE |
| Verbenaceae J. St. Hil. | | | | | | | |
| *Lantana camara* L. | S | P | Nov.-Feb. | Ch | | No | NE |
| Lamiaceae Martinov | | | | | | | |
| *Anisomeles indica* (L.) Kuntze | H | A | Sep.-Jan. | Ch | | No | NE |
| *Clerodendrum infortunatum* L. | S | P | Feb.-Jul. | Ch | | Ma | NE |
| *Leonotis nepetifolia* (L.) R.Br. | H | A | Apr.-Jul. | Th | | Me | NE |
| *Mesosphaerum suaveolens* (L.) Kuntze | H | A | Sep.-Jan. | Ch | | Me | NE |
| *Ocimum americanum* L. | H | P | All | Ch | | Na | NE |
| *Ocimum basilicum* L. | H | P | May-Jul. | Ch | | Na | NE |
| *Vitex glabrata* R. Br. | T | P | Apr.-Sep. | Ph | N | Me | LC |
| *Volkameria inermis* L. | S | P | Nov.-Jan. | Ch | | No | NE |
| Orobanchaceae Vent. | | | | | | | |
| *Orobanche aegyptiaca* Pers. | H | A | Sep.-Feb. | Cr | | Le | NE |
| *Striga angustifolia* (D. Don) C. J. Saldanha | H | A | Jul.-Nov. | Th | | Le | NE |
| Asterales Link | | | | | | | |
| Asteraceae Bercht. & J. Presl | | | | | | | |
| *Acanthospermum hispidum* DC. | H | A | Nov.-Feb. | Th | | No | NE |
| *Ageratum conyzoides* L. | H | A | Nov.-Mar. | Th | | Mi | LC |
| *Blainvillea acmella* (L.) Philipson | H | A | Dec.-Mar. | Th | | No | LC |
| *Blumea lacera* (Burm.f.) DC. | H | A | Aug.-Feb. | Th | | Mi | LC |
| *Chromolaena odorata* (L.) R. M. King & H. Rob. | H | A | Mar.-Sep. | Ch | | Mi | NE |
| *Cyanthillium cinereum* (L.) H. Rob. | H | A | Aug.-Mar. | Th | | Mi | NE |
| *Elephantopus scaber* L. | H | A | Sep.-Jan. | Th | | No | NE |
| *Gnaphalium polycaulon* Pers. | H | A | Feb.-Apr. | Th | | Le | LC |
| *Grangea maderaspatana* (L.) Poir. | H | A | Dec.-May | Th | | Le | LC |
| *Mikania micrantha* Kunth | C | A | Sep.-Feb. | Ph | N | No | NE |
| *Sphaeranthus indicus* L. | H | A | Nov.-Apr. | Th | | Na | LC |
| *Sphagneticola calendulacea* (L.) Pruski | H | A | Apr.-Oct. | Th | | Mi | NE |
| *Xanthium strumarium* L. | H | A | Sep.-Apr. | Th | | Me | NE |

Notes: Abbreviation: Habit= C-Climber, H= Herb, S= Shrub, T= Tree; Life-Span: A= Annual, B= Biennial, P= Perennial; Raunkiaer's Life-form and Sub-type: Ch= Chamaephytes, Cr= Cryptophytes, He= Hemicryptophytes, MM= Megaphanerophytes, M= Mesophanerophyte, N= Nanophanerophytes, Ph= Phanerophytes, Th= Therophytes; 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; Leaf spectra: Ap= Aphyllous, Le= Leptophyll, Ma= Macrophyll, Me= Mesophyll, Mg= Megaphyll, Mi= Microphyll, Na= Nanophyll, No= Notophyll; IUCN Red List status: LC= Least Concerned, NE= Not Evaluated, VU= Vulnerable

## RESULTS AND DISCUSSION

**Taxonomic composition.** A total of 217 taxa (species and infraspecies) belonging to 196 genera, 59 families and 27 orders, were recorded. Based on this composition, the top two clades were Asterids and Rosids, while over 70% of the flora belong to Eudicot and Core Eudicot orders. According to Table 1 and Fig. 2, the most represented orders (≥10 species) are from Poales (30 or 13.82%), Fabales (28 or 12.90%), Lamiales (23 or 10.60%), Gentianales (19 or 8.76%), Malvales (15 or 6.91%), Caryophyllales (14 or 6.45%), Solanales (14 or 6.45%), Asterales (13 or 5.99%) and Malpighiales 12 (5.53%). A study by Gastauer *et al*., (2017) highlighted a similar distribution, while Gnanasekaran *et al*. (2012) reported similar studies in a sacred grove on angiosperms of Cuddalore district, Tamil Nadu, India. Pérez-Luque *et al*. (2014) has also illustrated similar types of order contribution.

