STUDIES ON PLANT DIVERSITY AND REGENERATION OF A FEW TREE SPECIES IN THE SACRED GROVES OF MANIPUR

By

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DECLARATION

I, Khumbongmayum Ashalata Devi, hereby declare that the subject matter of this thesis entitled "***Studies on plant diversity and regeneration of a few tree species in the sacred groves of Manipur***" is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/ Institute.

This is being submitted to the North-Eastern Hill University, Shillong for the award of the degree of Doctor of Philosophy in Botany.

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GENERAL INTRODUCTION

Since time immemorial conservation of natural resource has been an integral part of diverse cultures in different ways. Nature worship has been a key force in determining the human attitudes towards conservation and sustainable utilization of biodiversity. The traditional worship practices show the symbiotic relation of human beings and nature. Various indigenous communities all over the world lived in harmony with the nature and conserved the biodiversity. In course of time, science and technology developed and industries were established and expanded to meet the increasing demands of the people and to take care of various developmental activities. This has led to the fast depletion of biodiversity in different ecosystems. Although we have acquired a great deal of scientific and technical knowledge, we are still bewildered by a number of natural phenomena that remain mysterious to us. We have little knowledge about many species that exist on the earth especially those which are not within our reach. Global biological resources are threatened due to habitat alteration, over-exploitation, pollution and introduction of exotic species. The increased human population has also exerted tremendous pressure on biodiversity. This has adversely affected the ecological balance and socio-economic status of the people as it directly or indirectly contributes to the welfare and stability of the environment and society. Ecologists, environmentalists and conservationists are all aware of importance of biodiversity conservation for sustainable development and ecological balance of nature. Thus the conservation of biodiversity became an issue of global, regional and national significance. Many areas were declared as protected and various *in-situ* and *ex-situ* conservation practices were also undertaken in different parts of the world. Many laws governing the biodiversity conservation were also enacted from time to time. Besides these formal laws, there were many traditional conservation practices of indigenous communities in many parts of the world, which contributed to the conservation and protection of biodiversity. A good example of such traditional practices is the conservation and protection of small forest patches by dedicating them to local deity by various indigenous people of the world. Such forest patches are called "sacred groves". Sacred groves are the tract of virgin forest harbouring rich biodiversity, protected by the local people based on the ground of indigenous cultural and religious beliefs, and taboos. They are the repositories of rare and endemic species and can be regarded as the remnant of the primary forest left untouched by the local inhabitants and protected by them due to the consideration that the deities reside in these forests. The area of sacred groves ranges from few square metres to several hectares. Physically, it is a piece of forest land, but culturally, it is associated with deities, rituals and taboos. Every sacred grove carries its own legends, lore and myths which form the integral part of the oral traditions of local people. Diverse cultures perceive these groves in different ways and accordingly, have their own method of encoding various rules to conserve them. The inextricable link between present society to the past in terms of biodiversity, culture, religious and ethnic heritage has been found in sacred groves. In the present society, there are several endogamous populations that continue to practice many forms of nature worship. Various traditional communities of our country follow nature worship in their own ethnic ways, based on the premise that all creations of nature have to be protected. The concept of sacred groves could be traced to such communities as have preserved several virgin forests in their pristine form by dedicating them to the ancestral spirits or deities. As a result of these, sacred groves still possess a great heritage of diverse gene pool of many forest species. Some of the species present in sacred groves are considered as sacred species having socio-religious importance and possessing medicinal values. There exists some fascinating examples of forest patches harbouring native vegetation, which has been intertwined with the various aspects of indigenous/ cultural and religious practices along with the associated taboos (Gadgil and Vartak 1976). The concept of sacred groves is well recognized by many traditional societies of the world. Gadgil and Berkes (1991) have mentioned that various traditional approaches to conservation of nature require a belief system which includes a number of prescriptions and proscriptions for restrained resource use. The overall concept of the sacred groves, woven carefully with the various religious beliefs, taboos and traditions, its role in conservation and maintenance of nature, and erosion of the sacred values or traditions due to changes in religious beliefs and the socio-economic scenario, increase in population and developmental pressure is presented diagrammatically in Figure I.1.

It is believed that the existence of sacred virgin forest dates back to several thousands of years when human society was in the primitive state.

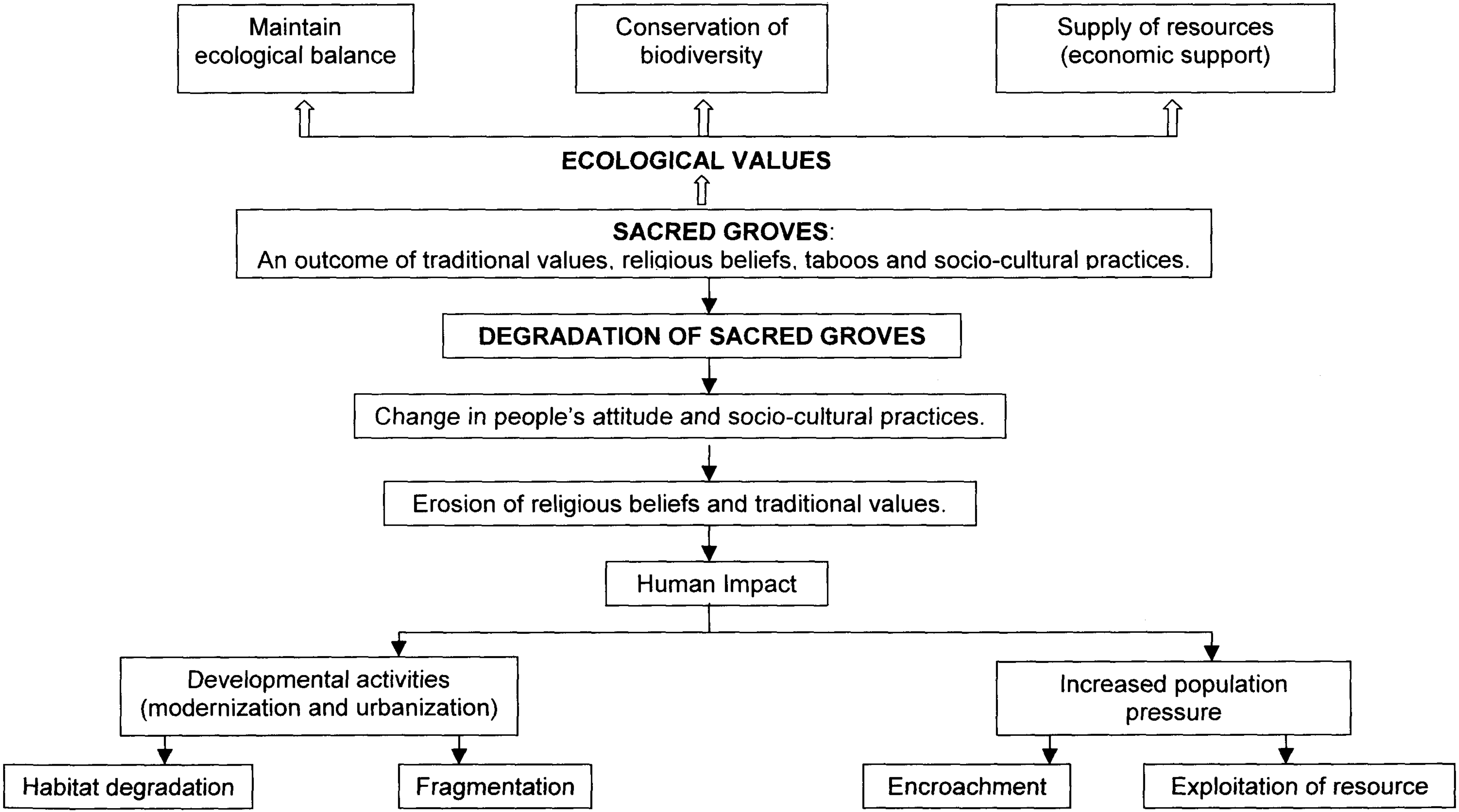

Figure I. 1. Diagrammatic representation of sacred groves, their ecological value and relationship with people's changing traditional beliefs and human impact.

Gadgil and Vartak (1975) have traced the historical link of the sacred groves to the pre- agricultural, hunting and gathering stage of societies. Hence, virgin forest is believed to be pre-Vedic in origin, i.e. about 3000 to 5000 BC. From time immemorial, in India as well as in parts of Asia and Africa, care and respect for nature has been influenced by religious beliefs and indigenous practices. Thus, sacred groves were distributed around the earth in Africa, Asia, Europe, Australia and America (Hughes and Chandra 1997). They have been reported from Ghana, Nigeria, Syria, Turkey and Japan (Gadgil and Vartak 1976). A document of MAB (1995) has described the sacred groves present in Ghana, Senegal, and Sumatra. Setting aside patches of forest land and leaving them intact because of the social fencing has been the practice for centuries in our country. Indian society comprises several cultures, each with its own set of traditional methods of conserving nature and its creatures. Sacred groves are found all over India especially in those regions where indigenous communities inhabit. In India the earliest documented work on sacred grove is that of the first Inspector General of Forests, D. Brandis (1897). About after 75 years later, in 1973, Professor Madhav Gadgil and Dr. V. D. Vartak conducted floristic and ethnobotanical studies on the sacred groves of Maharashtra. The existence of sacred groves all along the Himalayas from northwest to northeast, central Himalayas of Kumaon and Garhwal, Darjeeling and Meghalaya has been reported by Burman (1992). Further, sacred groves are reported from different parts of India (Jamir 2000, Jamir and Pandey 2001, Law 2002, Mishra *et al.* 2004, Ramakrishnan 1996, Tiwari *et al.* 1998, Tripathi 2001, Upadhaya 2002, Upadhaya *et al.* 2003) and are known by different names given to them in ethnic terms (Bhakat 1990), and managed by local people for various reasons. They have been variously named in different states, such as "*kavu*" in Kerala, *devaravana* or *devarakadu* in Karnataka, *sarana* or *jaherthan* in Jharkhand, *dev van* in Himachal Pradesh, *devrai* or *devgudi* etc. in Maharashtra, and *ki law lyngdoh* or *ki law kyntang* etc. in Meghalaya. One thing is evident that wherever the sacred groves existed, the indigenous traditional societies having spiritual relationships with the existing physical environment sustained them.

Various ethnic groups of north-eastern India have preserved and protected several forest patches and even individual trees or animals due to their belief in nature worship. A study on the status of some sacred groves in the Himalayan region indicated that the economic forces are influencing the traditional communities to discard the community-oriented protection to such areas and they are now being exploited (Saxena *et al.* 1998, Singh *et al.* 1998). Such scenarios are common elsewhere too (Ramakrishnan *et al.* 1998).

The state of Manipur, in the northeastern India is known for its ecologically distinctive and rich biodiversity having many endemic flora and fauna, and rich cultural diversity. However, due to population explosion and various developmental activities forests are not in the same condition as they were a few decades back. Large-scale destruction of forests due to anthropogenic pressure has altered the composition and diversity of species leading to a rapid loss of many species including rare and endemic ones. Besides, the forest land has been converted into wastelands in many areas and the natural environment has been adversely affected. In this context the traditional ecological knowledge and resource management systems practiced by the indigenous communities in ancient days need to be properly understood and revived. Boojh and Ramakrishnan (1983) argued that religious beliefs are the only hope and way of conserving relict vegetation. In this regard, the sacred groves where deities are believed to reside are protected from human interference by the Meitei community, an indigenous people of Manipur. This practice assumes a great significance in biodiversity conservation. Dedicating a patch of forest to deities is a common practice with the Meitei community of Manipur who follow ancestral practices of animism with the central focus on the worship of forest patches which they regard as sacred abode of various deities. According to their belief, these forest patches (or sacred groves) are the property of gods/deities and must not be damaged in any way. The areas of groves may vary from few square meters to several hectares and may be present along an altitudinal gradient and at such locations, which are usually rich in biodiversity. The '*Umanglai*' (sacred deities or sylvan-deities) are the only deities that are believed to reside in sacred groves of Manipur. Thus associating the forestlands to the deities and affording protection to these forests contributes a great deal to the conservation of biodiversity, culture and religion. Umanglais are worshiped with the celebrations called '*Lai-Harouba*" (the pleasing of God) annually in their dwelling groves. The celebrations provided a venue for the Meiteis to promote the varieties of indigenous folklore, visual and performing arts that nurtured and fostered sacred groves through centuries. The role of sacred groves is manifold in maintaining the ecological balance, conserving biodiversity, and fulfilling the need of people. Moreover, the socio-cultural practices of indigenous people also play a great role in protecting and conserving the sacred groves. Therefore, a symbiotic relationship between people and sacred grove can be seen in this part of the northeast India. Unfortunately, the fate of sacred groves is not secure. They have lost their richness over the years owing to many factors. The decline of sacred groves can be attributed to the change in social values and religious beliefs as a result of modernization and urbanization. Erosion of traditional values and beliefs of the Meitei community and considering the rituals/practices associated with the groves as superstition by a large section of the people especially the younger generations have also played a significant role in the degradation of sacred groves. ~~Nonetheless~~, due to population explosion, various anthropogenic pressures and developmental activities, sacred groves have also become the victim of encroachment and exploitation, though the extent of degradation in the sacred groves is less as compared with the other forests. Degradation of groves not only signifies loss of rich and relict vegetation but also the loss of rich cultural diversity. Therefore, it has become an urgent need to make an inventory of the groves, their biodiversity, and people's attitudes towards them and develop strategies for their conservation.

A few studies have been conducted on sacred groves of different parts of India, such as Andhra Pradesh, Central Himalaya, Karnataka, Kerala, Maharashtra, Meghalaya, Pondicherry, Tamil Nadu and West Bengal. The role of beliefs, folklores and taboos associated with sacred groves has been emphasized by several workers (Basu 2000, Gadgil and Vartak 1975, 1976, King *et al.* 1996, Kushalappa *et al.* 2001, Ramanujam and Kadamba 2001, Singha and Maikhuri 1998, Swamy *et al.* 1998, Vartak and Gadgil 1981). Plant biodiversity in Karnataka (Kushalappa *et al.* 2001), Meghalaya (Haridasan and Rao 1985, Jamir 2000, Khan *et al.* 1997, Upadhaya 2002), Tamil Nadu (Ganesh *et al.* 1996) and status and strategies for the conservation of biodiversity in Meghalaya (Khan *et al.* 1997, Tripathi 2001, Tiwari *et al.* 1998b) have also been studied. Floristic composition of sacred groves in different parts of the country viz., Karnataka (Vasanth *et al.* 2001), Kerala (Chandrashekara and Sankar 1998, Rajendraprasad 1995), Meghalaya (Law 2002, Pandey 2003, Tripathi 2001, Upadhaya 2002, Upadhaya *et al.* 2003), Pondicherry (Kadamba *et al.* 2000, Ramanujam and Kadamba 2001, Ramanujam and Kumar 2003), Tamil Nadu (Sethi 1993), West Bengal (Basu 2000) and life form spectrum of sacred grove in Western Ghats (Pushpangada *et al.* 1998, Rajendraprasad *et al.* 1998) have also been investigated. The studies on regeneration status of some important species in sacred groves were reported from Karnataka (Boraiah *et al.* 2001, 2003, Kumar and Swamy 2003) and Meghalaya (Barik *et al.* 1992, Khan *et al.* 1986, Rao *et al.* 1990, 1997).

However, no such detail work has been done on the sacred groves of Manipur. Devi (2000) mentioned the existence of about 365 sacred groves in Manipur and Rajendro (2001) did the mapping of a few sacred groves of Manipur with special reference to concentration of rare and endemic species in these groves. Directory of ancestral deities (*Umang lai*) residing in various sacred groves of Manipur was published by Chandrashekhar (1987) and Kulachandra (1963, 1996). The present investigation presents an inventory of sacred groves of Manipur, and focuses on plant diversity, vegetation characteristics and ethnobotanical studies of a few selected sacred groves, and also on regeneration of a few important tree species occurring in these groves.

The study presented in this thesis covers the following aspects:

1. Inventory of sacred groves, people's attitude towards sacred groves and documentation of ethnobotanical values of the plant species occurring in sacred groves.
2. Floristic composition and species diversity of the selected sacred groves and population structure of a few tree species.
3. Biological spectrum and habitat diversity in four sacred groves of Manipur.
4. Growth and survival of seedlings of selected tree species.

An attempt has been made to formulate strategies for the conservation of sacred groves on the basis of the data generated on the above aspects.

The thesis begins with the '**General Introduction**' which sets out the objectives of the study. ***Chapter I*** presents the '**Review of Literature'**, which is followed by ***Chapter II*** dealing with the inventory and status of sacred groves in Manipur. Description of the study site, climate, soil and a few sacred groves selected for detailed study has been given in ***Chapter III***. The studies on floristic composition, population structure of selected tree species and ethnobotanical aspects are included in ***Chapters IV-VI***. Experimental studies on growth and survival of tree seedlings has been presented in ***Chapter VII***.

The results of the entire study have been synthesized and discussed in an integrated manner under '**General Discussion**' which is followed by **Summary** of the work. The thesis ends with the list of literature cited in the thesis.

CHAPTER I

Review of literature

Animistic beliefs of the forest dwelling traditional societies are primarily responsible for the existence of the protected refugia of the typical natural ecosystem type of a given region which are often conserved as 'sacred groves' by many societies all over the world (Ramakrishnan 2002). The sacred groves of Asia and Africa and royal hunting forests are historical examples (Chandrashekara and Sankar 1998, Kanowski *et al.* 1999). Sacred groves are the tracts of virgin forest that were left untouched by the local inhabitants and protected due to the belief that the deities reside in them. It is believed that these sacred virgin forests date back to several thousands of years when human society was in the primitive state. They represent the parts of a landscape with well defined geographical features, delimited and protected by traditional societies for cultural/religious reasons (Ramakrishnan *et al.* 1998). All forms of vegetation in the groves are supposed to be under the protection of reigning deity of that grove, and the removal of even a small twig is taboo (Vartak and Gadgil 1973). Collection and removal of any material from the sacred groves is prohibited (Gadgil 1987, Khan *et al.* 1987, Khiewtam and Ramakrishnan 1989). Sacred groves can be used as indicators for potential natural vegetation (Schaaf 1998) and are vital for wellbeing of the society. Sacred groves or sacred trees function as a home for birds and mammals, and hence, they indirectly help in the conservation of living organisms (Islam *et al.* 1998). Besides, the sacred groves provide a number of ecosystem services such as reduction in erosive force of water, control of mass movement from upper reaches, availability of water of desired quality and natural dispersal of seeds of useful species. The sacred groves also help maintain the desirable health of ecosystem, reduce habitat destruction, conserve the viable population of pollinators and predators, serve as the potential source of propagules that are required for colonization of wastelands and fallows, preserve the indigenous flora and fauna and preserve the cultural and ethical practices developed through indigenous knowledge of generations (Godbole *et al.* 1998, Khiewtam 1986, Ramakrishnan and Ram 1988, Singh *et al.* 1998). Thus, traditional nature worship practices as followed in different parts of world do contribute to the promotion of the regional/national goals of conservation of biodiversity.

