Biodiversity Value, Status, and Strategies for Conservation of Sacred Groves of Meghalaya, India

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ABSTRACT

The tribal communities of Meghalaya in northeast India—Khasis, Garos, and Jaintias—have a tradition of environmental conservation based on various religious beliefs which have been passed on from one generation to the other. Based on these beliefs, certain patches of forests are designated as sacred groves under customary law and are protected from any product extraction by the community. Such forests are very rich in biological diversity and harbor many endangered plant species including rare herbs and medicinal plants. Seventy-nine sacred groves were located, denoted on a geographical map of Meghalaya, and studied for their biodiversity value, status, and vegetation characteristics. A baseline floristic survey revealed that at least 514 species representing 340 genera and 131 families were present in these sacred groves. The status of sacred groves was ascertained through canopy cover estimate. A little over 1.3% of total sacred grove area was undisturbed, 42.1% had relatively dense forest, 26.3% had sparse canopy cover, and 30.3% had open forest. The vegetation characteristics and species diversity of an undisturbed sacred grove were compared with that of an unprotected disturbed forest. The species diversity indices were higher for the sacred grove than for the disturbed forest. The species composition and community characteristics differed significantly between the two forests. Sociocultural aspects of sacred grove conservation were analyzed, and views of the local people were enlisted. Based on the findings, conservation strategies for sacred groves were suggested.

INTRODUCTION

The importance of sacred groves in biodiversity conservation has long been recognized (Kosambi 1962; Gadgil & Vartak 1976; Haridasan & Rao 1985). Sacred forests have been reported to exist in many parts of Asia and Africa. Sacred groves of Ghana, Senegal, and Sumatra were described in MAB (1995), and existence of such forests in Nigeria, Syria, Turkey, and Japan has been reported by Gadgil and Vartak (1976). In India, sacred groves are found in the states of Bihar, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Meghalaya, and Rajasthan. However, no comprehensive study on biodiversity of sacred groves of any of these states is available except Maharashtra (Gadgil & Vartak 1976; Mitra & Pal 1994).

The sacred groves of Meghalaya are traditionally managed community forests, and they often represent the relic climax vegetation of the region (Barik *et al.* 1992). ~1000 km^2 forest in Meghalaya, which is ~5% of the total area of the state, is protected by the local tribals as sacred groves (Anonymous 1984). These forest patches have been protected since time immemorial mainly because of religious beliefs and social sanctions attached to them (Bor 1942a). They are the repository of biodiversity (Gadgil & Chandran 1992) and provide safe sites for reproduction of a variety of floral and faunal resources (Darlong 1995). Several endangered species are now confined only to these groves (Haridasan & Rao 1985).

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They help in maintaining viable populations of pollinators and predators, conserve germplasm (Khiewtam 1986), and serve as a potential source of propagules required for colonization of degraded wastelands and fallows. In addition, due to their dense vegetation often spread over hundreds of hectares, sacred groves provide such important ecosystem services as conserving soil, protecting water sources and catchment areas, and helping to maintain downstream water quality (Tiwari *et al.* 1995).

The antiquity of the sacred groves is evident from the presence of numerous tall monoliths erected in memory of departed elders of the local tribes. The sacred groves are usually managed by a committee of nominated members belonging to the local community which is chaired by the priest of the community who is also responsible for performance of the religious ceremonies and rituals. According to local government law (District Council Forest Act 1958), "the sacred groves shall be managed by the person or persons to whom the religious ceremonies for the particular village(s) are entrusted in accordance with the customary practice in vogue. No timber or forest produce shall be removed from the sacred groves except for the purposes in connection with religious functions or ceremonies recognized by religious head of the local community." The local people maintain that *Syiwan* deity would be offended if trees are cut and flowers and fruits plucked from these forests (Khan *et al.* 1986). They believe that the gods and spirits who live in the forest look after the welfare of the people and protect them from natural calamities, sickness, and invasion by enemies (Rao 1992).

Clearing of nearby forest areas has of late brought pressure on these sacred groves, and in places where religious beliefs have eroded and the short-term economic gains have got the upper hand, the sacred groves are being encroached upon. These factors are contributing toward depletion of sacred groves in the state. However, there still exist hundreds of patches of forests that are relatively undisturbed and often untouched amidst degraded and barren landscape. Despite their conservational, cultural, and aesthetic importance, the sacred groves of Meghalaya are little studied with regard to their biodiversity value and status. A taxonomic account of the sacred grove at Mawphlang was published by Hazra (1975). Khan *et al.* (1987) studied the population structure of tree species, whereas Barik *et al.* (1992, 1996a, 1996b) and Rao *et al.* (1990, 1997) studied community composition, gap-phase regeneration, and regeneration ecology of dominant tree species in this sacred grove. Khiewtam (1986) and Khiewtam and Ramakrishnan (1993) studied the vegetation, litter and fine root dynamics, and nutrient flow in a sacred grove at Cherrapunjee.

The present study was undertaken with the objective to document and analyze the biodiversity value and status of sacred groves in Meghalaya. The view points of the local community were enlisted to find out the causes of degradation and to evolve strategy for conservation of the sacred groves.

STUDY AREA

Meghalaya is situated in northeast India between the latitudes of 25° 45′ N and 26° 10′ N and longitudes of 89° 45′ E and 92° 47′ E (Figure 1), covering a total geographical area of 22,429 km^2. The land is predominantly hilly, and altitude ranges between 100–1900 m from mean sea level. The climate of Meghalaya is monsoonic with an average annual rainfall of 2200 mm. Most rainfall occurs during mid-May to September. Mean maximum temperature ranges between 15–25°C and mean minimum temperature ranges between 5–18°C (Figure 2).