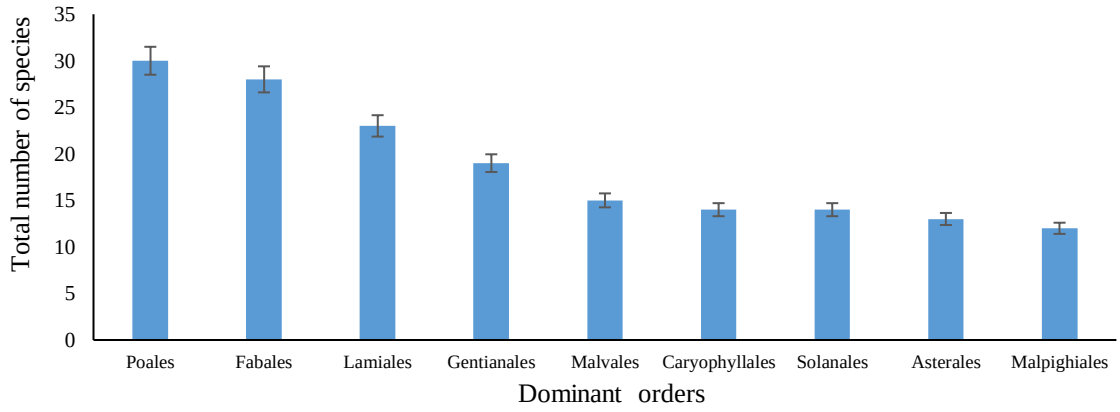


**Fig. 2.** Dominant orders (≥10 species) in the Maa Mongalmoyee Than (MMT).

Fig. 2 shows the best-represented families (with ≥10 species) are Fabaceae 27 (12.44%), Poaceae 22 (10.14%), Asteraceae 13 (5.99%), Malvaceae 13 (5.99%) and Apocynaceae 10 (4.61%). Meanwhile, one family comprised 9 (4.15%), another family covered 5 (2.30%), six families contained 8 (3.69%), two families contained 6 (2.76%), two families covered 3 (1.38%) and ten families comprised 2 (0.92%) species, each. Also, 32 other families were found contain only a single species each. Numerous scholars (Ghildiyal *et al*., 2016; Sen & Bhakat, 2019) discovered the same type of dominant families, in sacred groves within India. These hegemony was also reported by many other authors (Badshah *et al.*, 2016; Haq *et al*., 2018; Khan *et al*., 2018; Xu *et al.*, 2018; Farooq *et al*., 2019; Asif *et al*., 2020). This is in accordance with the results, stating Fabaceae, Poaceae and Asteraceae, are the most represented, within the investigated area. Meanwhile, the most represented five genera are *Cyperus*, *Fimbristylis*, *Senna*, *Sida* and *Solanum*, comprising three species, each. Also, twelve genera, including *Amaranthus*, *Diospyros*, *Eragrostis*, *Euphorbia*, *Evolvulus*, *Justicia*, *Mimosa*, *Ocimum*, *Phoenix*, *Ruellia*, *Trichosanthes* and *Viscum* hold two species each. Table 1 shows the remaining 157 species, containing a single genus, each.

**Species diversity in different growth form.** This study showed the sacred grove harboured a total of 217 plant species (Table 2), [179 dicots (82.49%) and 38 monocots (17.51%)], belonging to196 genera [163 dicots (83.16%) and 33 monocots (16.84%)], 59 families [52 dicots (88.14%) and 7 monocots (11.86%)], and 27 orders [22 dicots (81.48%) and 5 monocots (18.52%)].

