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Vascular plant diversity in the sacred groves of Jaintia Hills in northeast India

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Abstract. Diversity of vascular plants was studied in three sacred groves of the Jaintia Hills, in northeast India. About 395 species, 250 genera, and 108 families comprising pteridophytes, gymnosperms and angiosperms were found in the groves. Orchidaceae, Rubiaceae, Asteraceae and Lauraceae were dominant families and *Ficus* was the largest genus, with nine species. About 160 tree species were distributed in canopy, subcanopy and under canopy strata of the forest. Concentration of tropical and temperate elements of the neighbouring Sino-Himalayan and Burma-Malayan regions, and endemic (54 species), rare (31 species) and primitive taxa (38 species) due to favourable climatic conditions and prolonged protection have contributed to the high species richness of the groves. Their better management and protection is important for the conservation of plant diversity in the region and also for the benefit of indigenous tribes of the state.

Introduction

Areas having an exceptional concentration of endemic species and experiencing loss of habitat have been termed biodiversity *hot-spots* (Myers et al. 2000). Together they occupy about 1.4% of the Earth's surface and contain about 44% of the world's total flora. Out of 25 hot-spots identified on the earth, two of them, namely Indo-Burma and the Western Ghats, are located in the Indian subcontinent (Groombridge 1992; Myers et al. 2000). Due to the presence of a large number of primitive and ancient flowering plants in the region, the Indo-Burma region of northeast India was considered as the cradle of ancient angiosperms (Takhtajan 1969). Meghalaya, a small state in northeast India, is reported to have 3128 species of flowering plants including 1236 endemic species (Khan et al. 1997). The floristic richness of the state has also been recognised by several earlier workers (Hooker 1854; Brandis 1897; Kanjilal 1934).

Traditionally the tribal communities in Meghalaya have been preserving small patches of virgin forest since time immemorial due to their religious belief. These forest patches, popularly known as sacred groves, serve as refugia for large numbers of endemic and rare plants of the region (Hajra 1975a, 1975b; Khan et al. 1997; Tiwari et al. 1998). The importance of sacred groves in conservation of biodiversity

has recently gained wide acceptance; hence, several studies have been carried out in India to assess the biodiversity of the groves located in the Western Ghats and in the Central Himalayas (Chandrashekara and Sankar 1998; Singh and Saxena 1998; Sinha and Maikhuri 1998; Singh et al. 1998; Swamy et al. 1998). Despite the vast and varied flora in northeastern India, information on biodiversity of the sacred groves is still limited and only a few studies have been made to understand the phytodiversity of the region (Hajra 1975a, 1975b; Khan et al. 1997; Tiwari et al. 1998).

This paper deals with vascular plant diversity in three sacred groves located in the eastern part of Meghalaya state and discusses their importance in conservation of regional plant diversity.

Study site

The study was conducted in three sacred groves situated near Jowai town (latitude 25°26′32″ N, longitude 92°12′ E, altitude 1200–1300 m a.s.l.) of the Jaintia Hills, in the state of Meghalaya (Figure 1). All three groves, namely Khloo Paiu Ram Pyrthai, Urkhla, and Khloo Langdoh (hereafter referred to as Sg-1, Sg-2, Sg-3, respectively) are located within a radius of 2 km of Jowai town and represent the relic humid subtropical forest of the area. They are well protected except during the annual Beh dein khlam festival, when the forest is disturbed by cutting straight boles of certain tree species for performing rituals associated with this festival of the local Jaintia tribe. The area of the sacred groves, their physiographic and soil characteristics are given in Table 1.

The general climate of the area is monsoonic with marked seasonal variation in rainfall and temperature. The annual rainfall recorded at Jowai during the study period (1997–1998) was 5282 mm. The rainy season starts in early April, with interrupted showers, but incessant rain begins in June and continues until September, often stretching until October. About 75% of the total annual rainfall is received between June and September. August, with a mean minimum temperature of 18 °C and mean maximum temperature of 26 °C is the warmest month of the year, while January, with a mean minimum temperature of 4 °C and mean maximum temperature of 15 °C is the coldest month. The period between March and May, with relatively high temperature and scanty rains, represents mild-summer. The post-monsoon months (October and November), when rain almost ceases and temperature starts declining, represent autumn. Winter (December–February) is characterised by minimal rainfall and temperature.