The soils of Meghalaya are derived from the underlying gneiss, schist, and granite. They have been grouped under the latosol (oxysol) type (Pascoe 1950). Most soils are lateritic in origin and vary from sandy loam to clay loam. The soils of valleys and plains are more fertile than are the upland soils. Organic carbon content varies between 3.2–6.4%. The soils are acidic in reaction with a pH range of 4.5–6.5 (Rao *et al.* 1990). Most of Meghalaya is situated on a plateau which is a detached block of the Indian peninsula. In the south, the plateau is marked by deep gorges, spurs, and abrupt slopes, but the northern portion is dotted with numerous hills which gradually merge with the Brahmaputra plain.

According to a 1991 population census, the population of Meghalaya was 1,760,626; the density was 78.5 persons per km^2. Khasi, Garo, and Jaintia tribes inhabit the three hills known by the same name that together constitute Meghalaya. Most Meghalayans have adopted Christianity during the past 150 years.

Meghalaya supports rich forests. According to the Forest Survey of India Report (1995), 18% of

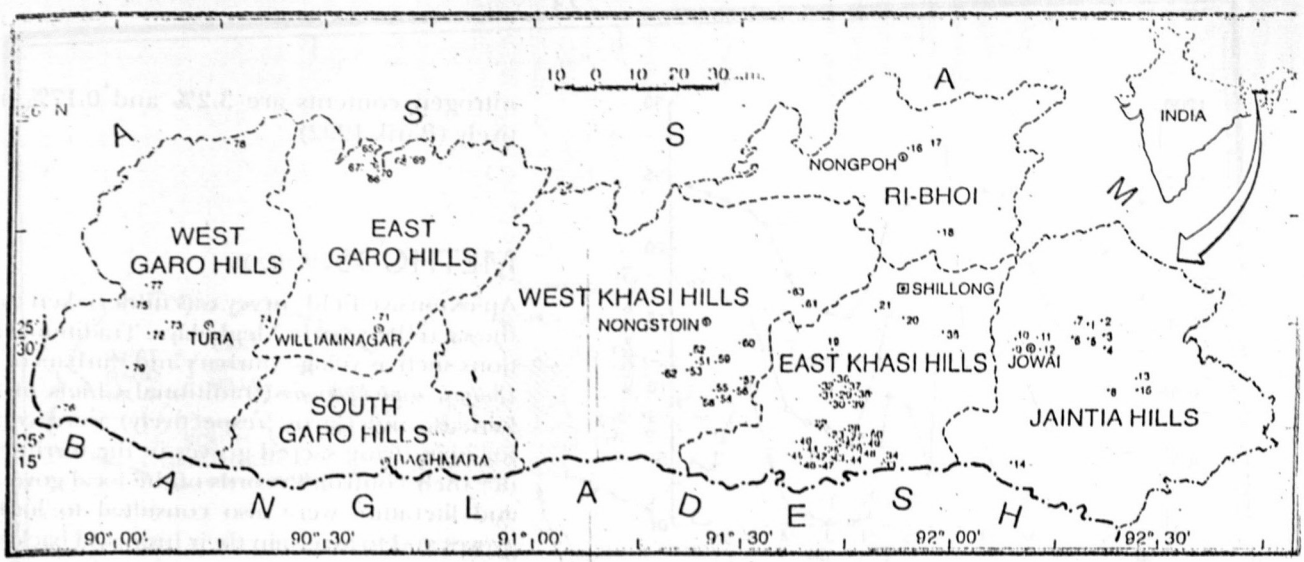

FIGURE 1. Geographical map of Meghalaya, India, showing distribution of 79 sacred groves.**JAINTIA HILLS:** RALIANG, 1. Blai Law, 2. Poh Puja, 3. Poh Moorang, 4. Pun Lyngdoh, 5. Byrsan; SHANGPUNG, 6. Poh Lyngdoh, 7. Law Kyntang; KHLIEHRIAT, 8. Khlaw Blai; JOWAI, 9. Khloo Paiu, 10. Trepale Jowai, 11. Khloo Lyngdoh, 12. Mokhain; SUTNGA, 13. Myndihati, 14. Syndai, 15. Jalong; **RI-BHOI DISTRICT:** UMSAW NONGKHRAI, 16. Pahampdem, 17. Nong Lyngdoh, Nongkhrai, 18. Sophetbneng, Nongkhrai; **EAST KHASI HILLS:** MAWPHLANG,19. Law Lyngdoh; NONGKREM, 20. Law Lyngdoh, Smit , 21. Lum Shyllong, Laitkor; CHERRAPUNJI, 22. Law Kyntang, Khlieh Shnong, 23. Law Adong, Khlieh Shnong; MAWSMAI, 24. Ram Jadong, 25. Blei Bah, 26. Mawlong Syiem, 27. Pom Shandy, 28. Law Adong; LAIT-RYNGEW, 29. Law Suidnoh, 30. Law U-Niang, 31. Madan Jadu, 32. Law-Ar-Liang; KHADAR SNONG, 33. Lum Diengjri, 34. Mawmang; KHADAR BLANG, 35. Wahkhem; SOHRARIM, 36. Law Lieng, 37. Law Mawsaptur, 38. Law Dymmiew; MAWMIHTHIED 39. Law Nongshim; MAWMLUH, 40. Mawsawa; WAHLONG, 41. Mawryot, 42. Niangdoh, 43. Rijaw; UMWAI, 44. Umtong, 45. Diengkain, 46. Mawthoh, 47. Maw Kyrngah; MAWLONG, 48. Kynsang, 49. Umthri, 50. Umkatait; **WEST KHASI HILLS:** MAHARAM SYIEMSHIP, 51. Law Lyngdoh, Nonglyngkien, 52. Lum Sanglia, Nonglyngkien, 53 Lum Blei, Nonglyngkien, 54. Law Lyngdoh, Notnglang, 55. Law Kyntang, Mawlangwir, 56. Law Kyntang, Mawten, 57. Law Lyngdoh, Rangmaw, 58. Law Kyntang, Mawthawiaw, 59. Nongsynrih; MAWIANG SYIEMSHIP,60. Law Lyngdoh, Nonglait; NONGKHLAW SYIEMSKIP, 61. Law Adong, Mawlong; NOBOSOHPHOH SYIEMSHIP, 62. Kyllai Lyngngun, Mariam,63. Lyngdoh, Mawnai; **EAST GARO HILLS:** 64. Kimpra Hills, Risubakrapara,65. Konkal Hills, Risubakrapara, 66. Walchi Ruram Hills, Risubakrapara, 67. Ganna Ramram Rock, Megapgiri, 68. Miapara rongadom, 69. Boro Miapara, 70. Jongola, 71. Rautagiri; **WEST GARO HILLS:** 72. Gor agiri, 73. Damalgiri, 74. Angalgiri, 75. Asigiri, 76. Jelbongpara, 77. Sadolpara, 78. Jhanjipara, 79. Daronggiri.