Descriptive account of religious and cultural practices, and people's attitudes related to sacred groves, forests/ecosystems/landscapes have been extensively studied by several workers (Anonymous 1996, Bachmann 1992, Frazer 1980, Gadgil and Vartak 1976, Khiewtam and Ramakrishnan 1989, Messerschmidt 1987, Nair *et al.* 1997, Ramakrishnan 1996, Singh *et al.* 1996). The existence of sacred groves has been reported in many parts of Asia, Africa Europe, Australia and America by Hughes and Chandra (1997 and 1998). Groves are also reported from Ghana, Nigeria, Syria, Turkey and Japan (Gadgil and Vartak 1976). A document on Man and Biosphere (1995) described sacred groves in Ghana, Senegal and Sumatra. Various sacred sites associated with rich vegetation in Bangladesh were reported by Hussain

(1998). The Dubla Island sacred grove in Sundarban mangrove forest harbours rich vegetation and is a place of worship for low caste Hindus, who visit it once in a year for prayer (Islam *et al.* 1998). In Afghanistan, after advent of Islam, the creation and conservation of sacred grove became a part of historical and geographical tradition of the rural people (Mohamed Zaman 1998). The positive role of sacred groves in the socio-economic and cultural lives of many rural folks in Ghana has been possible because of the collective efforts of people to protect them (Michaloud and Durry 1998). However, in Mongolia sacred groves are not protected by the Government but few sacred places which have been declared officially as sacred sites are protected by the Government (Gongorin 1998).

In India the earliest documented works on sacred groves dates back to 1897 when the first Inspector General of Forests, D. Brandis, wrote: "Very little has been published regarding sacred groves in India, but they are, or rather were very numerous. I have found them in all provinces..." Later, Gadgil and Vartak (1976, 1981a, 1981b) traced the historical link of sacred groves with the pre-agricultural, hunting and gathering stage, before human being had settled down to raise livestocks or till land. In India, sacred groves are found mainly in tribal dominated areas and named differently (Bhakat 1990) viz. 'Sarna' or 'Dev' in Madhya Pradesh, '*Devrais*' or 'Deovani' in Maharashtra, 'Sarnas' in Bihar, 'Orans' in Rajasthan, 'Sidharavana' or Devarkadu' or Pavithravana' in Karnataka, 'Sarpakavu' and 'Kavu' in Tamil Nadu and Kerala, '*Dev van*' in Himachal Pradesh, '*Ki law lyngdoh*' or '*Ki law kyntang*' etc. in Meghalaya, and '*Sarana*' or '*Jaherthan*' in Jharkhand.

Ramakrishnan (1996) reported the existence of sacred groves in different parts of India. Most of the sacred groves reported from India are in the Western Ghats, North Eastern India and Central India (Balasubramanyam and Induchoodan 1996, Chandran *et al.* 1997, Gadgil and Vartak 1976, Rodgers 1994). Occurrences of sacred groves were reported in Meghalaya (Boojh and Ramakrishnan 1983, Tiwari *et al.* 1998a), Western Ghats in south peninsula, Madhya Pradesh and Maharashtra (Kosambi 1962). Chandran *et al.* (1997) and Mitra and Pal (1994) also reported the occurrence of sacred groves in Meghalaya, Bihar, Rajasthan and the states along the Western Ghats. Their existence along the Himalayas from northwest to northeast, central Himalayas of Kumaon and Garhwal, Darjeeling and Meghalaya were described by Burman (1992) and Rodgers (1994). Many sacred groves were reported from Meghalaya, Manipur and Karbi Anglong area of Assam, states in north-eastern India (Tripathi 2001). Sacred mangroves, experiencing minimum or no damage at all having some sort of religious significance, were reported from different parts of India, viz., Rann of Kutch, Maharashtra, Goa, Tamil Nadu and West Bengal (Untawale *et al.* 1998).

About 4215 sacred groves covering an area of 39,063 hectares are estimated to be distributed in India (Malhotra 1998). Gadgil and Vartak (1975, 1976) made an inventory of the sacred groves or '*Devrais*' of the state of Maharastra. Detail information on the location, area and associated deity, folklores and traditional beliefs of 233 groves from different districts of Maharastra were collected by Gadgil and Vartak (1981b), who recorded a range of vegetation from semi evergreen to dry deciduous type in rainfall regimes from 5,000 mm to 500 mm. According to Burman (1992), the number of sacred groves in Maharashtra in the Western Ghats is much more than the number recorded by Gadgil and Vartak (1976, 1981b) in their various studies. Balasubramanyan and Induchoodan (1996) reported 761 sacred groves in Kerala with floristic wealth of over 722 species belonging to 217 families and 474 genera. Induchoodan (1996) revealed that out of the 761 sacred grove in Kerala, 399 (32.17 %) were of less than 0.02 ha in extent and only 362 groves were larger than 0.02 ha. Kalam (1996) and Kushalappa *et al.* (2001) inventoried 1214 sacred groves covering an area of 2550.45 ha in Kodagu district in Karnataka. The groves in Karnataka have been protected in the names of 165 different deities and perhaps it has highest density of the groves in the world and could be regarded as the 'hotspot' of sacred grove tradition in the world (Kushalappa *et al.* 2001). Kadamba (1998) enumerated 80 sacred groves from a sector of the south-eastern coast encompassing the Marakkanam-Pondicherry-Cuddalore regions and their status has been assessed on the basis of their appearance and composition (Kadamba *et al.* 2000). In Andhra Pradesh, 425 sacred groves were reported from Anantapur, Kurnool, Prahasam, Nellore and Cuddapah districts (Anonymous 1996). Sunitha and Rao (1999) studied the characteristics and distribution of the flora of the sacred groves in Kurnool district of Andhra Pradesh. Basu (2000) reported a sacred grove from the Purulia district of West Bengal spreading over 72,681m^2 area harbouring 106 species. Panda *et al.* (2003) reported 10 important sacred groves of Santhals from the Bankura district of West Bengal. Singh *et al.* (1998) recorded several sacred groves in Himachal Pradesh, of which most of them were of small size. Similar pattern is reported by Ingles (1994) in three districts of central Nepal. Tiwari *et al.* (1998a) inventoried 79 sacred groves of Meghalaya. According to their study, only 1.3% of the total sacred grove area was undisturbed, 42.1% area had relatively dense forest, 26.3% had sparse canopy cover, and 30.3% had open forest. Devi (2000) reported 365 sacred groves from Manipur.

The importance of sacred groves in the conservation of biological diversity has been well recognized. Gadgil and Vartak (1975, 1976) found a grove in the Koloba district of Maharashtra harbouring a solitary specimen of the liana *Entada phaseoloides*. A new species of a leguminous climber *Kunstleria keralensis*, has been reported from one of the sacred groves of Kerala (Gadgil and Chandran 1992). They observed that *Gurjan* tree (*Dipterocarpus indicus*) has its northern limit in the Western Ghats in a couple of sacred groves of Uttara Kannada. *Ficus benghalensis* L. (Aal) in sacred groves at Suriampettai plays the role of a keystone species providing a niche for the large number of birds and plants (King *et al.* 1997). According to several report there is a concentration of rare, endemic and endangered species in sacred groves. Chandrashekara and Sankar (1998) recorded 73 species in three sacred groves of Kerala, and among them 13 are endemic to South-Western Ghats, 3 are endemic to Western Ghats and 1 is endemic to peninsular India. Khan *et al.* (1997) reported that about 4% of the total plant species found in Meghalaya are confined to sacred groves. According to Haridasan and Rao (1985) at least 50 rare and endangered plant species of the state of Meghalaya are found only in sacred groves. Gadgil and Chandran

(1992) have also noticed a small population of endangered primates, and lion-tailed macaques in and around Katlekan sacred grove of Uttara Kannada.

Religious and cultural importance of the species is a factor promoting their sustainable utilization as well as conservation (Singh *et al.* 1998). Importance of the sociologically recognized plants which have linkage with the deities of the groves or other religious practices in maintaining the ecological balance was addressed by Rodgers (1994). Such sociologically recognized plants are the 'sacred species', the concept of 'sacred species' could be recognized as a social evolution through a process of condensation of sacred groves to the lowest level in the hierarchical organization (Ramakrishnan 1998, Ramakrishnan 2002). Some of the common sacred species are *Ficus* of Fig family, which is culturally valued across Asia region and amongst many tribes of Africa (Khaneghah 1998, Michaloud and Durry 1998, Ramakrishman 1998) and Oak in central Himalaya (Ramakrishman 1998, Sinha and Maikhuri 1998). *Ficus religiosa* and *Ocimum sanctum* are the sacred species for the Hindus. Sacred trees in different parts of Iran are related to different faiths and beliefs, and have close linkage with local ecological values (Khaneghah 1998). In Maldives, medicinal plants of traditional importance are sacred (Hussein 1998). A number of sacred groves have been reported from different parts of Garhwal Himalaya by Sinha and Maikhuri (1998).

Ecological studies on sacred groves have revealed that they have certain distinctive ecological characteristics. Vegetation structure in sacred groves of Kerala (Rajendraprasad 1995) indicates the presence of distinct tiers of trees, shrubs and herbs, climbers and stranglers, epiphytes, and parasites. The sacred groves of Kerala harbour many wild relatives of cultivated plant species. Broadly, the vegetation of these groves has been classified into two types viz. evergreen type and the moist deciduous type (Chand Basha 1998). Menon and Sasidharan (1994) evaluated the production of the sacred grove systems. Biological spectrum of sacred groves of Kerala closely resembles normal spectrum except in case of therophytes (Pushpangadan *et al.* 1998). Vasanth *et al.* (2001) carried out a detailed vegetation analysis of a sacred grove in Nandikoor Village of the Udupi district in Karnataka. The stand density of the grove was low compared to that of Pilarkan reserve forest, a secondary semi-evergreen forest in the same district (Shivaprasad *et al.* 2001). Sacred groves (Sarna) of Madhya Pradesh are characterized by the vegetation with a cluster of Sal trees; all living and non-living components of the grove are sacrosanct and protected (Patnaik and Pandey 1998). Several workers have studied floristic composition of sacred groves of different states of the country like Garhwal Himalaya (Sinha and Maikhuri 1998), Meghalaya (Jamir 2000, Jamir and Pandey 2002, Mishra *et al.* 2004, Pandey 2003, Tiwari *et al.* 1998b, Tripathi *et al.* 2002, Upadhaya 2002, Upadhaya *et al.* 2003), Kerala (Chandrashekara and Sankar 1998, Induchoodan 1988) and Tamil Nadu (Britto *et al.* 2001. Kumar and Swamy 2003, Sethi 1993, Visalakshi 1995). King *et al.* (1996), Ramanujam and Kadamba (2001) and Swamy *et al.* (1998) studied the traditional culture associated with the sacred groves in Tamil Nadu. Sinha and Maikhuri (1998) reported that species diversity of tree stratum in the sacred grove was lower while density and basal cover values were significantly higher as compared with the other forest areas, and the sacred grove nurtures rich fauna also. Various ecological aspects of Mawphlang sacred grove, such as community characteristics, gap phase regeneration and regeneration ecology of dominant tree species were studied by a number of workers (Barik 1992, Barik *et al.* 1992, 1996a, b, Khan *et al.* 1986, 1987, Rao 1992, Rao *et al.* 1990, 1997). Higher species diversity indices were recorded in the sacred grove than the disturbed forest (Tiwari *et al.* 1998b). Species composition and community characteristics of sacred groves and disturbed forests were also reported significantly different. Hajra (1975) has published a taxonomic account of the sacred groves at Mawphlang. Khiewtam (1986) and Khiewtam and Ramakrishnan (1993) studied the vegetation, litter and fine root dynamics, and nutrient flow in a sacred grove of Cherrapunji. Nagoni sacred forest reported from Himachal Pradesh had high species richness though there were no significant differences between sacred and non sacred forests (Singh *et al.* 1998). Fragment sizes and diversity of species assemblages in Sholas and sacred groves showed that larger fragments harbour similar composition of species whereas smaller fragments of forest are more diverse among themselves with respect to their species composition (Tambat *et al.* 2001) and this may have important implications for designing the size of the protected areas. A comparative assessment of regeneration of woody flora between the sacred groves and reserve forests showed that number of regenerating rare/endemic plant species was higher in the sacred grove as compared with the reserve forests (Boraiah *et al.* 2001, 2003).

It has been seen that religious beliefs and taboos that protect the groves are being eroded over the years due to various reasons and thus the present status of sacred groves is rather precarious. Various anthropogenic pressures due to developmental activities, urbanization, exploitation of resources and increased population have threatened many groves of the country. Sacred groves (Orans) located in Shekhala village of Rajasthan are becoming degraded due to erosion of peoples' sentiments towards conservation of biodiversity, introduction of exotic species and concern for more income generation (Singh and Saxena 1998). Likewise, sacred groves in Peepasar and Khejarli villages of the state were degrading due to uncontrolled grazing (Jha *et al.* 1998). Conversion of sacred groves to coffee plantations and human habitation is the major threat for the conservation of groves in Kodagu districts of Karnataka (Kushalappa and Bhagwat 2001). Increasing threats to biodiversity demand new conservation approaches emphasizing on the hidden values of conservation to the local communities and positive local attitude towards national and global conservation goals (Saxena *et al.* 1998). Traditional ways of resource management are becoming non-functional due to direct conflict between ever increasing human population and limited natural resources (Sinha and Maikhuri 1998). Considerable changes have been taking place in the physical extent, vegetation structure and nature of worship in sacred groves of Karnataka due to developmental activities (Kushalappa *et al.* 2001). Boojh and Ramakrishnan (1983) argued that with the ongoing large-scale deforestation activities in the region, the religious beliefs are the only hope and way of conserving this relict vegetation. On the other hand, Tiwari *et al.* (1998b) in the context of sacred groves of Meghalaya remarked that traditional beliefs regulating subsistence practices no longer seem to exist in reality, and even where they do, they are being increasingly disregarded. Cultural changes are so rapid for many groups in the society especially the young people that they no longer learn the methods by which their ancestors maintained such fragile ecosystems (Clay 1988). This is a global tragedy, for "with the disappearance of each indigenous group the world loses an accumulated wealth of millennia of human experience and adaptation' (Posey 1983). For ecologists, traditional ecological knowledge offers a means to improve research and also to improve resource management and environment impact assessment (Brooke 1993, Inglis 1993, Stevenson 1996). Therefore, a holistic understanding of the current status, structure, function and dynamics of sacred grove ecosystem is an essential prerequisite for assessing their ecological role, production potential and conservation values. Furthermore, it is very important to uphold traditions and beliefs in order to protect our resources and to establish a sustainable society.

Depletion of sacred grove not only symbolizes the loss of the rich relict flora and fauna but also its rich tapestry of culture associated with the grove (Kushalappa and Bhagwat 2001). Management of sacred groves and sacred sites through the traditional local system is now being challenged by a number of economic and social issues, thus the traditional methods are rendered less effective. Therefore, there is an urgent need to assess the status of such areas in terms of biodiversity in general and medicinal plant wealth in particular. Role of sacred groves in conservation of the regional medicinal plants has been reported from different parts of the country. Chilkigarh sacred grove in Midnapore district of West Bengal (Bhakat and Pandit 2003) recorded 105 species of useful medicinal plant species from the grove, of which 12 are threatened elsewhere in the district. Protection of a large number of medicinal plants in 'Kavus' of Kerala (Pushpangadan *et al.* 1998), 'Zaheerthan' in Purulia district of West Bengal (Pandit 2000) and 'Hariyali' sacred site of Garhwal Himalaya (Sinha and Maikhuri 1998) are some of the noteworthy examples.

High altitude Himalaya is rich in native, endemic diversity and medicinal plants. Conservation, utilization and assessment of the implications of exploitation of these species have become an important task (Dhar 2002, Sumit and Dhar 2002). Availability and habitat preference of critically endangered medicinal plants of west Himalaya was assessed for their conservation (Airi *et al.* 2000). Problems and prospects of the development of medicinal plant resources in different regions of the country have also been studied (Biswas *et al.* 2003, Darshan and Veb 2003, Sarin 2003, Srinivasmurthy *et al.* 2003).

The interrelationship between the human beings and plant and animals in their surrounding environment gives an idea of ethnobotany. Various communities of the world are still dependent on different species of plants and animals for their livelihood and health care. Ethnobotanical investigation with reference to tree wealth in the life and economy of the tribal people in Andhra Pradesh revealed that various species are available and used by the different ethnic groups for various purposes such as for treating their common diseases and disorders (Rani *et al.* 2003). Tolchha-Bhotiya sub-community inhabiting the buffer zone villages of Nanda Devi Biosphere Reserve has strong faith and belief in traditional health care system/herbal treatment and they depend on various medicinal plants. There is a need to record and document their knowledge of various medicinal plants, which are being used for treating different ailments by local practitioners (Maikhuri *et al.* 1998). Health care system of Zay people in Ethiopia still partly depend on medicinal plants for treatment of various ailments. Most of the remedies are prepared from a single species and are mainly taken orally (Giday 2001).

People of Manipur, are directly or indirectly dependent on the surrounding biological resources. They have acquired rich knowledge of the resources and have their own ways of utilizing and conserving the resources. The traditional system of health care and disease-curing methods practiced by herbal medicine-men are indigenous in Manipur. Pioneer work on ethnobotany of Manipur was done by Sinha (1986, 1987, 1990, 1996). Several other workers (Devi 1989, 1990, Singh 1991, 1995b, 1996, 1997a, b, c, Singh and Singh 1996, 2000, Singh *et al.* 1988, 1992, 1996, 1997, 1999, 2003) have also studied the ethnobotanical and ethno-medicinal plants. About 1200 plant species were reported, out of which 430 species were local medicinal plants used in various ailments (Sinha 1996). Singh *et al.* (2003) published an account of cumulative knowledge on the traditional herbal medicine of Manipur. Meitei community of Manipur has their own indigenous way of using some of the plants for medicinal purpose since ancient times.

'Maiba' the indigenous herbal healer or medicine-men of Manipur acquired rich knowledge of various medicinal plants that were found in wild or were cultivated and they used them for the treatment of various ailments. Sometimes treatments are associated with the religious practices that are performed by 'maiba'. The protection of the plants through some superstitious practice used in the day to day traditional customs has a significant role in biodiversity conservation (Singh and Singh 1996). Use of *Bambusa nutans* (Utang) leaves, culms and bamboo strips (*Paya*) in specific traditional superstitious customs and religious ceremonies is a peculiarity of Meitei community of Manipur (Singh 1995a). Singh *et al.* (1992) reported 52 medicinal plant species that are also utilized as food, vegetables, spices etc. Singh (1997a) systematically enumerated some of the indigenous medicinal plants used against eleven complications including poisonous bites. He also collected 31 species of medicinal plants and listed the plant parts used as medicine and mode of application against the corresponding diseases or complications (Singh 1997b). Detail information on the plants used for the treatment of dog bite was collected from traditional practitioner (Maibas) and extensive survey was made on some of the plants, which are commonly used for the treatment (Singh and Singh 2000). In addition to the plants, information on the medicinal values of animals collected from remote areas of the state were also recorded (Singh *et al.* 1997). Women and child health care has always received utmost attention in the Meitei community. An integrated study for systematization of the existing biomedicine knowledge and orientation of the folk medicine with reference to women and child health has also been conducted (Singh and Singh 2003a). The medicinal plants used in the traditional first-aid treatment by the Meitei community has been claimed to be remarkably effective. 33 species employed in the first-aid treatment were verified by Singh and Singh (2003b). Some of the plants are used in medico-sexual and related complications (Singh 1996). Other than the medicinal uses, an ethnobiological information regarding indigenous soaps and detergents used by the Meitei community was also documented (Singh *et al.* 2002). Ethnobotanical uses of fourteen common pteridophytes have been reported by Singh *et al.* (2001).