**Table 2**. Total angiospermic taxa.

| Group | Orders | Families | Genera | Species | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Herbs | Shrubs | Trees | Climber | Total |
| Dicots | 22 | 52 | 163 | 78 | 35 | 17 | 49 | 179 |
| Monocots | 5 | 7 | 33 | 33 | 1 | 1 | 3 | 38 |
| Total | 27 | 59 | 196 | 111 | 36 | 18 | 52 | 217 |

Furthermore, 111(51.15%) of the reported species were classified as herbs, 36 as shrubs (16.59%), 18 as trees (8.29%) and 52 as climbers (23.97%). According to Table 1 and Table 2, herbs, shrubs, trees and climbers represented 78, 35, 17, 49 and 33, 1, 1, 3 species respectively, of the total 179 (82.49%) dicots and monocots 38 (17.51%) monocots. These denoted 35.94%, 16.13%, 7.83%, 22.58% and 15.21%, 0.46%, 0.46%, 1.38%, respectively, of the total species.

**Life span.** Table 1 shows the life cycle classification of flora in the sacred grove. Based on this classification, 86 (39.63%) plants are annual (go through their life cycle in one growing season), 1 (0.46%) plant is biennial (life cycle of two years) and 130 (59.91%) plants are perennial (stay alive for more than

two years), and able to survive most unfavorable conditions.

**Life form and biological spectrum.** The biological spectrum shows phanerophytes [76 (35.02%)] are most frequent, followed by therophytes [73 (33.64%)], chamaephytes [33 (15.21%)], hemicryptophytes [30 (13.82%)] and cryptophytes [5 (2.30%)]. Of the phanerophytes, nanophanerophytes [64 (29.49%)] are more common than mesophanerophytes [7 (3.23%)] and megaphanerophytes [5(2.30%)] (Table 3, Fig. 3).

**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 | 76 | 35.02 | 46.00 | -10.98 |
| Megaphanerophytes | 5 | 2.30 | 3.00 | -0.7 |
| Mesophanerophytes | 7 | 3.23 | 28.00 | -24.77 |
| Nanophanerophytes | 64 | 29.49 | 15.00 | 14.49 |
| Chamaephytes | 33 | 15.21 | 9.00 | 6.21 |
| Hemicryptophytes | 30 | 13.82 | 26.00 | -12.18 |
| Cryptophytes | 5 | 2.30 | 6.00 | -3.7 |
| Therophytes | 73 | 33.64 | 13.00 | 20.64 |
| Total | **217** | 100 | **100** | |

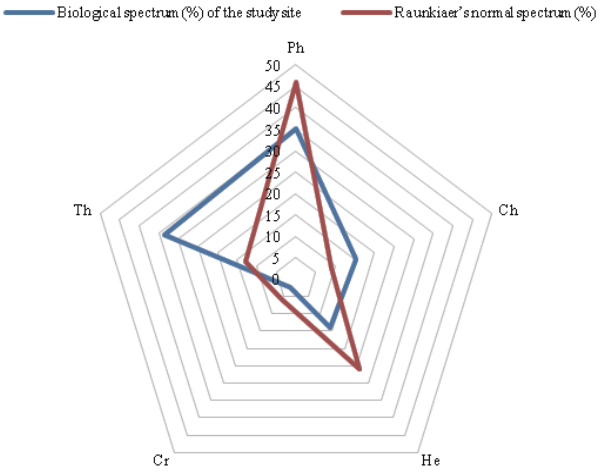


**Fig. 3.** Comparison of biological spectrum of MMT with Raunkiaer's normal spectra (Ph= Phanerophytes; Ch= Chamaephytes; He= Hemicryptophytes; Cr= Cryptophytes; Th= Therophytes).