the geographical area of the state is covered with dense forest (canopy cover >40%) and 52% is covered with open forest (canopy cover 10–40%). Due to heavy rainfall and steep terrain considerable areas of the state are degraded and desertified (Tripathi *et al.* 1996). The natural forests are quite often interspersed with shifting cultivation patches, degraded bamboo forests, and weedy vegetation. Nevertheless, the forest flora represents high endemism and consists of a number of elements from neighboring countries (Balakrishnan 1981-1983). The vegetation of Meghalaya has been extensively studied by Bor (1942a, 1942b), Griffith (1848), Haridasan & Rao (1985), Hooker (1872–1897), Joseph (1968), Kanjilal *et al.* (1934–1940), and Rao (1968, 1974). Major vegetation types of the state are tropical evergreen forest, tropical semievergreen forest, tropical moist deciduous forest, tropical dry deciduous forest, subtropical broad-leaved forest, subtropical pine forest, bamboo forest, grassland, and savanna. The natural forests of Meghalaya are very rich in terms of their biodiversity (Haridasan & Rao 1985). An estimated 3000 flowering plants, 300 ferns, 20 conifers, and equally high numbers of bryophytes algae, fungi, and microorganisms inhabit the forests of the state (K. Haridasan, personal communication). Varied conditions of rainfall, soil type and altitude within a close vicinity, unique geomorphology, and its geographical location have all contributed to the floristic and faunistic diversity of Meghalaya. However, as a result of unregulated tree felling during the past few decades large tracts of dense forests have turned into de-

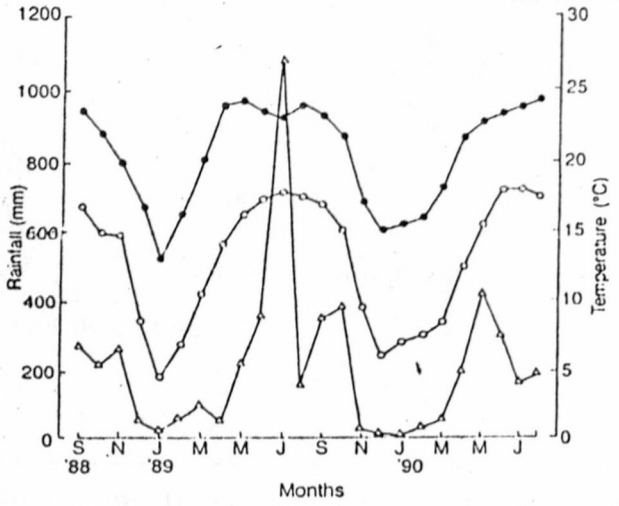

FIGURE 2. Monthly rain fall (triangles) and maximum (closed circles) and minimum (open circles) temperatures at Shillong during 1988–1990.

graded wastelands (Tripathi *et al.* 1996) and a large number of species have become rare and endangered (Tiwari *et al.* 1995).

To compare the vegetation and biodiversity of sacred groves with that of unprotected forests, the undisturbed sacred grove at Mawphlang (locally called *Law Lyngdoh*) and an unprotected disturbed forest at Upper Shillong were selected for the study (Figure 3). The two forests are situated within a radius of 15 km, and soil and climatic characteristics are very similar. A brief description of these forests is given in the following paragraphs.

MAWPHLAND SACRED GROVE

The sacred grove at Mawphlang, covering an area of ~75 ha, is situated at 1842 m above mean sea level, latitude 25° 34′ N and longitude 91° 56′ E. It is ~25 km southeast of Shillong, the capital of Meghalaya. The grove is a thick forest patch surrounded by a degraded rocky landscape covered by much grazed short grasses. The soil of this grove is sandy loam and acidic in reaction (pH 5.3). The mean organic matter and total nitrogen contents are 5.6% and 0.28%, respectively (Rao *et al.* 1990).

UPPER SHILLONG FOREST

The unprotected forest at Upper Shillong, ~12 km south of Shillong, is situated at 1850 m above mean sea level and is disturbed due to product extraction. The soil texture of this forest is loam and soil pH is 5.2. The mean organic matter and total nitrogen contents are 3.2% and 0.17%, respectively (Barik 1992).

METHODS

An extensive field survey was undertaken to locate the sacred groves in Meghalaya. Traditional institutions such as village durbars and durbars of *Syiems, Dollois, and Nokmas* (traditional Chiefs of Khasis, Jaintias, and Garos, respectively) were contacted for identifying sacred groves in the territories under their control. Records of the local government and literature were also consulted to locate the groves and to ascertain their historical background.

Identified sacred groves were denoted on the geographical map of Meghalaya by using Survey of India toposheets (scale: 1:50,000/1:250,000). Their areas were estimated using a prismatic compass/theodolite, employing standard survey/area estimation methods (Clark 1958).