Forests are one of the remarkable features of the land surface holding all forms of life. Forest biodiversity is considered a natural resource base of subsistence for the people of the tropical countries. From ecological point of view, the biological diversity is a function of diversity of different areas, habitats or ecosystems. Studies on plant biodiversity have been carried out in different ecosystems of the world (Charles and Thomas 1995, Connell 1978, Gentry 1988, Hubbell and Foster 1992, Johnston and Gillman 1995) and in India (Adhikari *et al.* 1991, Ganesh *et al.* 1996, Joshi *et al.* 1997, Visalakshi 1995). Various anthropogenic pressures change the natural environments (Rosser and Mainka 2002, Sala *et al.* 2000, Wakermagel *et al.* 2002), and threaten the species biodiversity and ecosystem function (Abbitt *et al.* 2000, Balmford *et al.* 2001, Ceballos and Ehrlich 2002, Cincotta *et al.* 2000, Cincotta and Engelman 2000, Forester and Machlis 1996, Harcourt and Parks 2003, Harcourt *et al.* 2001, Kerr and Currie 1995, Kirkland and Ostfed 1999, Mckinney 2001, Thompson and Jones 1999). Changes in climate due to pollution and deforestation have caused great damage to biodiversity in recent years. Impact of climate change on tree species composition and diversity has been reported by a few workers (Chandrashekara and Sreejith 2003, Shukla *et al.* 2002). Large-scale environmental changes, habitat fragmentation, and differential speciation and extinction rates of taxa are the factors commonly thought to be responsible for the depletion of plant diversity (Brown 1988, Cowling *et al.* 1992, Grubb 1987, Whittaker 1977). Studies on plant diversity through different elevations in various types of forest communities in India have been conducted by several workers (Bhuyan *et al.* 2003, Gokhale *et al.* 1995, Khan *et al.* 1997, Nadkarni *et al.* 1995, Parthasarathy *et al.* 1992, Parthasarathy and Karthikeyan 1997a, b, Pascal 1988, Pascal and Pelissier 1996, Sundarapandian and Swamy 1997, Swamy and Procter 1994, Yadava *et al.* 1991). Ganesh *et al.* (1996) recorded plant diversity at a mid-elevation evergreen forest of Kalakad Mundantherai, Western Ghats, India. Rich flora and high level of species endemism in north east India is significant for the biodiversity conservation (Khan *et al.* 1997). Shukla and Baishya (1979), Singh *et al.* (1993) and Singh and Yadava (1996) reported over 2137 species of flowering plants from Manipur which is also rich in species diversity and endemism. A comprehensive documentation of the flora of Manipur has been carried out by Deb (1961a, b) who reported 2192 plant species distributed over 213 families and 1012 genera. Clarke (1889) studied the flora of Manipur including Nagaland and reported 422 species from Manipur. Watt (1889-1899) explored the floristic composition of Manipur and reported 143 plant species including 10 monocotyledons plant. Besides these, Shukla and Baishya (1979), Singh *et al.* (1992), Singh and Yadava (1996), Singh *et al.* (2003) and Sinha (1987) have made important contribution towards understanding of the flora of the state.

In general, floristic composition, and structural and functional attributes of biotic communities are the indicators of the effects of biotic and abiotic factors, which are responsible for changing the trend of climax community development. The major anatomical features of the community may be understood by knowing the species composition and distribution (Dansereau 1960). Species distribution pattern among the different stands in alpine zone of the north-west Himalayas was recorded as contagious and random (Nautiyal *et al.* 1997) while in temperate forest of the Central Himalayas random distribution was common (Nayak *et al.* 1991). The structural and functional dynamism of the ecosystem may be altered due to biotic and abiotic factors. The biological spectrum reflects the adaptation of plant to the existing environment and primary climatic conditions (Smith 1980), and indicates the prevailing environmental conditions (Meher-Homji 1981). The occurrence of the similar biological spectra in different regions indicates similar climatic conditions. In ecological researches, beta diversity is being used in plant community classification (Itow 1988, Shmida and Wilson 1985, Wilson and Mohler 1983, Wilson and Shmida 1984).

Vegetation analysis is considered as a pre-requisite for the exploratory survey of any ecosystem. The analysis of vegetation in different communities of the world have been done by a number of workers (Behect 1991, Cao and Zhang 1997, Cao *et al.* 1996, Curtis 1959, Fremstad 1979, Greig-Smith 1983, Hegazy *et al.* 1998, Knight 1975, Koroleva 1994, Lee *et al.* 1990, Lieberman *et al.* 1996, Masaki *et al.* 1992, Uhl and Murphy 1981). The concept of vegetation class in phytosociology was deeply analyzed by Pignati (1996). Knight (1975) studied the phytosociology of species-rich tropical forest on Barro Colorado Island, Panama. A number of workers elaborately studied the structural attributes such as species richness, species diversity and evenness index in different forest communities (Aiba and Kitayama 1999, Bhuyan 2002, Curtis and McIntosh 1950, Givnish 1999, GranzowdelaCerda *et al.* 1998, Greig-Smith *et al.* 1967, Killen *et al.* 1998, Mutangah and Agnew 1996, Shehzad *et al.* 1999, Stocker *et al.* 1985). Some studies have focussed on vegetation analysis of natural forests of different climatic zones of India. Neave *et al.* (1995) proposed that climate was considered the main factor controlling the distribution of vegetation. The quantitative and qualitative analyses of forest vegetation along altitudinal gradient were done in Central Himalayas (Adhikari *et al.* 1991, Bankoti *et al.* 1992, Bhatnagar 1966, Khan 1996, Pathak *et al.* 1993, Ralhan *et al.* 1982, Saxena and Singh 1982a, b, Tiwari and Singh 1985, Upreti *et al.* 1985), eastern Himalayas (Nayak *et al.* 1991, Uma Shankar 2001), northeastern Himalaya (Rao *et al.* 1990, Singh and Yadava 1989), Western Ghats (Parthasarathy and Karthikeyan 1997a, b, Parthasarathy 1999, 2001), Eastern Ghats (Kadavul 2002, Kadavul and Parthasarathy 1999), and in tropical dry evergreen forest in south India (Visalakshi 1995). A considerable amount of information is also available on the forest vegetation of different parts of north-east India. For example, Beniwal and Haridasan (1992 a, b) and Bhuyan *et al.* (2003) have studied tree regeneration in the forest of Arunachal Pradesh; Bhatnagar (1996) has made phytosociological studies in evergreen forest of Assam; Khan *et al.* (1987), Pandey *et al.* (2003), Rao *et al.* (1990), Rao (1992), Singh and Ramakrishnan (1982), Tripathi and Khan (1992), Tripathi (2002) and Tripathi *et al.* (2002) have undertaken ecological studies on forests and tree regeneration in Meghalaya; and Deb (1960), Kikim 1999, Yadava (1986), Yadava and Singh (1988) and Yadava *et al.* (1991) have studied forest types and community structure of forests in Manipur.

Habitat fragmentation affects the ecology of tropical rain forests in many ways, such as reducing species diversity (Laurance *et al.* 2002, Lovejoy *et al.* 1986) and increasing the tree mortality and canopy-gap formation near forest edges (Laurance *et al.* 1997, 1998, 2001). Large trees are reproductively dominant and are important sources of food and shelter for animal population (Richards 1998), and thus their decline could have important impacts on fragment ecology.

Studies on phenology help in better understanding of the ecosystem function (Lieth 1970, Lieth and Radford 1971). Phenological observations provide a background for information on functional rhythms of plants and plant communities (Beatly 1974, Frankie *et al.* 1974, Lieth 1974, Opler *et al.* 1980, Putz 1979, Wareing 1909). Partial phenological analysis of tree species in terms of leafing, flowering, and fruiting data in different regions of the world were studied by many scholars (Beaubien and Johnson 1994, Borchert 1983, Croat 1975, Daubenmire 1972, Frankie *et al.* 1974, Heideman 1989, Hilty 1980, Janzen 1967, Koelmeyer 1959, Lieberman 1982, Lieth and Rafford

1971, Medway 1972, Murali and Sukumar 1993, 1994, Murphy and Lugo 1986, Opler *et al.* 1980, Putz 1979, Rathcke and Lacey 1985, Singh and Singh 1992, Sivaraj and Krishnamurthy 1992, Sun *et al.* 1996, Sundriyal 1990, Sundriyal *et al.* 1987, van Schaik 1986, van Schaik *et al.* 1993). Flowering phenology of many forest species, especially in the evergreen forest, has been studied in the tropics by several workers (Brokaw 1998, Cockburn 1975, Cunningham 1994, 1997 2000, Davies and Ashton 1999, Holmes 1942a, b, Holttum 1931, Koelmeyer 1959, Medway 1972, Ng and Loh 1974, Ng 1977, 1981, Pinto 1970). In India, phenological studies were made by several researchers in forest ecosystems of Central Himalaya (Negi *et al.* 1992, Ralhan *et al.* 1985a, b, Rawal *et al.* 1991, Sundriyal 1990), northeastern India (Bhuyan 2002, Boojh and Ramakrishnan 1981a, Khan *et al.* 2002, Kikim and Yadava 2001, Shukla and Ramakrishnan 1982a, Singh and Singh 1992) and southern India (Murali and Sukumar 1993, 1994).

Biotic factors are more likely to play a major role in moulding phenological events in tropical as compared to temperate environments, especially in the aseasonal tropics such as equatorial rain forests. There are several explanations for the evolution of the timing of life cycle events in trees. Resource allocation to different physiologically active sites which are competing for resources may be optimized (Alvim 1964). Thus selection may act for flowering to occur when resource availability is not a constraint. Plants also compete for such resources as pollinators or dispersers, and hence may have evolved staggered flowering and fruiting phenologies (Levin and Anderson 1970, Mosquin 1971, Stiles 1977, Waser 1979). However, others have argued that phenologies may simply be random (Cole 1981, Poole and Rathcke 1979). In seasonal tropical forests there can be pronounced aggregation in phenological events (Bullock and Solis-Megallenus 1990, Frankie *et al.* 1974, Janzen 1967, Murali and Sukumar 1994, Opler *et al.* 1980, Prasad and Hedge 1986). In an aseasonal neotropical dry forest in Costa Rica, Janzen (1967) found that trees flowered during the dry season. On the other hand, Opler *et al.* (1980) found that treelets and shrubs in the above forest flowered mainly during the wet season. No specific seasonality for fruiting has been reported for different regions (Costa Rica - Frankie *et al.* 1974; south India - Murali and Sukumar 1994, Prasad and Hedge 1986). The synchronization of flowering with leaf flushing seems to be related to moisture, temperature and photoperiod (Boojh and Ramakrishnan 1981a, Kikim and Yadava 2001, Murali and Sukumar 1994). Most of the studies on tropical phenology have been restricted to aseasonal forests (Jackson 1978, Medway 1972, Nevling 1971), and less attention has been paid to seasonal sub-tropical forests (Ralhan *et al.* 1985a, b, Shukla and Ramakrishnan 1982a). Seasonality exposes plants to regular and periodic changes in environmental conditions such as temperature and rainfall, and phenological events are often triggered because of these changes (Longman and Jenik 1974). In successional forest environment in northeast India, micro-environmental conditions change rapidly (Toky and Ramakrishnan 1983) along with drastic changes in edaphic characteristics (Ramakrishnan and Toky 1981).

Micro-environmental changes occurring during succession after slash and burn agriculture in northeast India (Ramakrishnan and Toky 1981, Toky and Ramakrishnan 1983) may serve as good example to relate the phenological differences to these changes. Plasticity in phenological behaviour is also an essential functional attribute that contributes to species becoming dominant in fallows (Devineau 1999). The differences of leaf fall may be due to micro-environmental differences such as insolation (Richards 1952). It has been suggested that it may be beneficial for a species to have the same vector for pollination and dispersal (Uma Shanker *et al.* 1990). Flushing and leaf production occur during the dry season of February to April, as was also observed for other seasonal forests (Boojh and Ramakrishnan 1981a, Frankie *et al.* 1974, Kikim and Yadava 2001, Medway 1972, Richards 1952, Shukla and Ramakrishnan 1982a, Sundriyal 1990).

Effects of fragmentation on plant phenology especially in the tropics have been inadequately assessed (Ackerly *et al.* 1990, Adler and Kiepinski 2000, Laurance *et al.* 2003, Nason and Hamrick 1997, Restrepo *et al.* 1999). Wright and van Schaik (1994) studied the effect of taller forest plant on the phenological events of tree species. Increased sunlight and hence photosynthetic energy near forest pasture edges would promote more frequent flowering, fruiting (Aldrich and Hamrick 1998, Wright and van Schaik 1994), and leaf production (Lovejoy *et al.* 1986), whereas higher desiccation and light intensities near edges would lead to increased leaf shedding (Sizer and Tanner 1999). A few studies have shown that various phenological events are triggered by rainfall (Foster 1982, Opler *et al.* 1976), water availability (Bullock and Solis-Megallenus 1990), temperature (van Schaik 1986) and photoperiodism (Daubenmire 1972). Some scholars have conducted research on the phenology of ferns (Ash 1986, Mehltreter and Monica 2003, Sharpe 1993, 1997, Wagner and Gomez 1983). Sharpe and Jernstedt (1990) and Tanner (1983) found that seasonal changes of phenological pattern of ferns were correlated to the environment of the species concerned, while Moran (1986) and Tryon (1960) reported no significant evidence for seasonality.

Regeneration is a key process for the existence of species in the community. It is also a critical part of forest management, because regeneration maintained the desired species composition and stocking after biotic and abiotic disturbances. The regeneration by seed is an important and frequently studied component of forest succession (Augspurger 1984a, De Steven 1991a, b, Gill and Marks 1991, Grubb 1977, Harcombe *et al.* 1982, Schupp 1990, Streng *et al.* 1989). Variation in seedling bank composition results from changes among species in several regeneration process, including seed production, seed dispersal, seedling emergence, seedling survivorship and seedling growth (Grubb 1977). Seed production, seed size, dispersal, seed viability and dormancy along with the microenvironmental conditions are the important factors determining the natural regeneration of a species. For the natural regeneration to be successful there must be adequate supply of seed and seedlings and seed must germinate on microsites where there is a reasonable probability of survival. The regeneration status/potential of a species in a community can be assessed from the population dynamics of seedlings and saplings in the forest community. Many workers have carried out studies on population structure and regeneration status in different forest ecosystems (Ashton and Hall 1992, Boraiah *et al.* 2001, Cao *et al.* 1996, Gunatileke *et al.* 2001, Khan *et al.* 1987, Marks 1974, Pritts and Hancock 1983, Rao and Singh 1986, Saxena and Singh 1984, Saxena *et al.* 1984, Uma Shankar 2001, Uma Shankar *et al.* 1998a, b, Vablen *et al.* 1979, Vijay and Totey 1999). Tree population structure and its implication for their regeneration has been studied in different forest stands of Garhwal (Aggrawal *et al.* 1991, Baduni and Sharma 2001, Bhandari 2003), Himachal Pradesh (Sood and Bhatia 1991), Western Himalaya (Pande *et al.* 2002), Western Ghats (Parthasarathy 2001) and north eastern region (Bhuyan 2002, Bhuyan *et al.* 2002, Maram and Khan 1998). In Manipur, Yadava *et al.* (1991) analysed the population dynamics of seedlings, saplings and young trees in a subtropical forest and assessed the implications of regeneration status for the forest management.

Community composition and tree population structure along a disturbance gradient has been studied in sub-tropical broad-leaved forests of northeast India (Khan *et al.* 1986, 1987, Rao *et al.* 1990). Presence of sufficient number of seedlings, saplings and young trees in a given population indicates a successful regeneration (Saxena and Singh 1984, Uma Shankar 2001). Sukumar *et al.* (1992) assigned the regeneration status of the species based on one time phytosociological data. Natural regeneration potential of *Toona citiata* was investigated by examining the fate of seed and seedling populations in Himalaya region (Thakur *et al.* 2001). Seedling growth and survival of *Elaeocarpus ganitrus* in nursery and natural forest stands under different environmental conditions has been studied by Bhuyan (2002). Age structure and regeneration of trees in forest ecosystems are strongly influenced by burning, clear felling, logging and grazing. Khan *et al.* (1986, 1987) studied the interactive influence of biotic and abiotic factors on regeneration of the tree species and observed that density of larger girth class individuals was greater in undisturbed forests (sacred groves) than in disturbed ones.

Regeneration of tropical forest mainly depends on the seedling ecology of tree species and this process plays a critical role in determining the future structure of the forest as a whole. Population dynamics of forest tree species is characterized by the fate of seed and seedlings (Augspurger 1984a, De Steven 1991b, Harcombe 1987, Harper 1977, Jones *et al.* 1994, Schupp 1990, Seiwa 1998, Shibata and Nakashizuka 1995, Streng *et al.* 1989). Various abiotic factors such as climate, season, time of canopy gap creation, shapes and sizes of disturbance patches etc., govern the dynamics of the forest, which influence the regeneration of woody species (Sukumar *et al.* 1992). Studies on the effect of microenvironmental factors on seedling survivorship and growth are limited (Streng *et al.* 1989). Survivorship and fine scale habitat characteristics of tree seedlings with regard to microenvironmental variations have been studied by Augspurger (1984b), Bazzaz and Pickett (1980) and Collins (1989). It has been observed that seedling survival rates were least during the first growing season and greater in subsequent years (Jones *et al.* 1994, Tanaka 1995). Lieberman and Li (1992) observed that germination and mortality were seasonal in their distribution, and mortality was highest in dry periods in a tropical dry forest in

Ghana. Burton and Mueller-Dombois (1984), Canham and Marks (1985), Clark *et al.* (1996), Connell *et al.* (1984), Fetcher *et al.* (1983), Veblen (1985) and Whitmore (1982) have studied the effect of light on survival and growth of tree seedlings, while Sorensen and Ferrel (1973) have investigated the role of temperature on the growth of juveniles. Seedling establishment and growth are influenced by soil moisture (Ashton *et al.* 1995, Lawrence and Ochel 1983, McLead and Murphy 1977, Mueller-Dombois *et al.* 1980, Potvin 1993, Schulte and Marshall 1983), soil nutrients (Campbell 1982, Rao and Singh 1985, Van Den Driessche 1982), thickness of the litter layer (Clark and Clark 1989, Facelli 1994, Molofsky and Augspurger 1992, Seiwa 1997), water stress (Schulte and Marshall 1983), drought (Bonner 1968, Borger and Kozlowski 1972), burning (Abbott and Loneragum 1984, O'Dowd and Gill 1984), micro-scale disturbance (Clark and Clark 1989, Kobayashi and Kamitani 2000, McCarthy and Facelli 1990), and canopy cover (Crow 1992, Harrington 1991, Streng *et al.* 1989, Titus 1990). Biotic factors like, herbivores (Forget 1997, Ida and Nakagoshi 1996, Khan and Tripathi 1991, Wada 1993), fungal infection or pathogen (Khan and Tripathi 1991, Mueller-Dombois *et al.* 1983, Sahashi *et al.* 1994, Seiwa 1998) and inter-species competition (Callaway 1992, Nakashizuka 1988, Yadav and Tripathi 1981) also affect the seedling demography. Both biotic and abiotic variables and their interactions within the forest environment also affect tree seedling survival and growth (Augspurger 1984a, b, Gause and Stone 1979, Whitmore 1975). Disease and predation of the seeds and seedlings play a key role in seedling emergence and establishment (Schupp *et al.* 1989). Several authors have studied the regeneration of a number of tree species in different climatic zones of the world (Barik *et al.* 1996a, b, Boerner and Brinkman 1996, Calabuig *et al.* 1996, Ellison *et al.* 1993, Espelta *et al.*1995, Hiroshi 1995, Lavorel *et al.* 1993, Leemans 1990, 1991, Lieberman and Li 1992, Matsuda *et al.* 1989, Reader *et al.* 1995, Shibata and Nakashizuka 1995, Streng *et al.* 1989). In natural forests of India, various studies were conducted by several workers on seed characteristics, seed germination, seedling growth and their population dynamics in response to various environmental conditions and disturbance (Bhuyan 2002, Kumar *et al.* 1994, Pandit *et al.* 1998, Rikhari *et al.* 1991, Saxena and Singh 1980, 1982a, 1984, Saxena *et al.* 1978, Singh and Singh 1984, 1986, 1987, Singh *et al.* 1986, Tiwari 1982, Upreti *et al.* 1985). Jeremy (1996) and Russell-Smith (1996) studied the seedling and sapling regeneration in tropical rainforest of northern Australia. Seedlings and saplings may respond differently to the same environmental conditions because of ontogenic differences and size differences (Ozaki and Ohsawa 1995, Paroish and Bazzaz 1985). Many studies have emphasized on natural regeneration of forest related to the spatial structure of different trees in different forest types (Annika 1993, Aun and Oshima 1996, Hornberg *et al.* 1995, Khan and Kleine 1990, Kigomo *et al.* 1990, Kittredge and Ashton 1990, Sabogal 1992, Szwargrzyk 1990). Edmos *et al.* (1993) studied tree population dynamics, growth and mortality in old growths in the Western Olympic Mountains. Ichikawa and Komizama (1989) studied the annual fluctuation of population density of seedlings and saplings in an evergreen coniferous forest on Mount Ontake (Japan). Kuusipalo *et al.* (1996) studied the population dynamics of tree seedlings in a mixed dipterocarp rainforest over a period of two years in Kintap, Indonesia. Larsen *et al.* (1997) concluded that reduced overstorey density is a commonly recommended method of increasing the regeneration potential of Oak (*Quercus*) forests.