Furthermore, the grove was found to constitute a higher percentage of therophytes (20.64%) and cryptophytes (6.21%), and a lower percentage of hemicryptophytes (12.18%) and phanerophytes (10.98%), compared to the normal spectrum exhibiting "thero-chamaephytic" phytoclimate. Meanwhile, of the phanerophytes, nanophanerophytes (14.49%) are somewhat larger, while mesophanerophyte (24.77%) and megaphanerophytes (0.7%) are comparatively smaller than the normal spectrum (Table 3). Therefore, the flora was compared to the standard range, developed by Raunkiaer for the flora world (1934), reflecting homogeneous climatic conditions (Sharma & Raina 2010). The $\chi^2$ test results showed a significant difference ($\chi^2$ = 47.663, df= 4, P < 0.0001) between the observed flora and Raunkiaer's normal spectrum. Table 3 shows this result is significant at P< 0.05, and regarded as extremely statistically significant (de Paula *et al*., 2017). The phanerophytes life form has the highest percentage, partly due to the local protection against certain taboos of the sacred grove.

According to Sharma & Raina (2017), the highest percentage of therophytes within the area, is related to the subtropic character and often associated with various factors, including soil and climatic conditions, combined with grazing, lopping, felling, deforestation, introduction of annual weeds, and other anthropogenic activities. Thus, the present study indicates the flora are mostly sub-tropical, and with a higher percentage of therophytes as well as chamaephytes, compared to normal biological spectrum. Therophytes were also discovered to be strongly preferred in disturbed areas, and to be prevalent in regions having biotic pressure or unfavorable habitat conditions (Al-Yemeni & Sher, 2010). This is

in accordance with the findings of this study. Nazir & Malik (2006) reported nanophanerophyte and therophytes as the biological spectra of Sarsawa hill Kotli. In addition, hot, dry and waterlogged conditions combined with overgrazing resulted in harsh conditions within the grove. This also agrees with the reports by Sher & Khan (2007), as well as Amjad *et al.* (2017), and Abbas *et al.* (2020) stating therophytes and nanophanerophytes are characteristic of subtropical ecosystems. Structurally and floristically, sub-tropical dry forests are less complex than wet forests, comprising about half or less wet forest tree species (Hasnat & Hossain, 2020). The forests serve as a refuge for valuable and endangered plants and animals. Hence, further study is required to quantify the data and suggest plans to conserve the sacred groves.

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

| Raunkiaer's life form | Leaf spectra | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Ap | Le | Na | Mi | No | Me | Ma | Mg | |
| Phanerophytes | 1 | 2 | 3 | 9 | 18 | 32 | 9 | 2 | **76** |
| Megaphanerophytes | | | | 1 | | 1 | 3 | | **5** |
| Mesophanerophytes | | | 1 | | 2 | 2 | 2 | | **7** |
| Nanophanerophytes | 1 | 2 | 2 | 8 | 16 | 29 | 4 | 2 | **64** |
| Chamaephytes | | 1 | 2 | 1 | 10 | 7 | 10 | 1 | **32** |
| Hemicryptophytes | | 17 | 10 | 3 | | | | | **30** |
| Cryptophytes | | 1 | 1 | | | 2 | 1 | | **5** |
| Therophytes | | 6 | 17 | 22 | 18 | 8 | 3 | | **74** |
| Total | **1** | **27** | **33** | **35** | **46** | **49** | **23** | **3** | **217** |

Notes: Ap= Aphyllous; Le= Leptophyll; Ma= Macrophyll; Me= Mesophyll; Mg= Megaphyll; Mi= Microphyll; Na= Nanophyll; No= Notophyll

**Leaf spectra.** According to the overall leaf size spectrum (Table 1, Table 4, Fig. 4), there were 27 leptophyllous (12.44%), 33 nanophyllous (15.21%), 35 microphyllous (16.13%), 46 notophyllous (21.20%), 49 mesophyllous (22.58%), 23 macrophyllous (10.60%) and 3 megaphyllous (1.38%), in the sacred grove. However, *Cuscuta reflexa* was an aphyllous (0.46%) species. Meanwhile, 11 Poaceae (2.67%), nine Poaceae (2.67%), eight Fabaceae (2.86%), six Malvaceae (1.71%), six Cucurbitaceae (1.52%) and five Malvaceae (1.33%) were discovered to be dominant families of the phylums leptophyll, nanophyll, microphyll, notophyll, mesophyll and macrophyll respectively. Table 1 and Table 4, as well as Fig. 4, also show the phylum megaphyll is equally distributed into Araceae, Cannabaceae and Fabaceae families.