Canopy cover of 56 sacred groves was estimated following the method given by Misra (1968) to ascertain the current status of the sacred groves. The groves were grouped into four classes depending on their percentage of canopy cover. Thus, sacred groves having 100% canopy cover were categorized as undisturbed, those having canopy cover >40% but <100% were classified as dense, the groves with canopy cover >10% but <40% were categorized as sparse, and those having <10% canopy cover were considered as the open groves category.

The baseline vegetation survey was conducted in different sacred groves by using standard taxonomic methods. Published literature on flora of Meghalaya were also consulted while preparing the floristic inventory of the sacred groves.

Density, frequency, and basal cover of tree and shrub species in the sacred grove at Mawphlang and in the unprotected forest at Upper Shillong were determined by laying randomly 20 quadrats of 10 × 10 m in each forest. For herbaceous species, 20 quadrats of 1 × 1 m were laid in each forest. Importance Value Index (IVI) of vegetation components was calculated according to the methods given by Misra (1968). The community indices such as Srensen's similarity index (Srensen 1948), Shannon index (Shannon & Weaver 1949), Pielou's evenness index (Pielou 1966), and species richness index were computed using the following formulae:

$$\text{Srensen's similarity index} = 2C/A + B \times 100$$

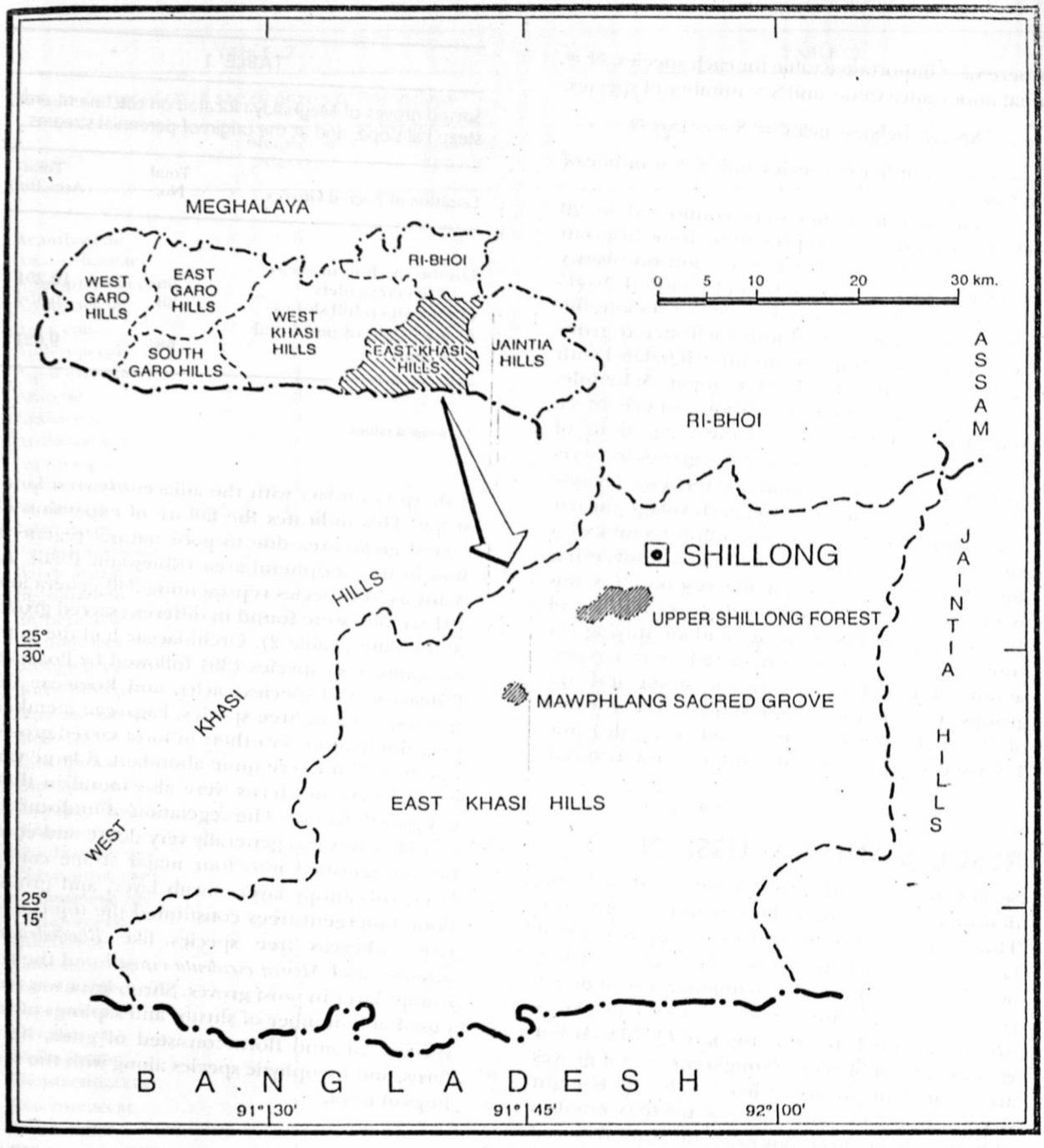

FIGURE 3. A part of the geographical map of Meghalaya, India, showing the locations of Mawphland sacred grove and Upper Shillong forest.

where A = number of species in stand A, B = number of species in stand B, and C = number of species common to both stands.

$$\text{Shannon index} = -(ni/N)\ \text{Log}\ (ni/N)$$

where ni = importance value for each species and N = total importance value.

$$\text{Pielou's evenness index} = -(ni/N)\ \text{Log}\ (ni/N)/\text{Log}_e S$$

where ni = importance value for each species, N = total importance value, and S = number of species.

$$\text{Species richness index} = S - 1/\text{Log } N$$

where S = number of species and N = number of individuals.