Canopy openings/gaps created due to natural disturbance are widely recognized as important for the establishment and growth of forest trees thus influencing the forest regeneration and species composition. Gaps are known to be important for the successful regeneration of many tree species (Clark and Clark 1992, Denslow and Hartshorn 1994), and contribute to the maintenance of forest diversity (Brandani *et al.* 1988, Enright *et al.* 1993, Orians 1982, Pickett 1983). Brokaw (1985a, b), Denslow (1987), Hartshorn (1978, 1980), Jones (1945), Runkle (1981) and Whitmore (1975) discussed the importance of canopy openings in the regeneration and architecture of forest trees, and forest composition. Recent studies by Denslow and Gomez Diaz (1990) and Runkle (1990) show that gaps play an important role in tree regeneration in undisturbed forest community, and an understanding of natural gap dynamics may be useful in the management of forest ecosystem by maintaining its biological diversity (Denslow and Spies 1990). Natural disturbances generated by tree or limb falls in tropical rain forests cause a great degree of spatial heterogeneity (Brokaw 1982a, b, 1985c, Martinez-Ramos 1985, Whitmore 1975, 1978, 1982) both within and among the gaps making the gap phase regeneration a complex phenomenon within the forest. Grubb (1977) outlined the general importance of regeneration niche in plant communities, while Connell (1978), Denslow (1980b), Huston (1979), Orians

(1982) and Ricklefs (1977) explicitly theorized that specialized gap phase regeneration requirements of species contribute to diversity of the forests. Collins and Good (1987) and Hutchinson (1978) have dealt with the effect of habitat heterogeneity on regeneration niche differentiation of tree seedlings. Canopy gaps are characterized by temporary increase in light availability (Canham 1984, 1988, Chazdon and Fetcher 1984a, b, March and Skeen 1976). Least proportions of light (1-2%) could reach the forest floor passing through the canopy cover (Chazdon 1988, Clark *et al.* 1996). Therefore, Hartshorn (1978) suggests that perhaps 75% of the tree species at La Selva Biological Station, Costa Rica are dependent on gaps for germination or growth before and beyond the sapling stage. Similar observations are reported in descriptions of forest dynamics in Australia (Hancock *et al.* 1996), Malaysia (Whitmore 1975), West Africa (Jones 1955, 1956) and South America (Denslow 1980b). Several workers also reported better growth and survival in tropical (Augspurger 1984b) and subtropical (Khan *et al.* 1986, Rao *et al.* 1997) forest trees in sunny areas. However, Khan and Uma Shankar (2001) have reported better growth and survival of seedlings of *Quercus semiserrata* in medium light regimes. Studies on seedling and sapling growth rates in gaps (Brokaw 1985b, 1987, Uhl 1982) and their growth responses in different light regimes (Bazzaz and Pickett 1980, Chazdon 1986, Pearcy 1983) suggest that species show a distinct niche partitioning within the complex gap-understorey environmental mosaic in the forest. Brokaw (1985b), Denslow (1987) and Orians (1982) postulated that germination, and survival of seeds and seedlings should vary with gap microhabitat and gap size. There is considerable difference in the response of tropical forest tree species to irradiance, particularly in photosynthetic response (Chazdon *et al.* 1996, Kitajima 1994, Oberbauer 1985, Oberbauer and Strain 1984, 1986, Pearcy 1987, Press *et al.* 1996, Turnbull 1991, Zipper and Press 1996) and relative growth rate (Agyeman *et al.* 1999, Coombe and Hadfield 1962, Kitajima 1994, Okali 1972, Pompa and Bongers 1991, Whitmore and Gong 1983). Mean relative growth rates (RGR) are used to analyze tree growth and for comparing the growth of seedlings of different sizes (Brand 1991, Evans 1972, Hunt 1982). Several authors found that deciduous woody species show higher potential of growth rates, higher specific leaf areas (SLAs) and higher photosynthetic rates than evergreen species (Cornelissen *et al.* 1996, 1998, Isabel *et al.* 2001, Reich 1998, Reich *et al.* 1997, Reich and Walters 1992). The greater relative growth rate (RGR) of deciduous species has been considered an important determinant of their distribution in productive habitats through greater competitive ability (Cornelissen *et al.* 1996, 1998). Fertilization effects on relative growth rate, biomass accumulation and tissue nitrogen and phosphorus were examined for seedlings grown under relatively high light by Lawrence (2003).

Light response of shade-tolerant tropical tree species in north-east Queensland has been studied by Juliette (2003). In addition to increased incident light levels, gap microclimate is generally characterized by lower humidity and higher temperature (Fetcher *et al.* 1985, Schulz 1960). In some studies soil temperature was found to be higher in gaps than the surrounding understorey (Fetcher *et al.* 1987), while in others (Becker *et al.* 1988, Vitousek and Denslow 1987, Uhl *et al.* 1988) higher soil moisture has been reported in the gaps. Overall literature clearly indicates that canopy gaps have positive effects on the survival and growth of tree seedlings.

Performance of seedlings also depends on resource availability and their physiological ability to efficiently use the higher level of resources present in gaps (Brokaw 1985b, Hladik and Blanc 1987). Studies comparing the performance of juvenile plants in gaps and understorey are many (Clark and Clark 1987, Welden *et al.* 1991). Demographic studies demonstrate greater growth, survival, and reproductions when plants occur in or near canopy openings (Bazzaz and Pickett 1980, Brokaw 1985b, 1987, Clark and Clark 1987, De Steven 1989, Whitmore 1978, Zagt 1997). Pompa and Bongers (1988) studied the effect of canopy gaps on growth of seedlings. Uhl *et al.* (1981) studied the vegetation dynamics in Amazonian treefall gaps. Lawton (1990) and Spies *et al.* (1990) have monitored the effects of canopy gaps on seedling mortality and population dynamics of trees. Aide (1987) and Gartner (1989) considered mild disturbances as a cause of seedling mortality, while Denslow (1987) attributed seedling mortality to the gap-understorey environmental mosaic. Lorimer (1989) studied survival and growth of understorey trees in Oak forests and Canham (1988) investigated growth and canopy architecture of shade-tolerant trees and their response to canopy gaps.

Several ecological studies have been made on forest species in terms of vegetation analysis, phenology, population structure and regeneration in different forest types of our country. In the north-eastern region also many ecological studies have been carried out on various aspects at stand and species levels (Barik 1992, Barik *et al.* 1992, Barik *et al.* 1996a, b, Beniwal and Haridashan 1992a, b, Bhuyan 2002, Bhuyan *et al.* 2003, Boojh and Ramakrishnan 1981a, b, c, 1982a, b, Khan 1986, Khan *et al.* 1986, 1987, 1999, Khan and Tripathi 1987a, b, 1989a, b, c, 1991, Khan and Uma Shankar 2001, Kikim 1999, Kikim and Yadava 1998, Kikim and Yadava 2001, Maram and Khan 1998, Rao 1992, Rao *et al.* 1990, 1997, Shukla and Ramakrishnan 1981, 1982a, b, Sundriyal *et al.* 1994, Sundriyal and Shrama 1996, Tripathi and Khan 1990, 1992, Yadava and Singh 1988, Yadava *et al.* 1991). However, very few studies have been carried out in forest patches that are protected by social fencing arising from the belief and taboos of local people i.e., in sacred groves. A number of ecological investigations have been made in sacred groves of Meghalaya (Barik 1992, Barik *et al.* 1992, 1996a, b, Jamir 2000, Khan *et al.* 1986, 1987, Khiewtam 1986, Khiewtam and Ramakrishnan 1993, Law 2002, Mishra *et al.* 2004, Pandey *et al.* 2003, Rao 1992, Rao *et al.* 1990, 1997, Tiwari *et al.* 1998a, b, 1999, Tripathi 2002, Tripathi *et al.* 2002, Upadhaya 2002, Upadhaya *et al.* 2003) but such studies are lacking in rest of the states of north-eastern India especially in Manipur.

CHAPTER II

Physical features and socio-economic aspects of Manipur, and status of sacred groves

Descriptive features of Manipur

Geographical location

The state of Manipur is situated in the extreme northeastern corner of India and lies between 23° 50′ to 25° 42′ N latitudes and 92° 58′ to 94°45′ E longitudes. It is centrally located on the eastern arm of the Himalaya-the Purvanchal (Chatterjee 1965), which separates India from Myanmar. The state is bounded on the east by the Surma tract and the upper Chindwin areas of Myanmar, on the west by the Cachar hills of Assam, on the north by Naga Hills of Nagaland, and on the south by the Chin hills of Myanmar. The total geographical area of the state is 22,327 sq. km. It is predominantly a mountainous state with central bowl-shaped valley formed by the deposits of alluvial soil. The state can be divided into two major regions namely the central valley with an area of 2,238 sq. km (10.02%), at the elevation of 750-900 meters and the surrounding mountains covering an area of 20,089 sq. m. The Imphal basin covers an area of 1,843 sq. km. The average elevation of the valley is 790 m above msl. The hills are spread from the north to south direction with an average height ranging between 1500-1800m. Some of the hills on the northern parts of the state have a height around 3000 m.

Generally, the state is sloping towards the south except some areas of south-western part. The hills of Manipur broadly fall into two groups, the Manipur eastern hills and the Manipur western hills, which differ from each other to a great extent in their layout, structure and relief. A number of other hills rise above the flat surface, which include the Langol, Heingang, Nongmaijing Ching, Langthabal and Waithou hills. Besides, a series of islands are also projected above the water surface of Loktak lake; Sendra, Ithing, Thanga and Karang being the most important among them. The hill region comprises five districts namely, Chandel, Churachandpur, Senapati, Tamenglong and Ukhrul. The Manipur valley, having an area of 2,067 sq. km comprises four plain districts viz., Bishnupur, Imphal East, Imphal West and Thoubal. The Barak basin forms a sub-division of Imphal East district.

Ecological status

Manipur, by virtue of its physical features, is endowed with rich floral and faunal resources, water resources and fertile soil. There are different types of forests ranging from tropical to sub alpine. Since Manipur belongs to the region which is located at the confluence of two tectonic plates (the Burmese and Indian), the region has been the center of origin of a variety of angiospermic plants and is a component of the trans-Himalayan Geological formation from the Tethys sea in the Archaean period (about one billion years ago). Climatic conditions differ from one place to another due to the terrain diversity, altitudinal variation and river regime.

Major soils found in the state are alluvial, peaty, red ferruginous, black regur and laterites. The soils of the state belong to two major types- residual and transported, which cover the hill areas and the central valley respectively (Vedaja 1998). The residual soil is red in colour and coarse in texture. The western slopes of the Manipur Western hills are covered by laterized red soils (Oxisol) while non-laterized red soils (Ultisol) cover the rest of the hills (Bareh 2001). Transported soils are of two types – alluvial and organic. The alluvial soil (Entisol) covers about 1600 km^2 area in the Manipur valley. These soils generally have clayey loam texture and grey to pale brown colour. They contain a good proportion of potash and phosphate, a fair quantity of nitrogen and organic matter, and are less acidic. The organic soils (Histosol) cover the low-lying areas of the central valley along the Loktak and other lakes and marshes. These soils remain under water during the rainy season. With dark grey colour and clayey loam texture, these peaty or bog soils have high acidity, abundance of organic matter, a good amount of nitrogen and phosphorus, but are poor in potash.

The natural vegetation of the state mainly consists of forests, which occupy about four-fifths of its geographical area. The forest vegetation of Manipur is spread over four distinct zones, viz. Myanmar border forests, Ukhrul pine forests, forests overlooking the valley and Barak drainage forests which belong to five different types of forests (Champion and Seth 1968) - (i) tropical wet evergreen, (ii) tropical moist deciduous, (iii) sub-tropical pine, (iv) tropical dry deciduous, and (v) montane wet temperate forests.

Socio-economic aspects

Manipur comprises many communities and is rich in art and culture, tradition and religious beliefs. The state has 29 scheduled tribes belonging to different ethnic groups, 7 scheduled caste communities, *Meitei pangals* (Manipuri Muslims) and *Meiteis*. The Meiteis are the indigenous people of Manipur who inhabit the valley (Manipur valley) areas comprising four districts namely, Imphal East, Imphal West, Bishnupur and Thoubal districts. The *Meitei* community constitutes half of the population. Besides Meitei, Meitei Pangals and several other tribes also inhabit the valley areas. As per 1991 Census of Manipur, the population of the plain/valley accounts for 66.6 %, while 33.4 % population remains in the vast hills of the state. The population of Pangals or Muslims (non-tribal) constitutes 12 % of the population in the valley. Meitei or Manipuri (non-tribal) community dominates the plain areas, accounting for about 52 % of the population, and it is this community which maintains most of the sacred groves occurring in Manipur. On the other side according to the population enumeration of the Census of India 2001, the population of Manipur stood as 23,88,634 persons (representing 0.23% of the total population of India), which shows that the population density per square kilometre increased from 82 in 1991 to 107 in 2001. Moreover, valley area is densely populated as compared to the surrounding hills. The literacy rate is 68.97%. Linguistically, the people of Manipur are polyglot. The majority of Meiteis are Hindu by faith. A large chunk of the Meiteis follows their synthesized form (pre-Hindu and Hindu) of religion whereas a good section of them practices their pre-Hindu religion. They believe in the Supreme Being, indigenously uttered as *Atiya Sidaba Mapu* and His two sons, *Sanamahi and Pakhangba.* In the second quarter of the 20th century, a section of the Meitei started a movement of desanskritizing their religion so that their pre-Hindu religion could be revitalized. As a result, Meiteis have now loosened themselves from the grip of the rigour of Hinduism. On the other hand, in the first half of the century during colonial rule, Christianity gained a momentum among the tribal people of Manipur who inhabited the hilly districts of the state through various missionary activities. The people of Manipur is comparatively poor. Agriculture occupies an important place in the economy of the state and is the main source of livelihood for most of the people in the villages and even for some part of the population in the towns. The hill people are highly dependent on forest resources.

History and status of sacred groves of Manipur

In Meitei cosmology, Meitei conceived the universe as a unity, but consisting of five or six layers or levels. The heaven is the dwelling place of the male deity, and the water is that of the female deity. During the reign (1597-1652) of Khagemba, the ancient king of Manipur, in consultation with the five gurus, codified the then existing knowledge regarding Umanglais and other deities (Higgins 1998). Literally, "*Umang lai*" means 'forest deities' (Hodson 1910, Parrat 1980, Shakespear 1913) and in shortened form it is understood as *"lai"*, which is the generic term for deities in Manipuri and used for both male and female deities. In early Meitei society, before Hinduism was introduced, preservation of forestlands was practiced in the name of sacred deities (Umanglai) by the Maibas and Maibis under the direction of the Maiba Loisang or Pandit Loisang. Hence, from time immemorial sacred groves have been in existence in Manipur, where sacred deities are worshipped. In the beginning there were 9 original Umanglais and 7 goddesses (Lairema or Lainura) who receive offerings during all ceremonies. However, the seven goddesses are not the spouse of nine gods. Among the original 9 Umanglais, *Athingkho* (Atiya) *Sidaba*, *Atiya Guru Sidaba*, *Asiba Guru Sidaba*, are the manifestations or incarnation of god as the creator, the preserver and the annihilator of this universe, respectively. The 7 goddesses produced the 7 *salai* (clans) of Manipur, and fire, water, wind, vegetable, fish, salt and cotton. From these original 9 gods and 7 goddesses, 364 lais (Umanglais and Lairemas) have emanated. Umanglais include the *Lamlai* (country deities) and *Sageilai* (family deities). Among the Umanglais, four Meitei tutelary Umanglais are the guardians of the four directions, collectively termed the *Maikei ngakpa* (guardians of the directions). They are associated with the mountains located in the appropriate direction relative to the central valley of Manipur (Saroj and Parratt 1997). *Koubru* is the guardian of the north-west, and *Wangbaren* and *Marjing* in the south-east and north-east, respectively. *Thangjing* is the guardian of the south-west of the valley at the southern end of Loktak lake and he dwells in the mountain in the same name and is the main Lai addressed in the Moirang version of the Lai Harouba (Shakespear 1910). These Umanglais are having their own sacred land of forest patches (sacred groves) named after their names.

Precisely, sacred groves of Manipur are the ideal places for worshipping the Umanglais and are meant for the preservation of forest, culture and religion. Meiteis use to worship Umanglais with the celebrations called '*Lai-Harouba*". Lai Harouba means 'Pleasing of gods' or merry festivals of the deities. The celebration starts with the onset of the wet season in the month of *Kalen* (in Manipuri calender). The main rituals of the Lai Harouba are performed by the *Maiba* (priest) and *Maibi* (priestess) and *Penakhongba* (the player of the *Pena*, an indigenous one stringed fiddle). The Lai Harouba exists in three main forms: the Kanglei (Meitei) Haraoba, the Moirang Harouba and the Chakpa Haraoba. The Chakpa Haraoba seems to be more primitive and still highly secretive where outsiders are excluded. Though there are some significant differences between them, the basic structure of the Lai Haraoba is common to all. The beginning of the *Lai Haoruba* is calling of Lais (*lai ikouba*) from their abode by Maibi, followed by "*Lai higaba*" bringing the Lais to the shrine. At the evening Penakhongba chants and plays the lullaby (*naosum*) for Lais to sleep, and each morning the Lais are greeted with an awakening song (*yakeirol eshei*). On the central day of the festival Lais are symbolically brought out into the courtyard to witness the rituals.