The vegetation of the groves may be classified under subtropical broad-leaved wet hill forest (Champion and Seth 1968). The forest canopy is composed of both evergreen and deciduous trees not exceeding 30 m height. The canopy and subcanopy trees together formed a continuous dense cover, whose continuity was broken by treefall gaps. The tree layer is composed of *Castanopsis tribuloides*, *C. purpurella*, *Cinnamomum glanduliferum*, *Neolitsea cassia*, *Drimycarpus racemosus*, *Persea odoratissima*, *Betula alnoides*, *Schima khasiana*, *Quercus*

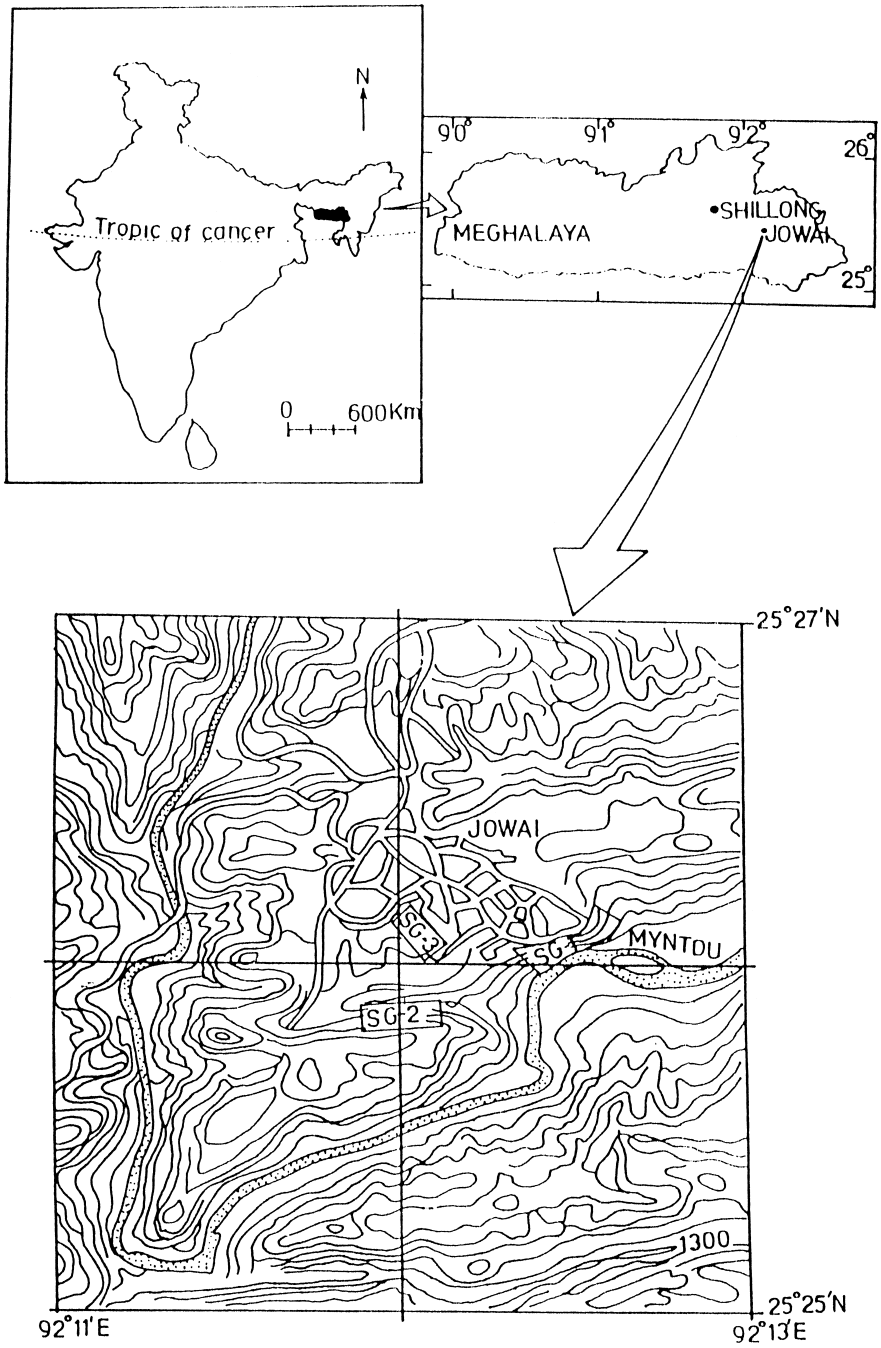

Figure 1. Physiographic maps and location of the three sacred groves in the Jaintia Hills of Meghalaya.

Table 1. Physiography and soil (0–30 cm depth) characteristics of the sacred groves in the Jaintia Hills.