Sociocultural studies were conducted in 20 selected sacred groves representing four different canopy cover classes. The information on history of sacred groves, religious and cultural background, and structure and function of sociopolitical institutions associated with each sacred grove was collected through group interviews and with the help of a structured questionnaire/schedule. The attitudinal changes on various aspects of sacred grove conservation and the suggestions of the people for conservation of the groves were recorded through unstructured interviews (Whyte 1977). Ten respondents from each village durbar responsible for the management/protection of a particular grove were selected for administering the schedule. Selection of the respondents was made after closely observing the proceedings of the meetings of village durbar and identifying key knowledgeable persons on sacred groves representing different socioeconomic strata and age groups. Thus, in total, 200 respondents consisting of 50 elderly persons (age > 50 years old) and 150 youths (age < 50 years old) were interviewed.

RESULTS AND DISCUSSION

Seventy-nine sacred groves were identified and denoted on the geographical map of Meghalaya. The area of the individual sacred groves varied between 0.01–900 ha. Most sacred groves (n = 66) were located on the catchment areas of major rivers or rivulets and 58 were located in places where perennial streams originate (Table 1). For example, Lum Shyllong-Nongkrem sacred groves are located in an area where as many as eight streams originate and supply water to a number of human habitations downstream. Several sacred groves (e.g., Trepale Jowai sacred grove) also occurs on the steep hill slopes. Being located on these critical sites, sacred groves protect the land and soil from erosion and help in maintaining the quality of water in the stream downhill.

SACRED GROVE VEGETATION

Sacred groves represent the climax vegetation of the area, and in most cases the vegetation formed a sharp boundary with the adjacent barren landscape. This indicates the failure of expansion of sacred grove area due to poor natural regeneration in the peripheral area (Khiewtam 1986). As many as 514 species representing 340 genera and 131 families were found in different sacred groves of the state (Table 2). Orchidaceae had the highest number of species (39) followed by Poaceae, Rubiaceae (28 species each), and Rosaceae (26 species). Among tree species, Fagaceae members were dominant over others in most sacred groves. Epiphytic flora were quite abundant. A large variety of lianas and ferns were also found in these old growth forests. The vegetation of undisturbed sacred groves was generally very dense and could be distinguished into four major strata: canopy layer, subcanopy layer, shrub layer, and ground flora. Emergent trees constituted the top canopy layer, whereas tree species like *Rhododendron arboreum* and *Myrica esculenta* constituted the subcanopy layer in most groves. Shrub layer was composed of a number of shrubs and saplings of tree species. Ground flora consisted of grass, herbs, ferns, and bryophytic species along with the seedlings of trees.

TABLE 1

Sacred groves of Meghalaya located on catchment area, steep hill slope, and at the origin of perennial streams

Location of Sacred Groves	Total No.	Total Area (ha)[1]
On the catchment areas of rivers/rivulets	66	10,251
On the steep hill slopes	38	6,454
At the origin of perennial streams	58	9,621

[1] Estimated values.

STATUS OF SACRED GROVES

Of 56 sacred groves, for which the data on canopy cover was collected, 12.5% belonged to the undisturbed category, 25% were dense forest, 20% were sparse forest, and a maximum of 42.5% belonged to the open category. Of the total area of 10,511 ha covered by these groves, 138 ha, constituting 1.3% of the total area, was still undisturbed. The sacred groves of Mawphlang and

TABLE 2

Floristic composition of sacred groves of Meghalaya

Family	Number of Genera	Number of Species
Acanthaceae	8	9
Anacardiaceae	2	2
Angiopteridaceae	1	1
Annonaceae	1	1
Apiaceae	5	5
Apocynaceae	3	3
Aquicoliaceae	1	6
Araceae	3	8
Araliaceae	4	4
Ardisiaceae	1	2
Aspidiaceae	4	5
Aspleniaceae	1	3
Asteraceae	12	17
Athyriaceae	1	2
Balanophoraceae	1	1
Balsaminaceae	1	7
Begoniaceae	1	3
Berberidaceae	2	2
Bombocaceae	1	2
Boroginaceae	2	2
Botrychiaceae	1	2
Burmanniaceae	1	1
Buxaceae	1	1
Caesalpiniaceae	2	3
Caprifollaceae	1	2
Caryophyliaceae	2	2
Celastraceae	2	5
Cheilanthaceae	1	1
Chloranthaceae	1	1
Commelinaceae	2	2
Compositeae	1	1
Corylaceae	1	1
Cucurbitaceae	1	1
Cuscutaceae	1	1
Cyperaceae	3	9
Davalliaceae	1	2
Delleniaceae	1	2
Denstaedtiaceae	1	1
Dioscoreaceae	1	2
Dipsacaceae	1	1
Droseraceae	1	1
Elaegnaceae	1	1
Elaeocarpaceae	2	5
Ericaceae	7	9
Eriocaulaceae	1	3
Erythroxilaceae	1	1
Euphorbiaceae	8	14
Fabaceae	4	7

(Continued)

TABLE 2

Continued.