The Lai Harouba festival is probably the most authentically Meitei of all the religious rituals of the Manipuri people, and the one which most closely preserves the ancient Meitei culture. As one foremost Manipuri has put it, 'The Lai Harouba mirrors the entire culture of the Manipuri people. It reveals its strength and weakness, the beliefs and superstitions, and perhaps also the charm and happiness of the Manipuri people. It reflects the people at their

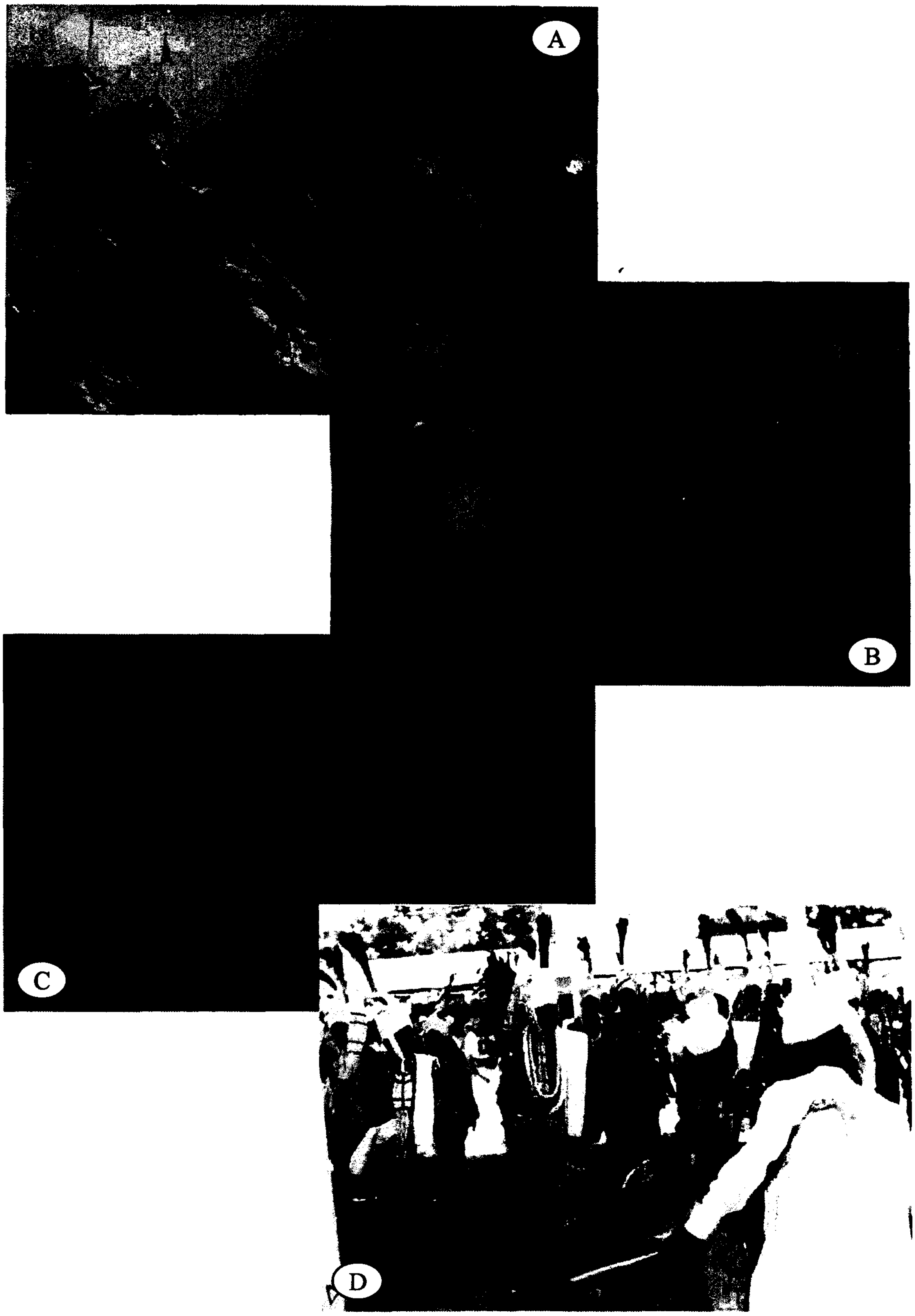

Plate 1. . Cultural programme performed during the 'Pleasing of God', *Lai-Harouba*. (A) – Procession of sylvan deities (*Lais*) during Ebudhu Thangjing Lai-Harouba at Moirang, Bishnupur, (B) – Dance by priestess (*Maibis*) with the male folk, (C) – Dance by female folk, and (D) – Dance by male folk.

intensest' (Singh 1961). During the festival numerous cleansing and apotheosis rites, offering of flowers and fruits, dance, sporting activities etc. are performed to please the God. The offering of *Sharen Katpa*, literally 'live offering' is even more significant. The flowers and fruits offered to deities are distributed to the people. The folk songs, dances and other rituals and practices are all related to love and affection towards the wildlife (flora and fauna).

Inventory of sacred groves

Hundreds of sacred groves are reported from Manipur (Devi 2000), which are distributed over a wide range of the region conserving many rare and endemic species of plants and animals of the state. Further, sacred groves are the ideal places of worshipping the *Umanglais* by the Meiteis. They play very important role in protecting and conserving the primitive cultures along with wild flora and fauna. However, the population explosion, effect of modern economy and changes in religious beliefs have adversely affected the sacred groves in terms of area, biodiversity, religious beliefs and taboos. It is high time to make an inventory of the sacred groves of Manipur, and to assess their status and role in biodiversity conservation through religious practices and associated taboo. Thus, an extensive field survey was undertaken to inventorise the sacred groves of Manipur during 2000-2002. Records of the local government and literature were consulted to locate the groves and to ascertain their historical background. Traditional institutes such as village headmen, *Maiba* and *Maibi* (priests and priestesses or the local medicine-men and medicine-women, respectively), and local people, educated persons, caretakers of the sacred groves etc. were contacted for identifying sacred groves in the territories under their control or in their knowledge. Data on sacred groves were collected from them through informal and formal interviews. Proforma for data collection regarding sacred groves was developed which is given below:

1. General information on sacred groves
   (a) Name of the sacred grove: (b) Care taker:
   (c) District: (d) Nearest human habitation:
   (e) Access to the grove:
2. Land description
   (a) Area covered by the grove: (b) Altitude:
   (c) Ownership over the grove (temple land/reserve forest/private land/community land/etc.):
   (d) Terrain - (plain/hill/foothills /hillocks/wetland etc.):
3. Historical/religious/social significance of the grove
   (a) Deity associated: (b) Festivals:
   (c) Community involved: (d) Myth, history and taboos:
4. Biodiversity of the grove
   (a) Nature of vegetation – (natural forest/plantation):
   (b) Sacred tree, if any: (c) Flora and fauna:
   (d) Degree of disturbance – (high, medium, low and nil):

5. Conservation status of the grove

(a) Nature of protection– (well preserved, partly threatened and threatened):

A total of 166 sacred groves were inventoried in and around the Imphal East and Imphal West districts of Manipur. Most of the sacred groves were open and did not have well-demarcated boundary, and therefore, the area measured for a given grove was mainly based on the information collected from the concerned village headman or caretaker of the grove and through measurement by drawing an imaginary line or boundary (using the knowledge of the caretaker or village headman or some authentic persons) around the grove. The size of the individual sacred grove varied from a clump of a few trees having an area 0.001ha to 40 ha within the elevation of 691 to 860 m (Table II. 1). The size of the sacred groves of Manipur is much smaller as compared to those of Meghalaya which varied between 0.01-900 ha (Tiwari *et al.* 1998a). Area of majority of the groves ranged from 0.09 ha to 1.5 ha. The total area of all the inventoried sacred groves comes to 175.62 hectares. Sacred groves of Manipur are distributed in different locations of the state. 145 groves were inventoried in the valley, 6 in the foothills, 7 in the hillocks and 4 each near catchment area or river banks and hills (Figure II. 1). The percentage area of sacred groves was highest in hillocks followed by hills (Figure II. 2). Their distribution in varied locations not only helps in the conservation of whole variety of valuable medicinal plants but also preserved

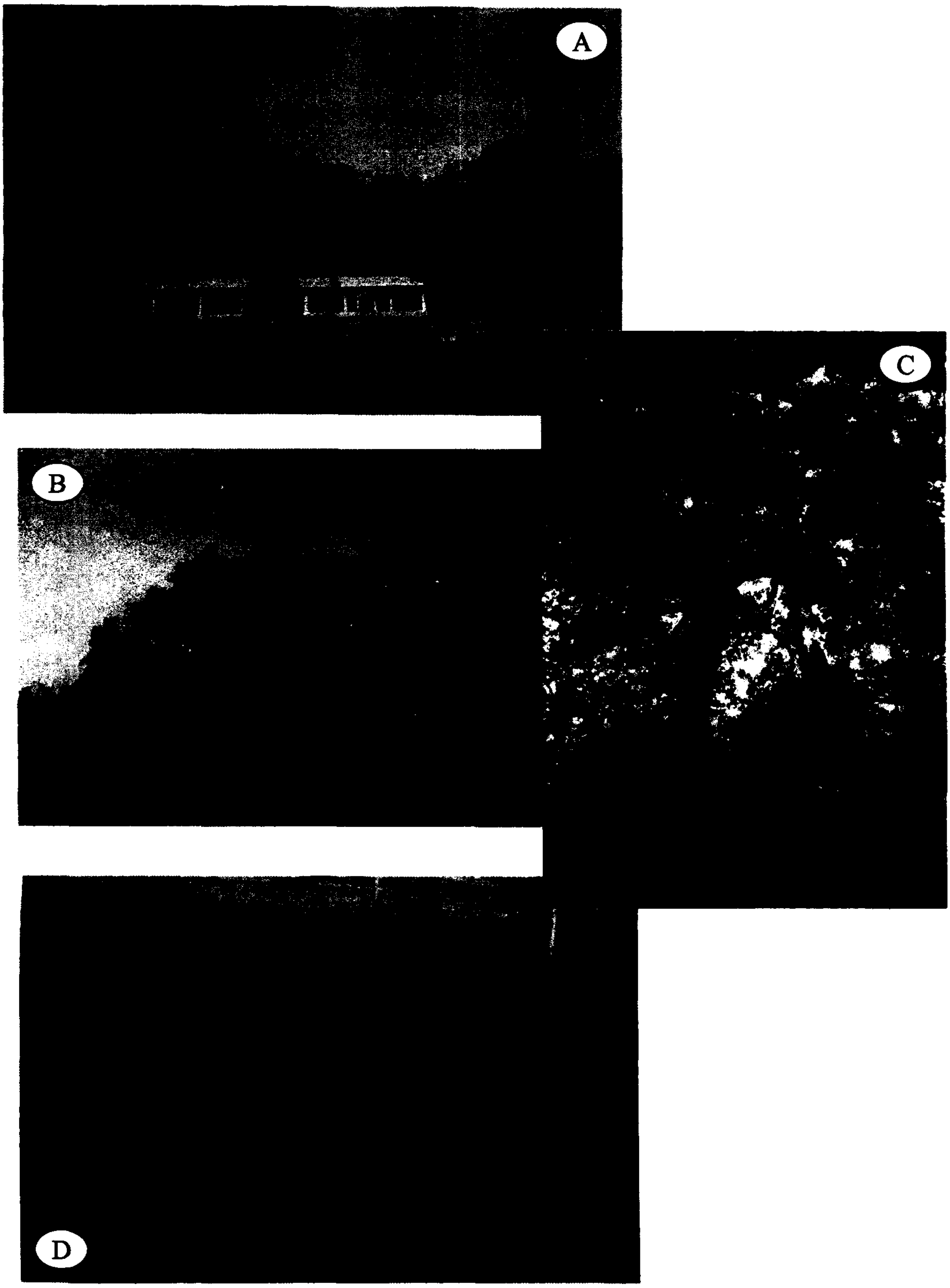

Plate 2. (A) - A common sight of sacred grove with temple, open temple hall and sitting hall especially constructed for the purpose of the celebration of deities (Lai-Harouba), (B) – *Ficus* species at 'Lamboikhul', an example of conservation of a single species with the associated taboos, (C) – A view of joining of *Ficus* trees considered as sacred and (D) – Sacred pond of Ebudhou Pakhangba Puruk Shoubi sacred grove at Uchekon.

Table II. 1. Details of sacred groves inventoried in Manipur.

Sl no.	Name of the Sacred grove	Distance from Imphal city (Approx. km)	Town/Village	Controlling authority (Community head/Village head, Care-taker) etc.	Area (Approx.)	Altitude (m)	Loca-tion	Main Diety	Main festival	Season	Ethnic group	Degree of distur-bance
1	Arai Leima	1.5 km	Lalabung	–	0.13 ha	691	V	Arai Leima	Lai-Harouba	April-May	Meitei.	High
2	Chabugbam Lairembi Laishana	13 km	Kodompokpi Mayai leikai	S. Kula Singh	20 sq.m	771	V	Chabugbam Lairembi Laishana, Khoiriphaba, Tampha Lairembi	Lai-Harouba	June	Meitei	Medium
3	Chakpa Panam Ningthou	27 km	Andro	Aseibam Nambor Singh	0.4 ha	–	V	Chakpa Panam Ningthou	Lai-Harouba	March	Chakpa	Negligible
4	Chingamathak Ema Lairembi	13 km	Singjamei Chingnga-mathak	N. Kanto Singh	0.21ha	758	HL	Ema Lairembi	Lai-mang phamba	March (Lamta Thanja)	Meitei.	Low
5	Chingol Ningthou	6 km	Chingmeiron Maning Leikai	Nakambam Indramani Singh	0.5 ha	768	V	Chingol Ningthou	Lai-mang phamba	March	Meitei (Nakam-bam clan)	Negligible
6	Chothe Thayai Pakhangba	30 km	Bishempur chothe thawai pakhangba khuman, Ward no. 6	Village head man	122.91 sq.m	860	V	Chothe Thayai Pakhangba	Lai-mang phamba	May	Chothe	Negligible
7	Chumthang Lairembi Mache	11 km	Bamdyar Awang Leikai	T. Iboungo Meitei	10 ha	716	HL	Chumthang Lairembi Mache	Lai-Harouba	April	Meitei	Low
8	Chumthang Lairembi Manou	10 km	Bandyar Ahallup	O. Mangi Singh	30 ha	746	HL	Chunthang Lairembi Manou	Lai- Harouba	April	Meitei	Low
9	Ebendhou Makubi Ching	18 km	Keithelmanbi	Longjam Khaba Singh	6.07 ha	815	HL	Ebendhou Makubi	Lai-Lamthok-pham of Ebudhou Koirouhanba	April-May	Meitei	Low
10	Ebudhou Khamlangba	2.5 km	Mayai Koibi	–	256.06 sq.m	710	V	Ebudhou Khamlangba	Lai-Harouba	Apri-May	Meitei.	High
11	Ebudhou Khamlangba	2.5 km	Sapam Leirak	–	0.1 ha	764	V	Ebudhou Khamlangba	Lai-Harouba	April-May	Meitei.	High
12	Ebudhou Khamlangba	47 km	Kakching Khullen Moirangthem Leikai	Head of the village	0.4 ha	820	V	Ebudhou Khamlangba	Lai-Harouba	April/May	Meitei	Medium
13	Ebudhou Koirouhanba	15 km	Moidampok	Longjam Khaba Singh	1.01 ha	793	V	Koirouhanba	Lai-Harouba	April-May	Meitei	Negligible

14	Ebudhou Marjing	7 km	Laipham Khounou, Sanhakpham	H. Ibomcha Singh	0.25 ha	768	V	Ebudhou Maring	Lai-Harouba	May	Meitei	Medium
15	Ebudhou Marjing	9 km	Achanbikei	N. Robindro Singh	0.45 ha	782	V	Ebudhou Marjing	Lai-Harouba	April-May	Meitei	Medium
16	Ebudhou Marjing	8 km	Khabam Awang Leikai, Kontha Khabam	Th. Douji Singh	0.1 ha	782	V	Ebudhou Marjing	Lai-Harouba	April-May	Meitei	Medium
17	Ebudhou Marjing	8 km	Ahallup	E. Nimai Singh	703.05 sq. m	781	V	Ebudhou Marjing	Lai-Harouba	April-May	Meitei	Medium
18	Ebudhou Marjing	9 km	Kairang	Y. Malaya Singh	0.2 ha	780	V	Ebudhou Marjing	Lai-Harouba	April-May	Meitei	Medium
19	Ebudhou Marjing (Heingang)	11 km	Heingang Mayai Leikai	M. Kukijao Hanjaba (Laipu)	0.1ha	754	V	Marjing	Lai-Harouba	April-May	Meitei	Medium
20	Ebudhou Meitreng Pakhangba	28 km	Bishempur Joypur Khunou, Kha.	Meisnam Kumar Singh	51.21 sq.m	721	V	Ebudhou Meitreng Pakhangba	Lai-chaklong katpa	Sept-Oct	Meitei	Medium
21	Ebudhou Nongda Lairen Pakhangba	4 km	Patsoi Part-II	Kayempaibam Khamba Singh	901.34 sq.m	776	V	Ebudhou Nongda Lairen Pakhangba	Lai-Harouba	June -July	Meitei	Low
22	Ebudhou Pakhangba	15 km	Wangoi	–	0.69 ha	700	V	Pakhangba	Lai-Harouba	April -May	Meitei.	Low
23	Ebudhou Pakhangba	31 km	Kwa Siphai, Wang Makhong	K. Mala Singh	256.06 sq. m	744	V	Ebudhou Pakhangba	Lai-Harouba	March	Meitei	Low
24	Ebudhou Pakhangba Puruk Shoubi	10 km	Uchekon	O. Manglem Singh.	0.25 ha	702	V	Ebudhou Pakhangba Puruk Shoubi	Lai Chaklong Katpa	Jan	Meitei.	Low
25	Ebudhou Sankardev	18 km	Wangoi	–	0.11ha	705	V	Ebudhou Sankardev	Lai-Harouba	April-May	Meitei	Low
26	Ebudhou Moirang Kacha	5 km	Okram Leikai, Singjamei	O. Kiso Singh	430.19 sq. m	803	V	Ebuthou Moirang Kacha	Lai-Harouba	April	Meitei	High
27	Ebudhou Thangjing	45 km	Moirang Laisang-them Leikai	Thangjing Seva Mandal Committee	1ha	777	V	Ebuthou Thangjing	Lai-Harouba	June- July	Meitei	Negligible
28	Ema Ebemma Leihoungou Thongak Lairembi	4 km	Eroisemba	–	0.25 ha	700	V	Ema Ebemma Leihoungou Thongak Lairembi	Lai-Harouba	March	Meitei	Low
29	Ema Konthokhanbi	1.5 km	Thangmeiband D.M.College	T. Kerani Singh	2.07 ha	710	V	Ema Konthokhanbi	Lai-Harouba	April-May	Meitei.	Negligible
30	Ema Laikhulembi	2 km	Houbam Marak	W. Damu Singh	0.1 ha	712	V	Ema Laikhulembi	Lai-Harouba	July	Meitei	High
31	Ema Nongaleima	3 km	Thangmeiban Hijam Diwan Leikai	Eldest man of The Hijan clan	0.2 ha	763	V	Ema Nongaleima (Hijam Lairembi)	Lai-harouba	March	Meitei	High