	Khloo Paiu Ram Pyrthai	Urkhla	Khloo Langdoh
Physiography			
Area (ha)	9	12	7
Slope direction	East, southeast	East, northeast	East
Slope angle (°)	10–40	20–30	10–30
	>40	>40	
Soil			
pH	4.84	4.88	4.86
TKN (%)	0.36	0.42	0.33
Organic carbon (%)	6.49	7.8	5.34
Available phosphorus (%)	0.016	0.017	0.017

Total Kjeldahl Nitrogen (TKN), organic carbon and available phosphorus contents were determined by the semi-micro Kjeldahl digestion method, Walkley and Black method and Molybdenum blue method, respectively (Allen et al. 1974).

kamroopii and *Syzygium tetragonum*. The shrub stratum is quite dense and composed chiefly of evergreen species. Leaf drip tips and epiphylls, the characteristic features of tropical and subtropical trees, were commonly seen in the forest. Besides profuse growth of mosses and other bryophytes, tree trunks and branches were covered with epiphytic angiosperms and pteridophytes. Woody climbers and twiners were common in the forest. Old trees were found entangled by twiners and lianas. Parasitic and saprophytic angiosperms such as *Aeginetia indica* and *Balanophora dioica* were often seen on the forest floor.

The soil in the groves was acidic and poor in nitrogen and available phosphorus (Table 1). The moisture content showed wide seasonal fluctuation from almost saturated conditions during the rainy season to a minimum of 15% in winter.

Methods

An extensive floristic survey was carried out in all the three sacred groves at monthly intervals between May 1997 and April 1999. Specimens of flowering and non-flowering vascular plants were collected and identified with the help of different floras (Hooker 1872–1897; Brandis 1906; Kanjilal et al. 1934–1940; Chatterjee 1940; Kataki 1973; Balakrishnan 1981–1983; Haridasan and Rao 1985–1987; Jamir and Rao 1988). The Herbaria at the Botany Department, North-Eastern Hill University and Botanical Survey of India, North-Eastern Circle, Shillong, were consulted for correct identification of the specimens. Lists of endangered, threatened, rare and endemic plants found in the sacred groves were prepared with the help of published works of Deb (1958), Balakrishnan (1981–1983), Chauhan (1983), Das and Deori (1983), Kataki (1983), Rao and Haridasan (1983), Haridasan and Rao (1985–1987), Nayar and Sastry (1990), Kumar (1991), Khan et al. (1997) and Samant et al. (1998). The voucher specimens were deposited at the herbarium of North-Eastern Hill University.

Results and discussion

Species composition

A total of 395 vascular plants (flowering and non-flowering), including three unidentified tree species, were recorded in the three sacred groves. This is about 26% of the species described in the flora of Jaintia Hills (Balakrishnan 1981–1983) and 12% of the flora of the state (Khan et al. 1997). The floristic composition of the sacred groves is similar to the subtropical evergreen forest described by Balakrishnan (1981–1983), as is evident by the presence of a large number of evergreen species of *Cinnamomum*, *Schima*, *Castanopsis*, and *Syzygium* in the forest. Apart from the subtropical species, a number of tropical and temperate elements are also present in the forest. Some of the tropical species present in these groves include *Lithocarpus fenestrata*, *Syzygium tetragonum*, *Xerospermum glabratum*, *Elaeocarpus floribundus*, *Sarcosperma griffithii*, *Symplocos paniculata*, *Ardisia griffithii*, *Macropanax dispermus*, *Schefflera venulosa*, *Brassiopsis glomerulata*, *Boehmeria macrophylla*, *Toddalia asiatica*, *Raphidophora* sp., *Pothos* sp., and *Cyathea* sp. The temperate elements are represented by species of *Rhododendron*, *Prunus*, *Ilex*, *Aralia*, *Betula*, *Viburnum*, *Senecio*, *Rubus*, *Sambucus*, *Clematis*, *Anemone*, *Ranunculus*, *Viola*, etc. and *Eurya japonica*, *Girardina palmata*, *Lyonia ovalifolia*, and *Pinus kesiya* (Mani 1974; Rao 1974; Balakrishnan 1981–1983). Physiographic and climatic conditions of the area, which represent a transitional zone between temperate and tropical climates, appear to be the major factors responsible for the presence of both tropical and temperate elements in the groves.

The species composition of the sacred groves showed affinity with the flora of the Sino-Himalayan and Burma-Malayan regions. This is evident by the presence of a number of species belonging to those regions (Puri 1960; Mani 1974; Balakrishnan 1981–1983). Some of the Sino-Himalayan species recorded in the sacred groves include *Polygala siberica* and *Prinsepia utilis*. The Burma-Malayan species found in the groves were mostly trees, such as *Engelhardtia spicata*, *Xantolis assamica*, *Cinnamomum* sp., *Pittosporum* sp., *Persea* sp., *Litsea* sp. and few shrubs such as *Lasianthus* sp. and *Goniothalamus sesquipedalis*.