Family	Number of Genera	Number of Species
Fagaceae	3	11
Flacourtiaceae	2	2
Gentianaceae	2	2
Geraniaceae	1	1
Gesneriaceae	2	2
Gleicheniaceae	3	4
Guttiferae	1	1
Heamodoraceae	1	1
Hamamelidaceae	2	2
Hymenophyllaceae	2	2
Hypericaceae	1	5
Hypolepidaceae	1	1
Iardizabalaceae	1	1
Juglandaceae	1	2
Juncaceae	1	1
Lamiaceae	9	10
Lauraceae	9	16
Lentibulariaceae	1	2
Liliaceae	6	6
Linaceae	1	1
Lindsaeaceae	1	1
Loxogrammaceae	1	2
Lycopodiaceae	1	4
Magnoliaceae	1	2
Malvaceae	1	1
Melastomataceae	5	8
Meliaceae	2	2
Menispermaceae	1	1
Mimosiodeae	1	1
Moraceae	2	2
Myricaceae	1	1
Myrisinaceae	4	5
Myrtaceae	3	5
Olacaceae	1	1
Oleaceae	4	5
Oleandraceae	1	1
Onagraceae	2	2
Orchidaceae	25	39
Oxalidaceae	1	2
Papilionaceae	1	1
Parnassiaceae	1	1
Pinaceae	1	1
Piperaceae	2	2
Pittosporaceae	1	1
Plantaginaceae	1	1
Poaceae	21	28
Polygalaceae	1	1
Polygonaceae	2	4

(Continued)

TABLE 2

Continued.

Family	Number of Genera	Number of Species
Polypodiaceae	8	13
Primulaceae	1	1
Proteaceae	1	2
Pteridaceae	1	3
Pyrolaceae	1	1
Ranunculaceae	4	4
Rhamnaceae	1	1
Rosaceae	12	26
Rubiaceae	18	28
Rutaceae	3	4
Sabiaceae	1	1
Salicaceae	1	1
Santalaceae	1	1
Saurauiaceae	1	1
Saururaceae	1	1
Saxifragaceae	1	1
Schizandraceae	1	1
Scrophulariaceae	6	6
Selaginellaceae	1	1
Simaroubaceae	1	1
Smilacaceae	1	3
Sterculiaceae	1	1
Styracaceae	1	1
Symplocaceae	1	6
Taxaceae	1	1
Theaceae	3	6
Thymelaeaceae	2	4
Urticaceae	5	7
Valerianaceae	1	1
Verbenaceae	4	5
Violaceae	1	2
Vitaceae	3	7
Vittariaceae	1	1
Woodsiaceae	2	2
Zingiberaceae	3	3
TOTAL	340	514

Raliang are the examples of this category. Another 4420 ha accounting 42.1% of the total area were in the dense forest category. Sparse forested sacred groves covered 2,765 ha area and constituted 26.3% of the total area. The open sacred groves covered an area of 3,188 ha which was 30.3% of the total area studied (Table 3).

TABLE 3

Area and number of sacred groves belonging to different status categories

Category[1]	Area (ha)	Number
Undisturbed	138 (1.3)[2]	7 (12.5)[2]
Dense	4,420 (42.1)	14 (25.0)
Sparse	2,765 (26.3)	11 (20.0)
Open	3,188 (30.3)	24 (42.5)
Total	10,511	56

[1] For definitions, see text.
[2] Value in parentheses are percent of total.

VEGETATION OF MAWPHLANG SACRED GROVE

The vegetation of Mawphlang sacred grove, typical of most undisturbed groves in the state, is described in detail. In this grove, trees of *Quercus dealbata* and *Rhododendron arboreum* were found toward the periphery, much like a protective fencing. *Quercus griffithii* and *Schima khasiana* trees were scattered randomly in the forest. Among other trees, *Exbucklandia* populnea, Engelhardtia spicata, Elecocarpus lanciifolius, *Pyrus* pashia, *Quercus glauca*, and *Symplocus chinensis* were very common. The trees were heavily loaded with epiphytic growth of aroids, piper, ferns and fern allies, and orchids. Among the epiphytic orchids, the common ones were *Pleon praecox*, Cymbidium *elegius*, *Oberonia* sp., *Otochilus* sp., *Eria* sp., and *Pholidota* sp. On the ground, orchids such as *Anoectochilus* sp., *Zeuxine* sp., and *Goodyyera* sp. were most abundant. The saprophytic orchid *Epipogium roseum* was also encountered on the forest floor rich in humus. On the forest floor, depending on the season, various fleshy fungi such as *Scleroderma* sp., *Geaster* sp., *Lycopordon* sp., *Clavaria* sp., and *Morchella* sp. were found. *Nidularia* sp. growing on decaying woods and *Agaricus* sp. forming fairy rings were also observed. The rocks and tree trunks, stems, and branches were covered by various types of lichens. *Usnea* sp. and *Parmelia* sp. were the most common. The most common ferns were *Lindsaea cultrata*, *Botrychium* sp., *Peranema* sp., Dryopteris sp., and *Polypodium* sp. A complete list of plants found in Mawphlang sacred grove is available from the authors.

TABLE 4

Density (plant $ha^{-1} \pm$ S.E.) and Importance Value Indices (IVI) of component species in the sacred grove at Mawphlang and the unprotected forest at Upper Shillong