32	Ema Panthoibi Lairembi	4.5 km	Patsoi Part-III	Thingbaijam Nilamani Singh	3.71 sq.m	782	V	Ema Panthoibi, Nongpok Ningthou, Lairembi	Lai-Harouba	April	Meitei	Medium
33	Ema Wangdongbi Pung	3 km	Tera	–	184.37 sq.m	692	V	Ema Wangdongbi	Laimang-phamba	Jan-April (Cheirou-ba, Emoinu)	Meitei	Negligible
34	Emoinu	15 km	Wangoi	Pounam Ranbir Singh	975.48 sq.m	700	V	Emoinu, Keirunghanba, Keirunghanbi	Lai Chaklong katpa	Jan (Emoinu Numit)	Meitei	Low
35	*Epa Sorarel*, Khoiriphaba	6 km	Yurembam Awang Leikai	*Sapam Brajamani* Singh	*627.09* sq.m	804	V	*Epa Sorarel*, Khoiriphaba	*Lai-Harouba*	June	Meitei	*Medium*
36	Eputhou Nongsaba	4 km	Kwakeithel Heinou Khonglembi, Guru Nongsaba Leikai	Yenjenbam Mangi Singh	0.1 ha	809	V	Eputhou Nongsaba	Lai-Harouba	June	Meitei	Low
37	Eputhou Nouthingkhong Pakhangba	3 km	Thangmeiband Lairenhanjaba Leikai	Secretary of laiharouba commetee	7.38 Sq.m	763	V	Nouthingkhong Pakhangba	Lai-Harouba	May	Meitei	High
38	Ereima Khanachouba	4 km	Oinam Thingngel Leikai	Oinam Madumagol	0.5 ha	820	V	Erum Ningthou	Lai-Harouba	April/May	Meitei	High
39	Erom Lairembi	5 km	Chingmakha Phuramakhong	E. Ebotombi Singh	368.73 sq. m	768	V	Erom Lairembi	Lai-chaklong katpa	Feb.	Meitei	High
40	Erom Laishram Lairenma	5 km	Chanam Phukhri Mapan, Erom Leikai	–	204.85 sq. m	786	V	Erom Laishram Lairenma	Ekou loukhatpa	April	Meitei	High
41	Erum Ningthou Kakching	45 km	Kakching	Head of the village	0.55 ha	820	V	Erum Ningthou	Lai-Harouba	April-May	Meitei	Low
42	Heingang Marjing	43 km	Heingang	K. Noubicha Singh	7.08 ha	734	H	Ebuthou Marjing, Sagol Sanglan, Chingsanglakpa.	Lai-Harouba	April-May	Meitei.	Low
43	Heirang khonung Lairembi	10 km	Lamlongei, Sabal Leikai	N. Nandabi Singh	200 sq.m	818	V	Heirang khonung Lairembi	Lai-harouba	May	Meitei	Low
44	Heisnam Panthoibi	4 km	Keisamthong Thangjam Leirak	H.Guro Singh	0.6 ha	808	V	Heisnam Panthoibi	Lai-Harouba	June	Meitei	High
45	Hodam Lairembi	4.5 km	Keisamthong Hodam Leirak	Head of the community	0.6 ha	807	V	Hodam Lairenbi	Lai-Mang-Phamba	April	Meitei	High
46	Huidompokpi Tarang Apanba	7 km	Yurembam Mayai Leikai	Khuraijam Babu Singh	0.65 ha	809	V	Huidompokpi Tarang Apanba	Lai-Harouba	July	Meitei	Low
47	Huidrom Lairembi	3 km	Keisamthong	–	673.08 sq.m	712	V	Huidrom Lairembi	Lai-Harouba	April-May	Huidrom clan	High
48	Kakching Wairi Khamlangba	46 km	Kakching Wairi Khamlangba	Nourem Mohandas Singh	0.4 ha	792	V	Ebudhou Khamlangba	Lai-Harouba	April-May	Meitei	Low

49	Kakwa Lairembi	4 km	Singjamei Waikhom leikai	Y. Magoljao Singh	1.5 ha	798	V	Lairembi	Lai-Harouba	May	Meitei	High
50	Kakwa Lairembi Ema Ereima	4 km	Kakwa Asem Leikai	Pak Shrama	0.75 ha	798	V	Ema Ereima	Lai-Harouba	May-June	Meitei	High
51	Kalika Lairembi/Khonji Mahadeva	11 km	Khongji Loukon	Seba committee member	5 ha	812	H	Kalika Lairembi	Lai-Harouba	March	Meitei	Negligible
52	Kangabam Yumjao Lairembi	2 km	Keisampat Kangabam Leikai	K.Brojen Singh	7.43 sq.m	712	V	Yumjao Lairembi, Nongdon Lairembi	Lai-Harouba	June-July	Meitei	High
53	Keisam Yumjao Lairembi	1.5 km	Keisampat	Head of the community	0.1ha	710	V	Yumjao Lairembi	Lai-Harouba	October	Meitei	High
54	Khoimom Lairembi	8 km	Luker Mamang Leikai	Wangkhem Sanu Singh	1.2 ha	801	V	Khoimom Lairembi	Lai-Harouba	June	Meitei	Low
55	Khuman Ningthou Pakhangba	4.5 km	Patsoi Part –I	Mutum Megaraj Singh	0.2 ha	795	V	Khuman Ningthou Pakhangba, Ema Malem Leisana	Lai-Harouba	June -July	Meitei	Low
56	Khunjao Lairembi	11 km	Malom Tulihal	Ngarangbam Ebochou Singh	0.2 ha	782	V	Khunjao Lairembi	Lai-Harouba	June	Meitei	Low
57	Khurai Lai Awangba	4 km	Khurai	Napey	0.54 ha	693	V	Lai Awangba	Lai-Harouba	June (Enga mangani panba)	Meitei	Negligible
58	Khurai Lai Khurembi	4 km	Khurai Sajor Leikai	People's of Kongpal	399.48 sq.m	763	V	Lai Khurembi	Lai-Harouiba	June-July	Meitei	Low
59	Khurai Ningthoubung Puri Puraba	4 km	Khurai Ningthoubung Leikai	Waikhom Nongyai	609.44 sq.m	695	V	Lai Puri Puraba	Lai Chaklong Katpa	March	Meitei.	Low
60	Khurai Puthiba	4 km	Khurai Lamlong	Puthem Manibabu	0.43 ha	766	V	Lai Puthiba	Lai-Harouba	June	Meitei.	High
61	Khurai Yumjao Lairenbi	4 km	Khurai	Tourem Jatrashing	929.03 sq.m	698	V	Yumjao Lairembi	Lai-Harouba	April (Nongma panba)	Meitei	Low
62	Kongpal Nongmai Leima	6 km	Kongpal	Noglekpam Sanapati Singh	0.14ha	695	V	Nongmaileima	Lai-Harouba	May	Meitei	Low
63	Kongpal Puri Puraba	6 km	Kongpal	Lukham Ebotomba Singh	595.32 sq.m	695	V	Puri Puraba	Lai-Harouba	May	Meitei	Low
64	Konjeng Lairembi	6 km	Konjeng Leikai	K. Gourashamba	0.16 ha	718	V	Ema Hourok Konthourembi	Lai-Harouba	June	Meitei (Konjeng -bam clan)	High
65	Konkham Loiyarakpa	15 km	Nambol konkham Leikai	Th. Maipak Singh	0.3 ha	727	V	Konkham Loiyarakpa	Lai-Harouba	April-May	Meitei	High

66	Konthoujam Lairenbi	11 km	Konthoujam	N. Sajoubi Singh	1.41 ha	691	V	Konthoujam Lairenbi	Lai-Harouba	April-May	Meitei	Negligible
67	Konung lairembi/ Ebudhu Laisana Yumjao Lairembi	29 km	C I college, Bishempur	Konung Lairembi Dev. and wild life protection committee	0.5 ha	888	HL	Konung lairembi/ Ebudhu Laisana Yumjao Lairembi	Lai-Harouba	April	Meitei	Low
68	Koubru	15 km	Phayeng	Angom Chandop Singh	40 ha	858	H	Koubru, Kounu, Loyarakpa, Nungthel Leima	Lai-Harouba	Oct-Nov	Chakpa	Negligible
69	Koubru	11 km	Lairelkabi Mamang Leikai	Chongtham Bari Singh	0.2 ha	832	V	Koubru	Lai-Harouba	March	Meitei	Low
70	Koubru	10 km	Heibongkokpi	Nourem Babu Singh	37.16 sq. m	812	V	Koubru	Lai-Harouba	March	Meitei	Low
71	Koubru	11 km	Lambal	–	1.5 ha	822	V	Koubru	Lai-Harouba	March	Meitei	Medium
72	Koubru	10 km	Tera Urak	Th. Tombi Singh	300 sq.m	817	V	Koubru	Lai-Harouba	March	Meitei	High
73	Lai Eshing Chaibi Laisenba		Nagamapal Market	P. Achouba Singh	676.01 sq.m	710	V	Lai Eshing Chaiba Lairenba	Lai-Harouba	May	Meitei	High
74	Lai Khurembi	10 km	Lamdeng Makha Leikai	Konjengbam Achou Singh	0.2 ha	824	F	Lai khurembi	Lai-Harouba	March	Meitei	Low
75	Laijing Ningthou	3 km	Thangmeiband Lairenhanjaba Leikai	Secretary of Laiharouba commette	4.45 sq.m	763	V	Laijing Ningthou	Lai-Harouba	May	Meitei	High
76	Lainingthou Ahanba	4 km	Khurai	Secretary of Lai-Harouba Committee	0.22 ha	694	V	Lai Ahanba	Lai-Harouba	May	Meitei.	High
77	Lainingthou Amudon	2 km	Amudon	T.Kunjabihari	737.46 sq.m	766	V	Lainingthou Amudon	Lai-Harouba	April-May	Meitei	High
78	Lainingthou Khamlangba	2 km	Uripok	H. Singhajit Singh	503.93 sq.m	710	V	Lainingthou Khamlangba	Lai-Harouba	April-May	Meitei	High
79	Lainingthou Khoiriphaba	11 km	Nambol	M. Ritichandra Meitei	10 ha	748	HL	Lainingthou Khoiriphaba	Lai-Harouba	April-May	Meitei	Low
80	Lainingthou Khoubomba	8 km	Changangngei Mamang leikai	N. Amou Meitei	444.53 sq.m	775	V	Lainingthou Khu-bomba, Tampha Lairembi, Khombuleima	Lai-Harouba	April–May	Meitei	Low
81	Lainingthou Liesing Chaibi	7 km	Lamsang Mayang Leikai	Thangjam Ibohal Singh	0.5 ha	778	V	Lai Esing Chaibi	Lai-Harouba	May-June	Meitei	Medium
82	Lainingthou Nongpok Ning-thou Panthoibi	7 km	Sekta	Erangbam Yaiskul Meitei	0.15 ha	763	V	Lainingthou Nongpok Ning-thou Panthoibi	Lai-Harouba	Hiyangei	Meitei	Negilgible
83	Lainingthou Nouthingkhong Lairembi Petanga Tamphaton, (Lai Khurembi).	2 km	Uripok	K. Guramani Singh	0.14 ha	712	V	Laikhurembi	Lai-Harouba	May	Meitei.	High

84	Laningthou Pureiromba	13 km	Lamlai	Ngangom Lokhon Meitei	0.28 ha	694	V	Laningthou Pureiromba	Lai-Harouba	March	Meitei.	Negligible
85	Laningthou Puthiba	4.5 km	Awang Khunou	Pukhrambam Budi Singh	742.22 sq.m	805	V	Laningthou Puthiba	Lai-Harouba	June	Meitei	Low
86	Laningthou Sanamahi	15 km	Wangoi	W. Ebochouba Singh and W. Pishak	0.76 ha	700	V	Laningthou Sanamahi, Khagemba, Nungburembi, Nungburemba, Thawai Yaibirembi	Lai-Harouba	April-May	Meitei	Medium
87	Laningthou Sorarel	13 km	Kodompokpi Mamang Leikai	Th. Jugeshwor Singh	18.58 sq. m	771	V	Laningthou Sorarel	Lai-Harouba	June	Meitei	Low
88	Lairembi	14 km	Khabi Mayai leikai	S. Kulabi Singh	0.2 ha	714	V	Lairembi	Lai-Harouba	April-May	Meitei	Medium
89	Laisana Pakhangba	31 km	Toupokpi Mamang Leikai	L.Ningthemjao Singh	768.19 sq. m	720	V	Laisana Pakhangba	Lai-Harouba	May	Meitei	Medium
90	Laishram Lairembi	4 km	Kwakeithel Laishram Leikai	Laishram Bihari Singh	445.93 sq.m	793	V	Laishram Lairembi	Lai-Harouba	April	Meitei	High
91	Laishram Yumjao Lairembi	3.5 km	Wangkhi Laishram Leikai	Laishram Mani Singh	0.2ha	778	V	Yumjao Lairembi	Lai-Harouba	March	Meitei	High
92	Langol Lairembi	8 km	Langol Housing Complex	A. Heirangou Singh	1 ha	800	F	Langol Lairembi	Lai-Harouba	May	Meitei	Low
93	Langthabal Laningthou Puthiba	8 km	Langthabal	K.Yaima	325.16 sq.m	764	V	Laningthou Puthiba	Lai-Harouba	Feb	Meitei	Medium
94	Langol Thongak Lairembi	5 km	Langol	W. Boro Meitei	5.05 ha	800	H	Langol Ashithel Ema Thongak Lairembi	Lai-Chaklong Katpa	Jan	Meitei	Low
95	Langthabal Kamakhya Mandir	8 km	Langthabal	Arangbam Thabalngou	0.24 ha	798	V	Druga	Lai-Harouba	March	Meitei	Medium
96	Leisangthem Lairembi	4 km	Leisangthem Leikai, Singjamei	L.Joy Singh	0.5 ha	786	V	Leisangthem Lairembi	Lai-chaklong katpa	March	Meitei	High
97	Loiyarakpa (Lanjing Thouba) Ningthemleima	6.5 km	Tabungkhog Makha Leikai	Asem Lakshman Singh	11.14 sq.m	776	V	Loiyarakpa Ningthemleima	Lai-Harouba	April-May	Meitei	Low
98	Mahabali (Mongba Hanba)	0.5 km	Imphal	Bashapati Biramagol Sharma, Bashaspati Gynashor Shrama	5.05 ha	710	C	Hanumanji	Hindu festival	All time	Hindu	Low
99	Maklang Nungthel Leima	16 km	Maklang	Commette president for the tenure of 1 year	0.4 ha	768	V	Nungthel Leima	Lai-Harouba	March	Meitei	Low

100	Mayang Ngamba /Loiyarakpa	27 km	Bishnupur makha Leikai	Th. Birahari Meitei	0.2 ha	854	V	Mayang ngamba /Loiyarakpa	Lai-Harouba	May-June	Meitei	Low
101	Mayokpha	2 km	Keisamthong	Elangbam Ibohal Singh	250.84 sq.m	712	V	Mayokpha	Lai-Puja	All time	Meitei	Negligible
102	Moirang Hanuba Epu	4 km	Takyel	–	163.88 sq.m	693	V	Moirang Hanuba Epu	Lai-Harouba	April-May	Meitei	Low
103	Moirang pokpa Ebudhou	3 km	Thangmeiband Polem leikai	Eldest man of Lairenlakpam clan	368.73 sq.m	763	V	Moirang Pokpa Eputhou	Lai-chaklong katpa	June	Meitei	High
104	Moirangpokpa, Moirangpokpi Macha Ebungo, Manou Ebema	7 km	Yurembam Mayai Leikai	Khuraijam Budhi Singh	0.4 ha	807	V	Moirangpokpa, Moirangpokpi Macha Ebungo, Manou Ebema	Lai-Harouba	April	Meitei	Medium
105	Mongba Hanba	16 km	Wangoi	–	37.16 sq.m	700	V	Mongba Hanba	Lai Chaklong Katpa	Jan (Emoinu Numit)	Meitei	Medium
106	Mongsangei Ebudhou Panganba	6 km	Mongsangei Ningthemjao Karong	Koijam Chandra Singh	706.53 sq.m	705	V	Ebodhou Panganba	Lai Chaklong Katpa	March.	Meitei.	Medium
107	Ngarangbam Loiyarakpa	14 km	Ngarangbam Makha Leikai	Khundrakpam Shelung Singh	0.1 ha	756	V	Loiyarakpa	Lai-Harouba	March	Meitei	Medium
108	Ngarangbam Pakhangba	14 km	Ngarangbam Maning Leikai	Kayenpaibam Tomba Singh	0.4 ha	758	V	Pakhangba	Lai-Harouba	May	Meitei	Medium
109	Ningthoukhong Oknarel Macha Ebemma	32 km	Ningthourel Oknarel Leikai	M. Joy Singh	0.27 ha	722	V	Ningthoukhong Oknarel Macha Ebemma	Lai-Harouba	April- May	Meitei	Low
110	Nongaren /Nongngaleima	29 km	Kha potsangbam, Mayai Leikai	P. Damu Singh	627.11 sq.m	719	V	Nongaren/Nongngaleima	Lai-Harouba	May	Meitei	Low
111	Nongdon Lairembi Pakhangba	11 km	Utlou Mamang Leikai	W. Angou Singh	0.2 ha	766	V	Nongdon Lairembi Pakhangba	Lai-Harouba	March	Meitei	Medium
112	Nongmailembi Leima	4 km	Top Awang Leikai	Thingbaijam Achouba Singh	0.75 ha	808	V	Nongmailembi Leima	Lai chaklong katpa	Janunary	Meitei	High
113	Nongpok Ningthou Panthoibi	9 km	Khumbong Awang Leikai	Oinam Nilakanta Singh	0.4ha	756	C	Nongpok Ningthou Panthoibi	Lai-Harouba	April	Meitei	Low
114	Nongpok Panthoibi	2 km	Nourem Leikai, Awang	Laishram Merashing	696.77 sq.m	710	V	Panthoibi	Lai-Harouba	Not fixed.	Meitei	High
115	Nongpok Panthoibi	5 km	Kongba Nongthongbam Leikai	Ngariyambam Rajani Singh	250.73 Sq.m.	783	V	Nongpok Panthoibi	Lai-Harouba	March	Meitei	Low
116	Nongpok Panthoibi	5 km	Kongba Khunou Leikai	Seba committee member	0.1 ha	813	V	Nongpok Panthoibi	Lai-Harouba	March	Meitei	Low
117	Nongshaba Yaiskul	4 km	Yaiskul	Yunam Paba Singh	232.26 sq.m	715	V	Nongsaba	Lai-puja	All time	Meitei	High