The presence of ancient angiosperms such *as Betula alnoides* and *Myrica esculenta* is another striking feature of the sacred groves. Primitive families like Annonaceae, Ranunculaceae, Piperaceae, Menispermaceae, Caryophyllaceae, Lauraceae, Myricaceae, and genera such as *Sarcandra*, *Holboellia*, *Corylopsis* and *Lithocarpus* are present in the groves (Takhtajan 1969).

Twenty plant species such as *Drimycarpus racemosus*, *Spondias axillaris*, *Styrax hookerii*, etc. not reported in the flora of Jaintia Hills (Balakrishnan 1981–1983) were recorded in the groves. A large number (73 species) of invasive shrubs and herbs such as *Lantana camara*, *Artemesia* sp., *Bidens pilosa*, *Galinsoga parviflora*, *Osbeckia* sp., *Pouzolzia hirta* etc., present on the periphery of the sacred groves also contributed to the species richness.

Table 2. Taxonomic diversity in the sacred groves of the Jaintia Hills of Meghalaya.

Natural orders	Families			Genera			Species		
	Sg-1	Sg-2	Sg-3	Sg-1	Sg-2	Sg-3	Sg-1	Sg-2	Sg-3
Pteridophytes	10 (12)	10 (10)	7 (8)	14 (8)	13 (6)	9 (5)	17 (6)	18 (5)	14 (6)
Gymnosperms	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)	1 (1)
Angiosperms									
Dicotyledons									
(a) Polypetalae									
Thalamiflorae	12 (14)	13 (13)	11 (13)	17 (10)	21 (10)	17 (10)	23 (9)	28 (8)	19 (9)
Disciflorae	9 (11)	9 (9)	9 (11)	13 (7)	12 (6)	18 (11)	18 (7)	21 (6)	20 (9)
Calyciflorae	10 (12)	14 (14)	12 (14)	18 (10)	29 (14)	23 (14)	29 (11)	42 (13)	28 (13)
(b) Gamopetalae	17 (20)	22 (23)	20 (24)	59 (33)	69 (33)	54 (32)	85 (32)	106 (32)	67 (30)
(c) Apetalae	16 (19)	16 (17)	14 (17)	31 (17)	30 (14)	26 (15)	54 (20)	63 (19)	40 (18)
Monocotyledons	10 (12)	12 (12)	10 (12)	25 (14)	34 (16)	20 (12)	41 (15)	53 (16)	31 (14)
Unidentified	–	–	–	–	–	–	1 (1)	2 (1)	3 (1)
Total	85	97	84	178	209	168	269	334	223

Values in parentheses are the percentage of the total.

Taxonomic diversity

About 94% of the total vascular plants in the groves were angiosperms, followed by pteridophytes and gymnosperms (Table 2). This corroborates the findings of Khan et al. (1997), who reported that angiosperms constitute about 94% of the total vascular plants of Meghalaya. Among the angiosperms, dicotyledons were the dominant component (79%). This observation is in conformity with the earlier reports (Balakrishnan 1981–1983; Haridasan and Rao 1985–1987) that there is predominance of dicotyledons (71%) in the flora of the Jaintia Hills and in the forest flora of Meghalaya.

Genera

Altogether 250 genera, including those of Sino-Himalayan origin such as *Actinidia*, *Anemone*, *Arisaema*, *Corylopsis*, *Clematis*, *Holboellia*, *Eurya*, *Camellia*, *Viburnum*, and *Lonicera*, were recorded in the three sacred groves. Out of these, 101, 126, and 101 were represented by only one species each in Sg-1, Sg-2 and Sg-3, respectively. The rest were multi-species genera. *Ficus* with nine species was by far the largest genus. Multi-species genera reported from many tropical forests, for example, on Mt. Kinabalu (Aiba and Kitayama 1999), in the Amazon (Valencia et al. 1994) and in Costa Rica (Nadkarni et al. 1995), contribute to the high species richness and diversity of these forests. Coexistence of congeneric species in the forest indicates differences in flowering phenologies, pollination and dispersal agents of the species (Valencia et al. 1994).

Families

There were 84 families of dicotyledons and 12 families of monocotyledons. Sixty-

Table 3. Dominant families represented in the sacred groves and in the flora of the Jaintia Hills.