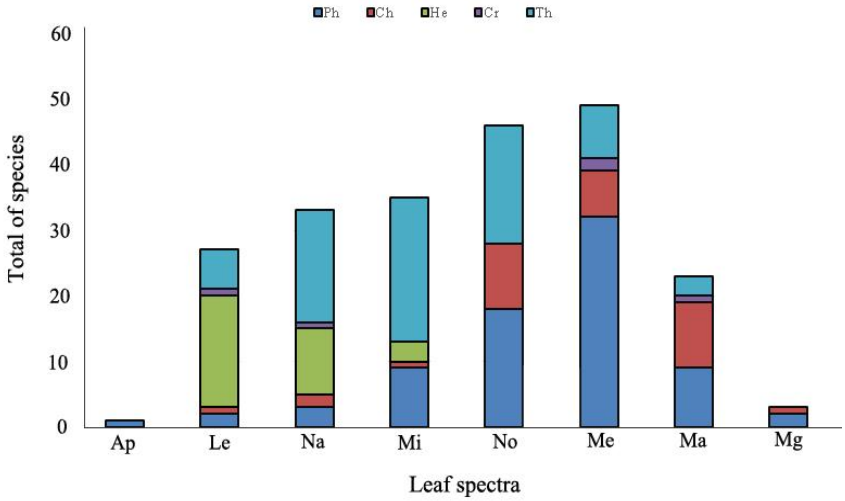


**Fig. 4.** Leaf spectral variation (Ap= Aphyllous; Le= Leptophyll; Ma= Macrophyll; Me= Mesophyll; Mg= Megaphyll; Mi= Microphyll; Na= Nanophyll; No= Notophyll; Ph= Phanerophytes; Ch= Chamaephytes; He= Hemicryptophytes; Cr= Cryptophytes; Th= Therophytes).

A leaf spectrum describes the plant adaptation and association in a community, with small-sized leaves present at the base and large leaves at the top, and is also correlated with climatic warming and water availability in the soil (Weber *et al*., 2012; Sakschewski *et al.*, 2015; Badshah *et al*., 2016). The presence of middle-sized leaves indicates a sub-tropical climate. Furthermore, the meso and notophyllous elements dominant in the sacred grove, show moisture availability or wet condition. As a result of the therophytes and chamaephytes present, the proportion of leaf size groups was observed to change seasonally. However, in all seasons, the phanerophytes and some chamaephytes retained almost the same status.

**IUCN categorization.** About 161 of these 217 plants have currently not been evaluated. Furthermore, there are 55 Least Concerned (LC) and 1 Vulnerable (VU) species. Table 1 shows the IUCN categorization. Based on this grouping, climber *Cayratia pedata* is the vulnerable species (Saha *et al.*, 2015). The results of threatened species assessment show most of the flora are perennial trees, while the phytosociological study with ecological data on IUCN red listed plants, indicates the plants are currently present and regenerate in the sacred groves, but disappear in nearby forests. This study therefore highlights the status and distribution of these species within the study area, the ecological characteristics required for their survival, and the threats to some of the species, identified by the IUCN criteria. Numerous factors led to the rise in numbers of vulnerable species. Overgrazing has been a significant cause of seedling destruction. However, anthropogenic activities, including the development of the plant and land-use amendment, are the foremost vital cause of this deterioration.

## CONCLUSION

This study shows the possibility of using the Raunkiaer strategy to evaluate the major differences between the populations of angiosperm plants, associations in the forested landscape or biome, the percentage of flora species resulting from the established ecological parameters and environmental gradients. In addition, life-form analysis clearly shows the sacred grove's biological spectrum is "thero-chamaephytic" phytoclimate. Meanwhile, there is a need to further juxtapose the adjacent natural strands pattern along the environmental gradients, to reveal more than the mere forest covers in the ecosystem data. This indicates biotic variables are significant in shaping landscape vegetation, by guiding succession, and demonstrates the effect of anthropogenic diseases favoring therophyte growth, within the sacred grove. Therefore, any more damage to the sacred grove is able to facilitate potential changes within its present phytoclimate.

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