118	Nouhal Lai	45 km	Kakching	Naorem Manibabu	962.8 sq.m	812	V	Nouhal Lai	Lai-Harouba	April-May	Meitei	Low
119	Nouthingkhong Pakhangba	11 km	Patsoi Awang Leikai	Mayenbam Mani Singh	0.37ha	700	V	Pakhangba	Lai-Harouba	April-May	Meitei	Medium
120	Nouthingkhong Pakhangba	4 km	Khongman Ketanapanung	Kangoujam Rupachandra Singh	0.14ha	709	V	Nouthingkhong Pakhangba	Lai-Harouba	March-April	Meitei, (Kangou-jam clan)	Medium
121	Nouthingkhong Pakhangba	5 km	Patsoi Part –IV	Mayenbam Mani Singh	1 ha	793	V	Nouthingkhong Pakhangba	Lai-Harouba	June -July	Meitei	High
122	Nungthel Leima	5.5 km	Tabungkhok Mayai Leikai	Thiyam Angou Singh	0.1 ha	775	V	Nungthel Leima	Lai-Harouba	April-May	Meitei	Low
123	Oknarel Khubam Yaba	34 km	Ningthoukhong Mamang leikai	K. Tombinou Singh	0.4 ha	727	V	Okanarel	Lai-harouba	April-May	Meitei	Low
124	Panganba	7 km	Bamol kapu Maning Leikai	Seba committee member	0.5 ha	812	V	Panganba	Lai-chaklong katpa	June	Meitei	Medium
125	Panganba	32 km	Ningthoukhong Mayai leikai	K. Kabochouba Singh	0.1 ha	725	V	Panganba	Lai-harouba	April-May	Meitei	High
126	Panthoibi	5 km	Kongba Khetri Leikai	Pongombam Nilachandra Singh	385.12 sq.m	782	V	Panthoibi	Lai-Harouba	March	Meitei	Medium
127	Panthoibi, Nongpok Ningthou	12 km	Utlou Mayai Leikai	Th. Mohon singh	0.2 ha	763	V	Panthoibi, Nongpok Ningthou	Lai-harouba	March	Meitei	Medium
128	Pathabi Ema Lairembi	36 km	Khoijuman Ward no. 3	W. Heramok Singh	0.25 ha	739	V	Pathabi Ema Lairembi	Lai-Harouba	March	Meitei	High
129	Phoijing Chaning Lairembi	17 km	Nambol, Phoijing	Kh. Chandramani Singh	12.75 ha	716	HL	Phoijing Chaning Lairembi, Channing Leima	Lai-Harouba	June-July	Meitei	Medium
130	Phouoibi	5 km	Shorok khaiban Leikai, Singjamei	Oldest man of Sorok khaibam clan	0.5 ha	767	V	Phouoibi	Lai-Harouba	May-June	Meitei (Sorok khaibam clan)	High
131	Pureiromba	9 km	Bamol kapu makha Leikai	Seba committee member	0.4 ha	812	V	Pureiromba	Lai-chaklong katpa	March	Meitei	Low
132	Pureiromba	9 km	Bamol kapu Awang Leikai	Secretary Pureiromba Youth club	0.1 ha	812	V	Pureiromba	Lai-Harouba	March	Meitei	Low
133	Pureironlaba and Chingsomba	27 km	Andro	Sarungbam Kula Singh	0.1 ha	–	C	Pureiromlaba	Lai-Harouba	June	Chakpa	Negligible
134	Puthiba	12 km	Touthong, Mamang Leikai	Usham Samu Singh	0.5 ha	798	V	Puthiba	Lai-Harouba	March	Meitei	Medium
135	Sagoltongba Ningthempokpa	11 km	Sagoltongba	Khwairakpam Mani Singh	1.03 ha	691	V	Ningthempokpa	Lai-Harouba	April-May	Meitei.	High
136	Sairelkhil Koubru	13 km	Shairelkhul	Konjengbam Devan Singh	0.5 ha	798	V	Koubru, Tonu, Loiyarakpa	Lai-Harouba	March	Chakpa	Low
137	Salam Sorarel	7 km	Salam Mayai Leikai	Laishangbam Mekhu Singh	921.83 sq.m	796	V	Sorarel	Lai-Harouba	March	Meitei	Low

138	Sawongbung Lairenbi	11 km	Sawongbung	Konjenbam Bikan Singh	209.03 sq.m	761	V	Sawongbung Lairenbi	Lai-Harouba	April-May	Meitei	High
139	Sayang Ningthou	3 km	Sayang Pukhri Mapan	Soraisam Thambalmanbi Devi	196.65 sq.m	785	V	Saynag Ningthopu	Lai-Harouba	June	Meitei	High
140	Sekmai Koubru	18 km	Awang Sekmai	Leishangbam Lokhon Singh	1.21 ha	770	V	Koubrou	Lai-Harouba	April-May	Meitei	Medium
141	Sekmai Ningthou Kakching	46 km	Kakching Moiran-gthem Leikai	Ksh. Ebecha Devi	0.2 ha	821	C	Sekmai Ningthou Kakching	Lai-Harouba	April-May	Meitei	Low
142	Sekmai Wangbarel	18 km	Awang Sekmai	Tourem Jatra Singh	0.25 ha	772	V	Wangbarel	–	–	Meitei	Low
143	Sorarel	29 km	Toubul bazaar	Y. Babudon Singh	0.2 ha	739	V	Sorarel	Lai-chaklong katpa	April	Meitei	High
144	Soubam (Mawam) Lairembi	3 km	Thangmeiband Hijam Diwan Leikai	Soubam damu Singh	696.77 sq. m	763	V	Soubam Lairembi	Lai-chaklong katpa	June	Meitei	Medium
145	Sugunu Lokningthou	126 km	Sugunu	–	696.77 sq.m	793	F	Lokningthou	Lai-Harouba	Nov.- Dec.	Meitei	Negligible
146	Sugunu Sanamahi	126 km	Sugunu	–	696.77 sq.m	793	F	Sanamahi	Lai-Harouba	Feb.	Meitei	Negligible
147	Sugunu Wangbarel	126 km	Sugunu	–	696.77 sq.m	793	F	Wangbarel	Lai-Harouba	May	Meitei	Negligible
148	Tairel Pokpi Koubru	14 km	Tairel pokpi	Village head man	1.5 ha	798	V	Koubru, Koumu	Lai-Harouba	March	Chakpa	Medium
149	Tamphaton Lairembi	4 km	Kwakeithel Lourembam Leikai	Oldest male of Louremban clan	0.1 ha	714	V.	Nungthel Leima	Lai-Harouba	June	Meitei (Lourem-ban clan)	High
150	Thanagrel	32 km	Kha Khunou	N. Hera Singh	0.25 ha	727	V	Thanagrel	Lai-Harouba	April-May	Meitei	Medium
151	Tharoijam Yumjao Lairenbi	7.5 km	Tharoijam	Tharoijam Kumar Singh	983.28 sq.m	796	V	Yumjao Lairenbi	Lai-Harouba	March	Meitei	Medium
152	Thoidingjam Lairembi	4 km	Lamlong	Th. Gugimohon Singh	348.39 sq.m	763	V	Thoidingjam Lairembi	Apokpa Lai katpa	May (Nini Panba)	Meitei (Thoiding -jam clan)	High
153	Thonang Panganba Lai Manou, Mayamba	29 km	Kha Potsangbam Mamang Leikai	Oinam Nupamacha Singh	0.4 ha	712	V	Thonang Panganba Lai manou, Mayamba	Lai-Harouba	May	Meitei	High
154	Thongmacha Macha Leihounu Lairembi	3 km	Sagolband Thangjam Leirak	Yangabam Jugeshor Singh	0.2 ha	756	V	Thongngak Macha Leihounu Lairembi	Laimang phamba	March	Meitei	High
155	Thonju Rakpa	8 km	Thongju part-11	–	0.33 ha	712	V	Thongju Rakpa	Lai-Harouba	Sajibu nongma panba	Meitei	High
156	Tokpa Pung Lainingthou	1.5 km	Thangmeiband D.M. College	A .Heirangngou Singh	37.16 sq.m	710	V	Tokpa Pung Lainingthou	Lai-Puja	All time	Meitei	Low

157	Tubileima	5 km	Tabungkhok Awang Leikai	Akoijam Kuber Singh	0.1 ha	775	V	Tubileima	–	–	Meitei	Medium
158	Uchekon Moriba	6 km	Uchekon	Nupamacha Nongkhom	0.5 ha	814	V	Moriba	Lai-Harouba	July	Meitei	High
159	Wangbarel	5 km	Kongba Nandeibam Leikai	Seba committee member	0.5 ha	812	V	Wangbarel	Lai-Harouba	June	Meitei	High
160	Wangkhei Loumanbi (Nongpok Panthoibi)	5 km	Wangkhei Loumangbi Leikai	O. Manglem Meitei	696.77 sq.m	710	V	Nongpok Panthoibi	Lai- Chaklong Katpa.	March	Meitei	High
161	Wangoi Wangbarel	16 km	Wangoi	–	929.03 sq.m	700	V	Wangbarel	Lai thong-hangba	Jan (Emoinu)	Meitei	Medium
162	Yangoi Ningthou	27 km	Bishempur Joypur khunou, Awang	Khaidem Ibomcha singh	0.81 ha	700	F	Yangoi Ningthou	Lai-Harouba	May	Meitei	Low
163	Yangoi Ningthou	32 km	Thangtek	M. Kula Singh	26.01 sq.m	713	V	Yangoi Ningthou	Lai-Harouba	May	Meitei	Low
164	Yangoi Ningthou	34 km	Khoijuman Ward no. 2	S. Budhi Singh	0.2 ha	739	V	Khoijuman Yangoi Ningthou	Lai-Harouba	April-May	Meitei	Medium
165	Yangoi Ningthou	30 km	Toubul Mayai Leikai	L. Ibohanbi Singh	0.33 ha	739	V	Yangoi ningthou	Lai-Harouba	May	Meitei	High
166	Yangoi Ningthou Lainingthou	4 km	Khurai Kongpal	Kongjenbam Ebochouba	0.2 ha	695	V	Yangoi Ningthou Lainingthou	Lai-Harouba	April-May	Meitei	High

C - Near catchment area or river bank, F - Foothill, H - Hill, HL - Hillock and V - Valley.

rare and endemic plant and animal species. However, due to various disturbances only a few (11%) of the groves are well preserved and are helpful in maintaining the ecological balance, while most of them are partly threatened (58%) and threatened (31%). The inventory is still rather incomplete and further inventory of such information from other groves is required.

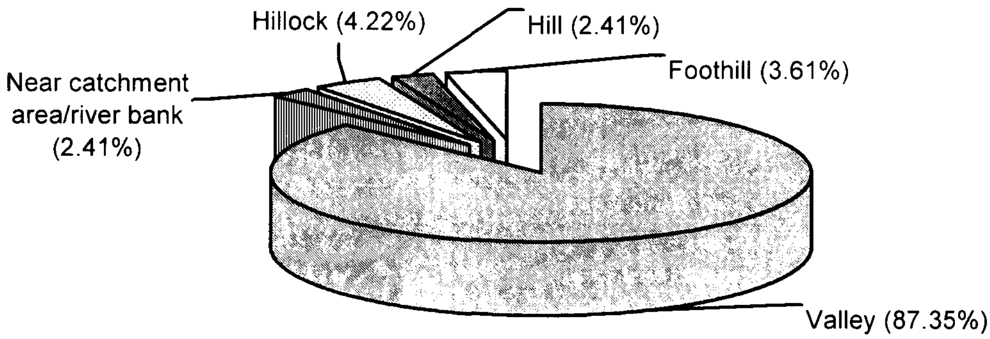

Figure II. 1. Distribution of sacred groves in the four districts of Manipur.

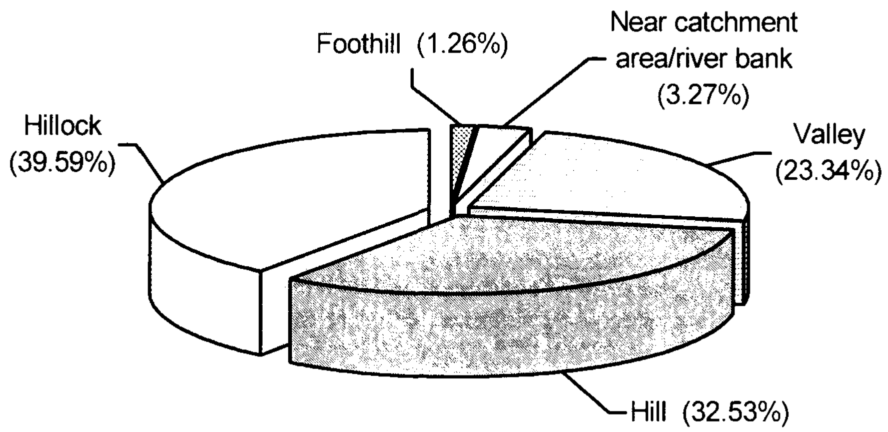

Figure II. 2. Area (%) of sacred groves present in different locations.

Nevertheless, the collected information can present an overview of the sacred groves in Manipur (Figure II. 3). Thirty seven groves are distributed in Imphal East, 99 in Imphal West, 22 in Bishnupur and 8 in Thoubal districts. Sacred groves located within the Imphal city are highly degraded and the areas of the groves are shrinking due to encroachment by the people living nearby the grove and due to governmental activities. The fate of the groves present along road sides is pitiable. They are always vulnerable to road expansion and other developmental pressure. Fortunately, those groves that exist in the suburban and village/remote areas are in better condition as compared to those located in the urban areas. However, the sacred groves that exit in the inaccessible areas are well protected. Though there are intrusions in the sacred groves that are not so difficult to access, such groves are only mildly disturbed and can recover from that level of disturbances if the utilization of resources is regulated by the people themselves.

People fear to enter the sacred groves and no one is permitted to cut down any plants, and it is supposed to be everyone's duty to protect the sacred groves situated in his surrounding. There are a number of groves in the valley, where trees like *Ficus religiosa, Ficus benghalensis* etc. are commonly found. In Konthoujam Lairembi sacred grove, 11 *Ficus* trees were connected to each other giving a specific structure in the grove, which has some myth behind it. The ficus trees support various kinds of animals including birds and innumerable invertebrate species. Lai Awangba sacred grove at Khurai Imphal, situated at the side of the road, has contributed a great deal to the conservation of natural and planted trees. Some of the

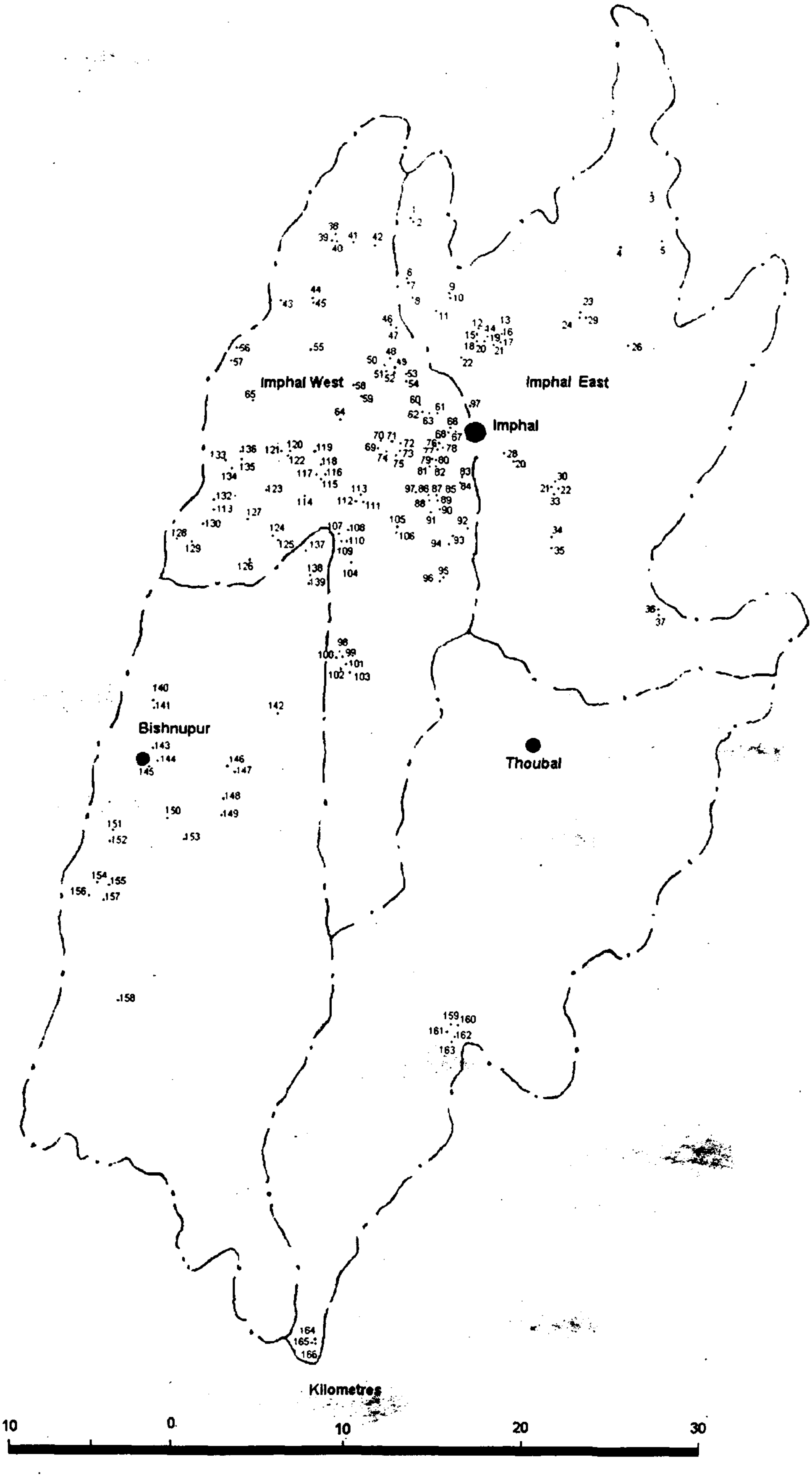
Imphal West
Imphal East
Imphal
Bishnupur
Thoubal
Kilometres
10
0
10
20
30

Figure II. 3. Geographical map of Manipur valley (Imphal East, Imphal West, Bishnupur and Thoubal) of Manipur showing 166 sacred groves.