Name of family	Sacred groves		Jaintia Hills[a]	
	Genera	Species	Genera	Species
Orchidaceae	14	27	50	141
Rubiaceae	16	23	31	75
Asteraceae	12	21	33	66
Lauraceae	6	17	9	24
Lamiaceae	10	12	20	31
Araliaceae	8	12	10	20
Rosaceae	5	11	12	29
Myrsinaceae	4	9	6	21
Moraceae	1	9	5	24
Fabaceae	6	8	25	66
Euphorbiaceae	6	8	22	44

[a] Data after Balakrishnan (1981–1983).

Table 4. Plant species richness in different synusiae of the sacred groves of the Jaintia Hills.

Growth form	Number of species			
	Sg-1	Sg-2	Sg-3	Endemic, rare
Canopy tree (> 20 m)	23	25	20	(6^e, 3^r)
Subcanopy tree (10–20 m)	32	41	37	(8^e, 5^r)
Small trees or large shrubs (2–10 m)	42	56	41	(10^e, 4^r)
Scandent shrubs or stragglers, etc.	15	16	17	(5^e, 5^r)
Lianas	28	34	23	(8^e, 2^r)
Epiphytes, epiphytic shrubs and parasites	41	47	25	(3^e, 3^r)
Shrubs	30	30	18	(6^e, 5^r)
Herbs	57	85	42	(8^e, 4^r)
Total	269	334	223	(54^e, 31^r)

Values in parentheses are the total number of endemic (e) and rare (r) species found in the three groves.

three families were represented by one genus each, while 46 families were represented by one species each. Pteridophytes and gymnosperms were represented by 10 and 2 families, respectively. Orchidaceae, with 14 genera and 27 species, was the dominant family followed by Rubiaceae, with 16 genera and 23 species (Table 3). The species-rich tropical forests are also rich in terms of families. For instance, Lieberman et al. (1996) encountered 91 families of tree species (>10 cm dbh) in Costa Rica, Vazquezg et al. (1998) found 103 families in tropical Mexico, and Williams et al. (1994) reported peak family richness in Cambodia, which has about 54% of the world's total number of families. In Meghalaya, Kumar (1984) has reported 130 families of angiosperms and pteridophytes from Balphakram sanctuary in the Garo Hills and Balakrishnan (1981–1983) has reported 165 families of angiosperms from the Jaintia Hills of Meghalaya. Compared to these findings, the three sacred groves studied here, with 96 families, stand out as rich in family representation.

Species diversity in different growth forms

The species richness in different growth forms constituting the vegetation synusiae (*sensu* Richards 1996) of the forest is given in Table 4.

Canopy trees
In each of the three groves the canopy was composed of 20–25 tree species, many of which were restricted to either one or two sacred groves. For instance, *Fraxinus floribunda* and *Elaeocarpus floribundus* were exclusive to Sg-1 while *Xerospermum glabratum, Litsea laeta* and *Cinnamomum glanduliferum* were present only in Sg-2. *Acer laevigatum, Drimycarpus racemosus* and *Neolitsea cassia* and *Podocarpus neriifolia* were present in Sg-3. *Persea odoratissima*, *Castanopsis purpurella*, *Lithocarpus fenestrata*, *Betula alnoides* and *Schima wallichii* were common to all three groves. Altogether 34 tree species, including two unidentified species, were present in the canopy layer. Lauraceae and Fagaceae were the dominant families. The presence of several climax species such as *Lithocarpus fenestrata*, *Engelhardtia spicata* and *Persea odoratissima* (Bor 1942) suggests that the groves are the remnants of the primary forest of the area.

Subcanopy trees
The subcanopy was composed of 56 species including one unidentified species. Out of these, 17 species were common to all the three groves. The commonly found species in this group were *Pithecellobium monadelphum*, *Vaccinium sprengilii*, *Xantolis assamica*, *Helicia nilagirica* and *Ficus lamponga*. *Rhododendron arboreum* and *Myrica esculenta* were restricted to Sg-1, while *Cinnamomum pauciflorum*, *Persea duthii* and *Quercus kamroopii* were present in Sg-2. *Garcina anomala*, *Melia azedarach*, *Spondias axillaris* and *Alangium chinensis* were exclusive to Sg-3.

Small trees or large shrubs
This group was rich in species diversity. Of the 70 species, the majority is shade tolerant. The most conspicuous and common species belonging to this group were *Camellia caudata*, *Coffea khasiana*, *Microtropis discolor*, *Turpinia nepalensis*, *Lasianthus sikkimensis*, *Styrax serrulatum* and *Clerodendrum wallichii*.