Species	*Mawphlang Sacred Grove*		*Upper Shillong Forest*	
	Density	IVI	Density	IVI
Tree Species				
Castanopsis kurzii	60 ± 2.2	18.43 (15)[1]	—	—
Corylopsis himalayana	40 ± 1.0	10.97 (23)	—	—
Engelhardtia spicata	12 ± 0.3	8.66 (25)	—	—
Exbucklandia populnea	80 ± 2.5	20.60 (14)	—	—
Ficus nervifolia	40 ± 1.6	11.80 (22)	—	—
Manglietia insignis	90 ± 3.5	29.04 (8)	—	—
Myrica esculenta	70 ± 1.5	25.15 (12)	16 ± 0.4	5.86 (12)
Pinus kesiya	—	—	144 ± 0.9	114.89 (1)
Pieris ovalifolia	—	—	16 ± 0.4	8.83 (14)
Prunus undulata	90 ± 3.2	20.70 (13)	—	—
Quercus dealbata	210 ± 2.8	52.27 (1)	48 ± 0.7	33.25 (7)
Quercus griffithii	150 ± 4.5	35.12 (4)	32 ± 1.4	34.75 (6)
Rhododendron arboreum	90 ± 2.8	29.06 (7)	92 ± 1.1	56.43 (4)
Schima khasiana	90 ± 2.3	26.09 (10)	76 ± 0.4	27.32 (9)
Taxus baccata	40 ± 3.4	14.67 (20)	—	—
Shrub Species				
Ardisia chrispa	40 ± 3.1	17.36 (17)	—	—
Baliospermum micrantha	50 ± 2.2	39.71 (3)	—	—
Camellia caduca	20 ± 1.3	16.74 (18)	56 ± 0.8	15.09 (13)
Cinamomum sp.	—	—	92 ± 1.3	5.67 (10)
Daphne bhalve	20 ± 1.3	14.86 (19)	—	—
Daphne shillong	100 ± 3.3	42.92 (2)	56 ± 0.8	20.02 (11)
Eurya japonica	50 ± 2.2	30.93 (6)	108 ± 1.3	30.82 (8)
Lindera pulcherrima	90 ± 4.8	33.58 (5)	—	—
Litsea elongata	12 ± 0.4	5.22 (26)	—	—
Mahonia pycnophylla	40 ± 2.8	17.66 (16)	—	—
Symplocus chinensis	70 ± 2.6	27.98 (9)	284 ± 3.5	98.69 (2)
Viburnum foetidum	30 ± 2.1	14.29 (21)	172 ± 1.5	41.41 (5)
Viburnum sinensis	50 ± 2.3	25.85 (11)	—	—
Others	60 ± 2.1	10.34 (24)	118 ± 1.9	63.09 (3)
Ground Vegetation (density × 10^3)				
Arundinella khasiana	6 ± 0.3	15.06 (10)	—	—
Brunella vulgaris	4 ± 0.2	11.49 (16)	24.2 ± 0.15	21.84 (4)
Centella asiatica	—	—	10.7 ± 0.11	9.90 (13)
Commelina sp.	16 ± 0.8	14.50 (11)	21.0 ± 0.11	2.68 (10)
Cyanotis cristata	4 ± 0.3	5.20 (20)	—	—
Cyperus rotundus	7 ± 0.2	18.22 (5)	5.0 ± 0.06	6.12 (16)
Dioscoria alata	8 ± 0.3	14.14 (12)	—	—
Drymeria cordata	21 ± 0.7	21.25 (3)	22.5 ± 0.19	17.53 (6)
Eupatorium adenophorum	—	—	5.7 ± 0.06	6.16 (15)
Eupatorium riparium	—	—	10.7 ± 0.1	12.85 (9)
Ferns	—	—	8.7 ± 0.09	7.42 (14)
Geranium sp.	5 ± 0.3	8.32 (18)	0.7 ± 0.15	0.99 (22)
Gliechenia langissima	45 ± 2.3	25.83 (1)	7.8 ± 0.42	25.57 (3)
Globa sp.	—	—	5.7 ± 0.04	17.00 (7)
Hypocharis radicata	15 ± 0.7	15.39 (8)	10.8 ± 0.06	2.01 (11)

(*Continued*)

TABLE 4

Continued.

Species	*Mawphlang Sacred Grove*		*Upper Shillong Forest*	
	Density	IVI	Density	IVI
Impatiens sp.	—	—	14.8 ± 0.13	13.23 (8)
Lycopodium clavatum	11 ± 0.7	13.57 (13)	8.2 ± 0.10	3.40 (19)
Oxalis corniculata	25 ± 1.3	17.71 (7)		
Oxalis latifolia	—	—	23.5 ± 0.19	19.22 (5)
Plantago major	36 ± 1.7	25.45 (2)	3.5 ± 0.04	4.36 (17)
Polygonum sp.	6 ± 0.3	7.94 (19)	14.5 ± 0.15	10.18 (12)
Potentilla blanda	7 ± 0.5	17.73 (6)	2.0 ± 0.03	2.58 (21)
Ranunculus diffusus	12 ± 0.5	15.15 (9)	3.0 ± 0.03	3.81 (18)
Rubia cordifolia	8 ± 0.5	11.93 (15)	—	—
Rubus sp.	9 ± 0.6	9.82 (17)	—	—
Selaginella sp.	29 ± 1.8	18.74 (4)	10.8 ± 0.42	29.69 (2)
Spiranthus sp.	—	—	2.0 ± 0.03	2.80 (20)
Others	11 ± 0.5	12.56 (14)	38.0 ± 0.62	60.66 (1)

[1] Values in parentheses are species rating on the basis of IVI.
[2] Dashes indicate species absence.

COMPARING BIODIVERSITY AND VEGETATION CHARACTERISTICS IN MAWPHLAND SACRED GROVE AND UPPER SHILLONG UNPROTECTED FOREST

The vegetation, community characteristics, and biodiversity of the Mawphlang sacred grove were compared with that of the Upper Shillong unprotected forest. There was a significant difference in community composition between the two (Mann-Whitney rank test on IVI distribution; $U_{26,11} = 253$; $P < 0.05$) (Table 4). The disturbance and product extraction in the unprotected forest seemed to have altered its community structure (Rao *et al.* 1990). The canopy layer (height > 10 m) in the sacred grove as well as in the unprotected forest was mainly composed of *Q. dealbata*, *R. arboreum*, *S. khasiana* and *Myrica esculenta*. In addition to the above species, *Q. griffithii*, *Q. glauca*, and *Manglietia insignis* were present in the sacred forest only. In the sacred grove, the subcanopy layer (3–10 m in height) was composed of *Exbucklandia populnea* and *Prunus undulata*. In the disturbed forest, this layer was dominated by the sprouts of *Q. dealbata*, *R. arboreum*, and *S. khasiana*. Secondary successional species like *Pinus kesiya* tend to become dominant and replace *Quercus* spp. in the disturbed stand. This was evident from its highest density in the disturbed stand and its complete absence from the sacred forest. The shrub layer was dominated by *Daphne shillong* in the Mawphlang sacred forest while *S. chinensis* was dominant in the disturbed forest. The herbaceous vegetation did not differ significantly between the two forests (Mann-Whitney rank test on IVI distribution; $U_{20,22} = 282$; $P > 0.05$).