Shrubs
Small perennial shrubs were represented by 39 species, of which 10 were common to all the three groves. Taxa like *Boehmeria platyphylla*, *Girardinia palmata*, and *Nicrandra physaloides* were confined to Sg-1, while *Sarcandra glabra*, *Hedyotis uncinella* and *Osbeckia stellata* were restricted to Sg-2.

Herbs
Ninety herbaceous species, including the secondary species, were found in the groves. The secondary invasive species were confined to the periphery and in disturbed patches of the grove. Some interesting herbaceous plants found inside the

groves include *Ophiorrhiza fasciculata*, *Begonia palmata*, *Anoectochilus roxburghii*, *Impatiens juripa*, *Sonerila maculata* and *Viola palmaris*.

Scandent shrubs and stragglers

The number of species varied between 15 and 17. Rosaceae had the highest number (5) of scandent plants. Other important species include *Embelia subcoriacea*, *Rubus ellipticus*, *Zanthoxylum oxyphyllum*, *Blumea riparia*, and *Toddalia asiatica*.

Lianas

This group constituted mechanically dependent plants requiring strong, erect plants to support, cling, twine, or climb. There were 36 species of such plants. Some of the common species in this category include *Fissistigma verrucosum*, *Cissampelos pariera*, *Cayratia japonica*, *Melodinus monogynus*, and *Entada scandens*.

Epiphytes

This was the most diverse group of plants after undercanopy trees and herbaceous species. Although Orchidaceae members dominated this group, a large number of Asclepiadaceae, Gesneriaceae members and Pteridophytes were also present. *Aeschynanthes sikkimensis*, *Lysionothus serratus*, *Pothos scandens*, *Raphidophora calophyllum*, *Hoya fusca*, *Agapetes* sp., *Pleione maculata*, *Pholidota* sp., *Dendrobium* sp. and *Bulbophyllum* sp. were some of the important epiphytes in the sacred groves.

Endemism

The endemic species recorded from the sacred groves (Appendix 1) may not necessarily be endemic to the Jaintia Hills or Meghalaya, rather they are endemic to the entire northeast India and the eastern Himalayas. About 14% of the total species recorded in the groves were endemic. In other words, one out of every seven species was endemic. Lauraceae, Balsaminaceae and Rosaceae had the highest number of endemic species (four species each). Three endemic genera, viz. *Drimycarpus*, *Tupidanthus*, and *Phlogacanthus* (Chatterjee 1940) were also found in these groves. *Acer laevigatum*, *Drimycarpus racemosus*, *Litsea laeta*, *Quercus glauca* (canopy tree), *Ilex venulosa*, *Citrus latipes* (subcanopy tree), *Sonerila khasiana* and *Impatiens khasiana* (herbs), *Ceropegia angustifolia*, *Fissistigma verrucosum* (climbers) and *Raphidophora callophyllum*, *Bulbophyllum griffithii* and *Aeschynanthes sikkimensis* (epiphytes) were endemic species. An analysis of the distribution pattern of endemic species in different synusiae of the forest reveals that the majority of them were either small trees or large shrubs (Table 4). The distribution of endemic species in different growth forms is reported to be 20% trees, 16% shrubs, 52% herbs and 11% climbers in the forest vegetation of south India (Ganesh et al. 1996) and 23% trees, 30% shrubs, 38.6% herbs and 8% climbers in the flora of Meghalaya (Khan et al. 1997).

Rarity

There were 31 rare species in the groves (Appendix 2), 20 of which were endemic. *Fissistigma verrucosum*, represented by five individuals in the groves, was collected after a gap of 70 years. Nine old trees of *Fraxinus floribunda*, a rare species (Rao and Haridasan 1983), were found in Khloo Paiu Ram Pyrthai forest. *Styrax hookerii*, another rare plant that escaped the collection of Haridasan and Rao (1985–1987), was collected from Khloo Langdoh forest.

Kumar (1991) found 111 rare plants in Balphakram National Park in the Garo Hills of Meghalaya, of which 51 species were endemic. Rao and Haridasan (1983) have reported 54 rare and threatened plants and Haridasan and Rao (1985–1987) have listed 44 rare dicotyledonous plants from Meghalaya. Compared to the above figures, it is quite clear that the three groves have a high concentration of rare plant species.

In conclusion, the favourable climatic conditions of the area, its geographic proximity to the species-rich eastern Himalayas, south-central China, Burma and the Malaya peninsula, coupled with prolonged protection have contributed to high taxonomic diversity at species, genera and family levels and concentration of endemic and rare species in the groves, which are the remnants of the subtropical wet hill forest of the region. However, in view of increasing anthropogenic pressure on land and plant resources in the region and erosion in the traditional belief, the sacred groves are being encroached by the local tribes themselves. Therefore there is an urgent need to protect these groves to conserve regional plant diversity, not only for ecosystem health but also for the benefit of the indigenous tribes who heavily depend on local plant diversity for their day-to-day requirements. This may be possible by developing a network of protected sacred groves through tribal traditional institutions, since more than 90% of the total forest in the state is under the control of the indigenous tribes.

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Appendix 1

Endemic plants found in the three sacred groves of the Jaintia Hills.

Name of the species	Family	Habit	Sacred grove[a]	Status in Meghalaya[b]
Acer laevigatum Wall.	Aceraceae	Tree	3	Rare
Aeschynanthes parasiticus Clarke	Gesneriaceae	Epiphyte	2,3	Common
Aeschynanthes sikkimensis (Clarke) Stapf.	Gesneriaceae	Epiphyte	1,2,3	Rare
Aeschynanthes superba Clarke	Gesneriaceae	Epiphyte	1,2	Common
Aralia thomsonii Seem.	Araliaceae	S. tree	2,3	Frequent
Ardisia griffithii Clarke	Myrsinaceae	S. tree	2,3	Frequent
Baliospermum micranthum Muell-Arg.	Euphorbiaceae	Shrub	1,2,3	Frequent
Bulbophyllum griffithii (Lindl.) Reichb.	Orchidaceae	Epiphyte	1,2,3	Rare
Callicarpa psilocalyx Clarke	Verbenaceae	Shrub	1,2	Rare
Camellia caduca Brandis	Theaceae	S. tree	1	Less frequent
Carpinus viminea Lindl.	Corylaceae	Tree	1,2	Rare
Ceropegia angustifolia Wt.	Asclepiadaceae	Climber	1,2	Rare
Cinnamomum pauciflorum Nees	Lauraceae	Tree	2	Rare
Citrus latipes (Swingle) Tanaka	Rutaceae	Tree	3	Frequent
Drimycarpus racemosus Hook.	Anacardiaceae	Tree	1,2,3	Frequent
Erythroxylum kunthianum Wall.	Erythroxylaceae	S. tree	1,2,3	Frequent
Fissistigma verrucosum (Hk.f.&Th.) Merr	Annonaceae	Climber	1,2,3	Rare
Glochidion thomsonii (Muell-Arg.) Hook.f.	Euphorbiaceae	Tree	1,2,3	Frequent
Gomphostemma lucidum Benth.	Lamiaceae	Shrub	1,2	Rare
Hedera nepalensis K.Koch.	Araliaceae	Climber	2	Rare
Ilex embelioides Hook.f.	Aquifoliaceae	S. tree	1	Rare
Ilex venulosa Hook.f.	Aquifoliaceae	Tree	1,2	Rare
Impatiens acuminata Hook.f.	Balsaminaceae	Herb	2	Frequent
Impatiens juripa Hook.f. and Thoms.	Balsaminaceae	Herb	1,2	Frequent
Impatiens khasiana Hook.f. and Th.	Balsaminaceae	Herb	1,2	Less frequent
Impatiens porrecta Hook.f. and Th.	Balsaminaceae	Herb	1,2,3	Less frequent
Ixora subsessiles Wall.	Rubiaceae	S. tree	2	Frequent
Lindera latifolia Hook.f.	Lauraceae	Tree	1,2,3	Rare
Litsea laeta (Nees) Hook.f.	Lauraceae	Tree	2	Frequent
Luisia Inconspicua (Hook.) King and Pantl	Orchidaceae	Epiphyte	1,2	Common
Neillia thyrsiflora D.Don.	Rosaceae	S. tree	2,3	Common
Osbeckia capitata Walp.	Melastomaceae	Herb	2	Common
Paramignya micrantha Kurz.	Rutaceae	S. tree	1,2,3	Frequent
Persea parviflora Meissn.	Lauraceae	Tree	1,2,3	Frequent
Phlogacanthus pubinervius T. Anders.	Acanthaceae	S. tree	3	Less frequent
Piper griffithii C.DC.	Piperaceae	Climber	1,2	Frequent
Piper peepuloides Roxb.	Piperaceae	Climber	1,2,3	Frequent
Pogostemon strigosus Benth.	Lamiaceae	Herb	1,2,3	Frequent
Polygonum bistorta L.	Polygonaceae	Herb	2	Common
Porana racemosa Roxb.	Convolvolaceae	Climber	2,3	Rare
Prunus jenkinsii Hook.f.	Rosaceae	Tree	1	Frequent
Psychotria symplocifolia Kurz.	Rubiaceae	Shrub	1,2	Rare
Quercus glauca Thunb.	Fagaceae	Tree	2	Rare
Raphidophora calophyllum Schott.	Araceae	Epiphyte	1,2,3	Common
Raphidophora decursiva (Roxb).	Araceae	Epiphyte	1,2,3	Common
Rubus assemensis Focke.	Rosaceae	Scandent	1,2,3	Common
Rubus khasianus Cordot.	Rosaceae	Scandent	1,2	Rare
Schima khasiana Dyer	Theaceae	Tree	1,2	Rare
Senecio jowaiensis Balakr.	Asteraceae	L. shrub	2	Less frequent
Smilax myrtillus DC.	Smilacaceae	Shrub	1,2,3	Common
Sonerila khasiana Clarke	Melastomaceae	Herb	1,2	Rare
Tupidanthus calyptratus Hk.f.	Araliaceae	Scandent	1,2,3	Rare
Turpina nepalensis W and A Prodr.	Staphylaceae	S. tree	1,2	Rare
Vacciinium vacciniaceum (Roxb) Sleum	Vaccinaceae	Epiphyte	1,2	Common
Viburnum simonsii Hk.f. and Thoms	Caprifoliaceae	Tree	1,2	Common