In general, species diversity in the sacred grove was much greater than in the disturbed forest. Species evenness index, Shannon index, and species richness index were also higher in the sacred grove than in the disturbed forest (Table 5). The regeneration potential of the two forests as depicted by their tree seedlings populations was compared (Table 6). The density of shade-intolerant species like *S. khasiana* was more in the disturbed unprotected forest, whereas seedlings of shade tolerants like *Quercus* spp. were more abundant in the sacred grove (see Barik *et al.* 1996a). Seedlings in the sacred grove were mostly found in tree fall gaps, and the success of seedling establishment was dependent on the size of the gaps (Rao *et al.* 1997). Competition for various resources among the seedling populations, especially for light and space in the sacred forest, hampers the success of recruited seedlings (Barik *et al.* 1996b; Rao *et al.* 1997).

SOCIO-CULTURAL ASPECTS

In the undisturbed sacred groves (canopy cover of 100%), traditional rituals are still performed in accordance with the customary beliefs. In dense groves (canopy cover of 40–100%), the traditional rituals such as worshipping of deity, sacrifice of birds and animals, and community dance are performed but not so rigidly as in the undisturbed groves. In the case of most sparse (canopy cover of 10–40%) and open groves (canopy cover < 10%), the traditional rituals are not performed and the traditional beliefs of the people living around them have eroded considerably. The procedural details about observance of the rituals are known to very few people. Most persons, especially those belonging to the younger generation (135 out of 150 interviewed), admitted that the religious belief that was central to sacred grove conservation is now considered as superstition. The scientific principle behind sacred grove conservation was known to only 14% of the people interviewed. The sacred groves have been an integral part of traditional tribal religion and culture which to a great extent has been replaced by Christianity; therefore, most tribes have become disinterested in performing the traditional rites, rituals, and religious ceremonies associated with the sacred groves. This was the most important single cause of degradation of sacred groves, and 95% of the respondents agreed. The advent of the present system of governance, which has brought in new institutions of judiciary and administration, has created new centers of power and thereby the authority of traditional chieftains has eroded over the years. Under the present system, the breakers of traditional laws could not be punished. Sixty-two percent of people opined that this was the second most important cause of degradation of sacred forests of Meghalaya.

From the interviews of elderly and knowledgeable persons belonging to tribal communities, it emerged that ignorance of common masses about its benefits, preponderance for short-term monetary gains over long-term conservational needs, greed for money among the rich, and sustenance needs of the poor are the other factors responsible for continued erosion of the sacred grove culture among these societies. Approximately 80% of the persons interviewed were of the opinion that unless economic benefit to the people is combined with the sacred grove conservation, no program in this regard is likely to succeed.

TABLE 5

Species diversity indices in the sacred grove at Mawphlang and the unprotected forest at Upper Shillong

Species Diversity Indices	Mawphlang Sacred Grove	Upper Shillong Forest
Species richness index	3.60	2.20
Species evenness index	0.96	0.84
Shannon index	1.00	0.80

CONSERVATION STRATEGIES

The ancestors of these tribal societies had recognized the fragility of the local ecosystems, which had thin top soil with low carbon and nitrogen contents (Khan *et al.* 1986). They had presumably realized the significant role of forests in such fragile ecosystems and perhaps appreciated the conservational value of forests, particularly in protecting water sources and in maintaining viable populations of game animals which is evident from the location of the groves (Table 1). The beliefs and rituals associated with sacred groves were probably used as a means of conservation. They perpetuated and transferred this knowledge accumulated over thousands of years of cultural

TABLE 6

Seedling density (plants $ha^{-1} \times 10^3$ S.E.) of important tree species in the sacred grove at Mawphlang and the unprotected forest at Upper Shillong

Species	Mawphlang Sacred Grove	Upper Shillong Forest
Pinus kesiya	—[1]	7.8 ± 0.28
Quercus dealbata	32 ± 1.12	2.00 ± 0.08
Quercus griffithii	12 ± 0.8	1.75 ± 0.11
Shima khasiana	9 ± 0.69	62 ± 0.32
Taxus baccata	23 ± 1.42	—

[1] Dashes indicate species absence.

experience to subsequent generations (Reichel-Dolmatoff 1979; Harp 1994).

The religious beliefs and rituals central to sacred grove preservation are now fast eroding, and therefore, these treasure houses of biodiversity cannot be protected indefinitely only through religious beliefs. Urgent external intervention has become inevitable if these forest patches, providing valuable ecosystem services to the local communities, are to be saved. One of the strategies of external intervention may be providing economic incentives to the people who are protecting/managing the groves and also to the people living in the surrounding areas. Creation of mass awareness about the intangible benefits and ecosystem services (Cairns & Pratt 1995) provided by these forest patches and their biodiversity value would be another essential component of the proposed conservation program. Development of ways and means for limited extraction of produce to sustain the interest of people in preservation of the groves is also required. Protection from fire, cattle grazing, and unauthorized product extraction is paramount to any conservation program, and this can only be achieved through active people's participation. Site-specific conservation/restoration strategies need to be evolved that consider the status of the grove and socioeconomic conditions of the people responsible for its management. Based on our interaction with the people, we suggest that a judicious blending of traditional knowledge and beliefs with the modern forest management practices can help in sustaining the undisturbed groves. However, the degraded sacred groves will need a higher level and more influential intervention requiring increased costs in terms of material and personnel for their restoration.

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