The species listed are endemic to the eastern Himalayas and northeast India. [a]1 = Khloo Paiu Ram Pyrthai, 2 = Urkhla, and 3 = Khloo Langdoh. [b]Sources: Chatterjee (1940), Deb (1958), Balakrishnan (1981–1983), Das and Deori (1983), Rao and Haridasan (1983), Haridasan and Rao (1985–1987), Kumar (1991), Samant et al. (1998) and Khan et al. (1997).

Appendix 2.

Rare plants of Meghalaya found in the sacred groves of the Jaintia Hills.

Name of the species	Family	Sacred grove[a]	Remarks
Acer laevigatum Wall.	Aceraceae	3	Endemic
Aeschynanthes sikkimensis (Clarke) Stapf	Gesneriaceae	1,2,3	Endemic
Ardisia depressa Cl.	Myrsinaceae	1,2,3	–
Ardisia odontophylla DC.	Myrsinaceae	1,2	–
Balanophora dioica Royle	Balanophoraceae	1,2	–
Baliospermum micranthum (Muell-Arg)	Euphorbiaceae	1,2,3	Endemic
Bulbophyllum griffithii (Lindl.) Reichb.	Orchidaceae	1,2,3	Endemic
Callicarpa psilocalyx Clarke	Verbenaceae	2,3	Endemic
Carpinus viminea Lindl.	Corylaceae	1,2	Endemic
Ceropegia angustifolia Wt.	Asclepediaceae	1,2	Endemic
Cinnamomum pauciflorum Nees.	Lauraceae	2	Endemic
Clematis acutangula Hook.f.	Ranunculaceae	1,2	–
Dendrobium devonianum Paxt.	Orchidaceae	1,2	–
Embelia vestita Roxb.	Myrsinaceae	1,2	
Fissistigma verrucosum (Hk.f.&Th.) Merr.	Annonaceae	1,2,3	Endemic
Fraxinus floribunda Wall.	Oleaceae	1	–
Gomphostema lucidum Benth.	Lamiaceae	1,2	Endemic
Hedera nepalensis K.Koch.	Araliaceae	2	Endemic
Ilex emblioides Hook.f.	Aquifoliaceae	1	Endemic
Ilex venulosa Hook.f.	Aquifoliaceae	1,2	Endemic
Lindera latifolia Hook.f.	Lauraceae	1,2,3	Endemic
Morinda umbelleta Linn	Rubiaceae	2,3	–
Pleione maculata (Lindl) Lindl.	Orchidaceae	1,2	–
Porana racemosa Roxb.	Convolvulaceae	2,3	Endemic
Psychotria symplocifolia Kurz.	Rubiaceae	1,2	Endemic
Sarcosperma griffithii Cl.	Sapotaceae	2,3	–
Schima Khasiana Dyer	Theaceae	1,2	Endemic
Sonerila khasiana Clarke	Melastomaceae	1,2	Endemic
Styrax hookerii Cl	Styracaceae	2,3	–
Tupidanthus calyptratus Hk.f.	Araliaceae	1,2,3	Endemic
Turpina nepalensis W and A Prodr.	Staphylaceae	1,3	Endemic

Sources: Kataki (1983), Chauhan (1983), Haridasan and Rao (1985–1987), Kumar and Rao (1983), Kumar (1991) and Nayar and Sastry (1990). [a]1,2,3 are as in Appendix 1.

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