Imphal East:1. *Sekmai Koubru*, 2. *Sekmai Wangbarel*, 3. *Lainingthou Nongpok Ningthou Panthoibi* (Sekta), 4. Sawoungbung Lairembi, 5. Lainingthou Pureiromba (Lamlai), 6.Ebudhou Marjing (Achanbikei), 7. Ebudhou Marjing (Khabam), 8. Ebudhou Marjing (Ahallup), 9. Ebudhou Marjing (Heingang), 10. Ebudhou Marjing (Heingang Mayai Leikai), 11. Ebudhou Marjing (Kairang), 12. Lainingthou Ahanba, 13. Kongpal Puri Puraba, 14. Khurai Yumjao Lairembi, 15. Khurai Lai Khurembi, 16. Kongpal Nongmaileima, 17.Nongmai Lembi Leima, 18. Khurai Lai Awangba, 19. Khurai Puthiba, 20.Yangoi Ningthou Lainingthou (Khurai Kongpal), 21. Khurai Ningthoubung Puri Puraba, 22. Thoidingjam Lairembi, 23. Pureiromba (Bamol kapu makha), 24. Panganba, 25. Pureiromba (Bamol kapu awang), 26. Kalika Lairembi, 27. Mahabali, 28. Wangkhi Loumanbi (Nongpok Ningthou), 29. Laishram Yumjao Lairembi. 30. Wangbarel (Kongba), 31. Nongpok Ningthou (Kongba Nongthombam leikai), 32. Nongpok Ningthou (Kongba Khunou leikai), 33. Panthoibi (Kongba Khetri Leikai), 34. Ebudhou Pakhangba Puruk Shoubi, 35. Uchekon Moriba, 36. Chakpa Panam Ningthou and 37. Pureiromba, Chingsoiba **Imphal West:** 38. Heirang Khonung Lairembi, 39. Koubru (Tera Urak), 40. *Puthiba (Touthang)*, 41. *Koubru (Lambal)*, 42. *Lai Khurembi (Lamdeng)*, 43. *Koubru (Phayeng)*, 44. Koubru (Lairel Kabi), 45. Koubru (Heibong Pokpi), 46. Ebudhou Marjing (Lai Phamkhunou), 47. Chinggoi Ningthou, 48. Soubam (Mawam) Lairembi, 49. Ema Nongaliema, 50. Moirang Pokap Ebudhou, 51. Ebudhou Nouthingkhong Pakhangba, 52. Laijing Ningthou, 53. Ema Konthokhanbi, 54. Tokpa Pung Lainingthou, 55. Lainingthou Lai Eshing Chaibi, 56.Koubru (Tairel Pokpi), 57. Koubru (Sairel Khul), 58. Langol Lairembi, 59. Ema Thongak Lairembi, 60. Arai Leima, 61. Lai Esing Chaibi Laisemba, 62. Lai Khurembi (Uripok), 63. Lainingthou Khamlangba (Uripok), 64. Ema Ebemma Leihounu Thongak Lairembi (Eroisemba), 65. Nungthel Leima (Maklang), 66. Keisam Yumjao Lairembi, 67. Kangabam Yumjao Lairembi, 68. Laishram Lairembi, 69. Moirang Hanuba Epu, 70. Ema Wangdombi Pung, 71. Lainingthou Amudon, 72. Thongak Macha Leihounu Lairembi (Thangjam Leirak), 73. Sayang Ningthou, 74. Ebudhou Khamlangba (Mayai koibi), 75. Ebudhou Khamlangba (Sapam Leiak), 76. Eputhou Nongsaba, 77. Tamphatom Lairembi, 78. Ema Lai Khurembi (Houbam Marak), 79. Huidrom Lairembi, 80 Mayokpha, 81. Hodam Lairembi, 82. Heisnam Panthoibi, 83. Nongsaba Yaiskul, 84. Erom Lairembi (Chingnga Makha), 85. Chingnga Mathak Ema Lairembi, 86. Ebudhou Moirang Kacha, 87. Ereima Khanachouba, 88. Leisangthem Lairembi, 89. Kakwa Lairembi, 90. Kakwa Lairembi Ema Ereima, 91. Phouoibi, 92. Nouthingkhong Pakhangba, 93. Thongju Rakpa, 94. Nongpok Panthoibi (Nourem leikai), 95. Langthabal Kamakhya, 96. Langthabal Lainingthou Puthiba, 97. Erom Laishram Laireima, 98. Ebudhou Pakhangba (Wangoi), 99. Lainingthou Sanamahi (Wangoi), 100.Mongba Hanba (Wangoi), 101.Emoinu (Wangoi), 102. Ebudhou Sankardeva, 103. Wangbarel (Wangoi), 104. Khunjao Lairembi, 105. Kongjeng lairembi, 106. Mongsangei Ebudhou Pakhangba, 107. Panthoibi, Nongpok Ningthou (Utlou), 108. Chabungbam Lairembi Laishna, 109. Nongdon Lairembi Pakhanagba, 110. Lainignthou Sorarel, 111. Nungthel Leima, 112. Tubileima, 113. Loiyarakpa (Ningthoukhong), 114. Lainingthou Khoiriphaba, 115. Ebudhou nongda Lairen pakhangba, 116. Ema Panthoibi Lairembi (Patsoi), 117. Khuman Ningthou Pakhangba, 118. Nouthingkhong Pakhangba (Patsoi-IV), 119. Nouthingkhong Pakhangba (Patsoi Awang leikai), 120. Epa Sorarel, Khoiriphaba, 121. Moirangpokpa, Moirangpokpi, macha Ebungo, Manou Ebemma, 122. Huidompokpi Tarang Apamba, 123. Sagoltongba Ningthem Pokpa, 124. Chumthang Lairembi Manou, 125. Chumthang Lairembi Mache, 126. Lairembi (Khabi), 127. Konthoujam lairembi, 128. Ebenthou Makubi Ching, 129. Ebudhou Khoiriphaba, 130. Nongpok Ningthou Panthoibi (Khumbong), 131. Ngarangbam Loiyarakpa, 132. Ngarangbam Pakhangba, 133. Khoimam Lairembi, 134. Lainingthou Puthiba (Awang Khunou), 135. Tharoijam Yumjao Lairembi and 136. Salam Epa Sorarel. **Bishnupur:** 137. Phoijing Chaning Lairembi, 138. Konkham Loiyarakpa, 139. Lainingthou Khoiriphaba (Nambol), 140. Yangoi Ningthou (Bishnupur), 141. Ebudhou Meitreng Pakhanagba, 142. Yangoi Ningthou (Thangtek), 143. Loiyarapka (Bishnupur), 144. Chothe Thawai Pakhangba, 145. Konung Lairembi, 146. Yangoi Ningthou (Toubul), 147.Epa Sorarel (Toubul), 148. Yangoi Ningthou (Khoijuman), 149. Panthoibi Ema Lairembi (Khoijuman), 150. Ebudhou Pakhangba (Kwa Siphai), 151. Thonang Panganba Lai Manou, Mayamba, 152. Nongngaliema, 153. Laisana Pakhangba, 154. Ningthoukhong Oknarel Macha Ebemma, 155. Oknarel Khubam Yaba (Ningthoukhong), 156. Thanagarel (Kha Khunou), 157. Panganba (Ningthoukhong)and 158. Ebudhou Thangjing (Moirang) **Thoubal:** 159. Nouhal Lai (Kakching), 160. Sekmai Ningthou (Kakching), 161. Erum Ningthou (Kakching), 162. Ebudhou Khamlangba (Kakching Khullen), 163. Ebudhou Khamlangba (Kakching Wairi), 164. Sugunu Wangbarel, 165. Sugunu Lokningthou and 166. Sugunu Sanamahi.

sacred groves are associated with sacred plant species and sacred ponds that are conserved as a whole. The sacred plants are having either medicinal or religious importance and are associated with cultural practices and beliefs as well as taboos. Rodgers (1994) has stressed the importance of the socially recognized plants as they are often ecologically important as well. *Terminalia arjuna (*Mayokpha) in the Mayokpha sacred grove, *Ficus religiosa* (Sana-khonang) and *Mangifera* sp. in Langol Thongak Lairembi sacred grove, *Syzygium jambos* in Konthoujam Lairembi sacred grove may be mentioned in this context. These tree species are worshipped on certain auspicious days for the welfare of the people. Moreover, deities had their favourite species which were also considered sacred. Leaves of sacred species like *Toona ciliata* (Tairel) and *Dactyloctenium aegyptium* (Pungphai) are used in many religious practices. List of sacred species along with their religious beliefs and taboos are given in table II. 2. A few of the sacred species are believed to be the incarnation of the deity. Climbing on the sacred trees, cutting, and plucking of any part of the species are strictly prohibited. If anyone wants to pluck the flower, leaves, bark, root, or any part of the sacred plant species, for the purpose of medicine or ritual practices one has to request the plant for this and offer money, flower or fruits or Paan (it consists of *Areca catechu* and *Piper betle*), *phiral* (small flag used during the worship) or in special cases, some sort of ceremony is performed by the priest (*Maiba*). It is also believed that if this normal indigenous procedure is not followed, the patient who used the plant as a medicine may face more trouble instead of the disease being cured. Sacred ponds are associated with myth and legend, and water of some

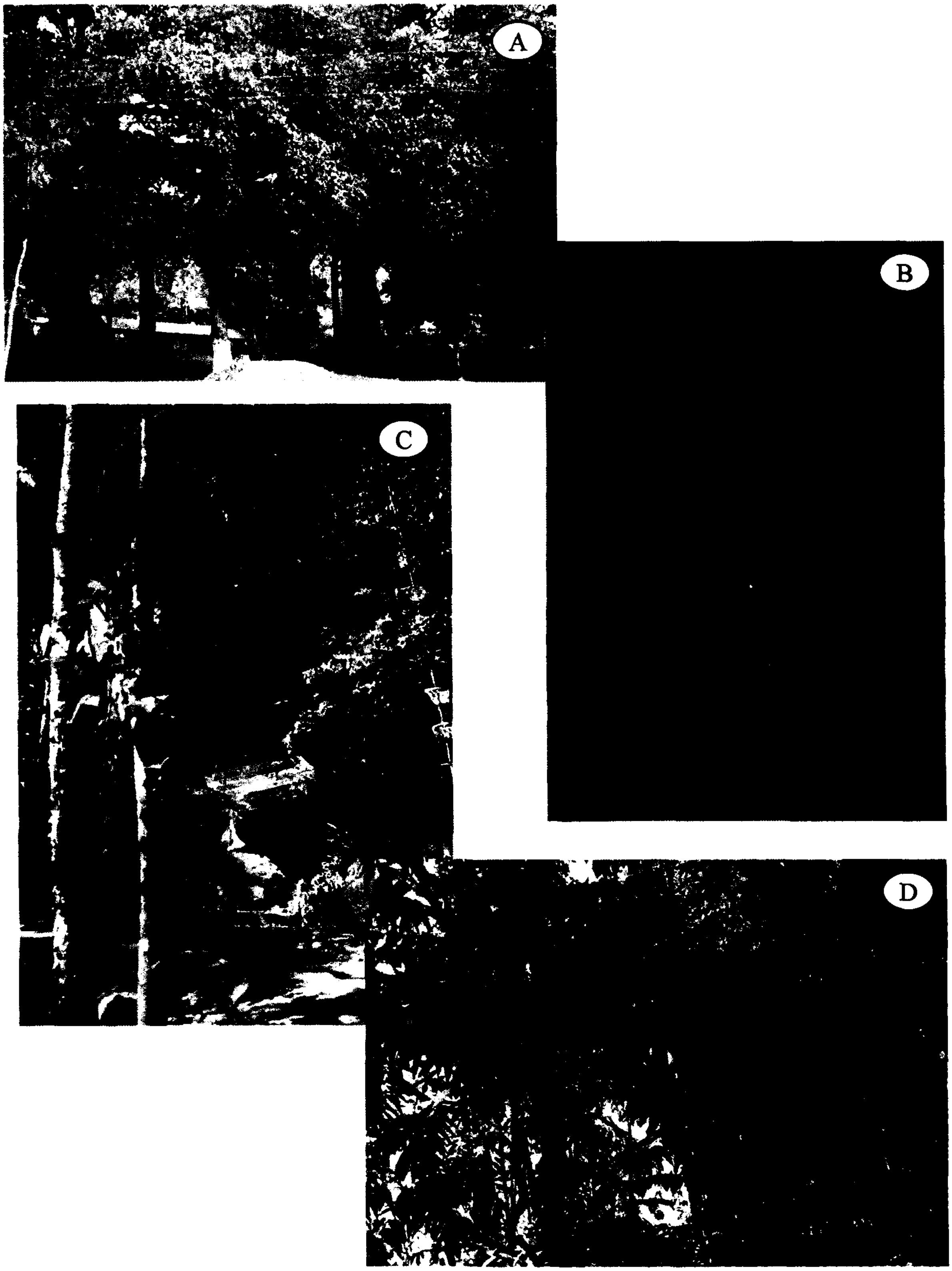

Plate 3. Sacred species and stone found in sacred groves. (A) – *Ficus* species, in Langol Ningthou sacred grove, (B) - Sacred species (*Terminalia arjuna*) having medicinal value, in Ebudhou Pakhangba Puruk Shoubi sacred grove at Uchekon, (C) – Sacred stone of Ebudhou Marjing in Heingang Marjing sacred grove, and (D) – Flowering of *Toona ciliata*, a sacred species.

of these ponds is believed to possess some remarkable qualities. Sacred pond of Ebudhou Pakhangba Puruk Shoubi at Uchekon Takhongpat Leikai is a typical example. The pond water is turbid and exuberant in many parts.

Table II. 2. Sacred plant species of Meitei community

Name of sacred plant species		Conception /beliefs or
Scientific name	Local name	uses
Artocarpus heterophyllus Lamk.	Theibong	Used in rituals
Blumea balsamifera (Linn.)D.C	Langthrei	Used in rituals and as medicine
Cudrenia nepalensis	Saitingkhang	Repel evil spirit
Cynodon dactylon Pers.	Tingthou	Used in rituals
Dactyloctenium aegyptium Beauv.	Pungphai	Used in rituals
Erythrina indica Lam.	Kurao angouba	Used in rituals
Ficus religiosa Linn.	Sanakhongang	A sacred tree
Mangifera indica Linn.	Heinou	Used in rituals
Ocimum sanctum Linn.	Tulsi	Incarnation of Brinda
Oroxylum indicum Vent.	Shamba	Associated with the mythology of Meitei legend
Plectranthus ternifolius D. Don	Khoiju	Repel evil spirit
Syzygium jambos Linn. (Alston).	Gulapjat	Sacred in Konthoujam Lairembi sacred grove; believed to be the incarnation of deity, Soraren
Terminalia arjuna (Roxb.)Weight & Arn.	Mayokpha	Sacred in Mayokpha sacred grove. Believed to be the incarnation of Ebudhou Pakhangba, a deity of Meitei community
Toona ciliata M. Roem	Tairel	Related with the existence of human life on earth and used in rituals
Xylosma longifolia Clos	Nongleisang	Used as medicine
	Yurei	Sacred tree in Channing Lairembi sacred grove

It is believed that skin disease could be cured after bathing with this pond water. Therefore, during the Lai Harouba or on any other auspicious day, people collect pond water, after performing some sort of rituals near the pond. Some of the sacred groves provide shelter to arboreal birds and mammals.

Ecological importance of sacred groves and people's attitude towards the conservation of sacred groves in Manipur

Biodiversity is the only factor that keeps the ecological phenomenon in a balanced state, which is necessary for human survival. The value of sacred groves is immense. They are of much ecological and genetical significance and also play an important role in wildlife conservation. Umanglai with unmolested vegetation harbours a number of wild plant species having great potential for economic use. Besides, several rare and threatened plant species are found here. Perhaps sacred groves could be called as the last refuge for these vulnerable species. The cultural trees like *Cassia fistula* (Choi), *Erythrina indica* (Kurao), *Toona ciliata* (Tairel), *Xylosma longifolia* (Nongleisang), *Celtis timorensis* (Heikreng), *Ficus religiosa* (Sana-khongnang), *Oroxylum indicum* (Shamba) etc. are grown naturally, and are conserved in most of the sacred groves. Medicinal plants like *Eupatorium birmaticum* (Langtheri), *Adhatoda vasica* (Nongmangkha), *Terminalia arjuna* (Mayokpha) etc. also grow in these groves. Thus sacred groves are the good source of a variety of medicinal plants, fruits, fodder, fuelwood, spices, etc. Few medicinal plants which are rare in forest, are conserved very well in some of the sacred groves e.g., *Melothria maderaspatana* (Lam thabi) in

Mahabali sacred grove. The conservation of plants in the Koubru sacred grove helps in the protection of several leopards and tigers that are threatened now-a-days. Mayokpha sacred grove at Elangbam Leikai Keisamthong is associated with the deity "Pungjao lakpa", an incarnation of "Pakhangba' (snake). Thus conservation of plants is associated with the conservation of all snakes inhabiting the area in and around this sacred grove and is given special protection and is particularly worshipped. In Konthoujam sacred grove native trees and other medicinal herb species have ever since been treasured and play a significant role in maintaining the ecological balance in that region. Langol and Heingang sacred groves have conserved the pine trees.

Sacred groves not only protect and conserve the flora but also the fauna. Animals like bees, lizards, snakes, monkeys etc. are also seen in many of the sacred groves of Manipur. Mahabali and Konung Lairembi sacred groves provide a natural shelter, and no doubt have become the last refuge in the midst of city area for arboreal birds and mammals especially monkeys and flying fox, which are conserved through traditional practices. Many of the birds are found nestling in the sacred groves. These animal species also play an important role in seed dispersal and help in regeneration of plant species. Practice of bee keeping is successful in some of the sacred groves and can be a good source of income. Besides these, sacred groves conserve the land and soil properties and contribute towards maintaining the ecological balance. Sacred groves have also helped in preserving the religious and cultural heritage of Meitei community.

The sacred groves extend all the benefits that forests offer to mankind. These are the forest patches protected by the people and for the people. If small quantities of plant resources were extracted for the medicinal use, for use as vegetables and for ritual purposes that may not be considered as destruction. Trees from the sacred grove may be cut down only for the purpose of the celebration connected with the sacred groves or for the requirement of other ritual practices. In each individual sacred grove there exists a complex inter-relationship between the indigenous cultural practices and integrity of people's knowledge, and the conservation of natural biological diversity in the region. *'Lai Harouba'*, celebrated in honour of the sylvan deities (*Umanglais*) who are believed to reside in sacred groves is still performed in every sacred grove. The rituals performed during the 'Lai Harouba' pertain to the worship of traditional deities and ancestors. The essence of the festival is to please the Lais in order to gain their favour. It is believed that according to the conduct of caring and pleasing of deities by the local people, deities protect them from sickness, harm, natural disasters, invasion by the enemies etc. (Rao 1992). A number of dances are performed in front of the ancient divinities by both men and women. The deity "Koubru" who resides on the top of Koubru hills is regarded as the head of Umanglais. In the months of May-June and Dec -Jan, Meiteis climb the hillslope the whole day to reach the hill-top, where deities' sacred place is located, for worshiping. The 'Lai Harouba' of deity-Moirang Ebudhou Thangjing, the ruling deity of Moirang is the most famous one and attracts huge crowd. It is held in the month of May. However, the greater emphasis on 'Lai Harouba' in term of cultural programme and paying less attention to the conservation aspect of the groves may cause degradation of groves.

A variety of cultural, religious, traditional beliefs and rites of ancient Manipur were associated with the love and care of wildlife contributing to their conservation. For example, a variety of fish (*Channa* sp.), cock and even bull are released on the New Year's day or any auspicious day or on the marriage day or during the 'Lai Harouba'. Recapturing of such released animals are forbidden. Various folklore and songs are sung which are related to the love and affection for wild denizens. Deep-rooted cultural beliefs restricted the use of some medicinal plants on specific days. Any bitter tasting medicinal plants or vegetables are collected before noon as the Meiteis believe that their medicinal value is lost if collected in the afternoon. If these practices are analysed scientifically, it would be clear that these beliefs, practices and taboos are not only of cultural and ritual value, they also help in the conservation of biological resources.

During the interview with the elderly people, *Maiba* (priest or local medicine-men) and others, it was clear that few decades back sacred groves that existed in the villages and even in the urban areas were much more rich in flora and fauna. All the species occurring in the sacred groves were left untouched and were conserved by the local people on the grounds of their religious and cultural beliefs. At the evening time they were able to enjoy looking at the birds flying to their homes after feeding and spending the whole day in the groves. People did not dare to pass near the groves alone or even in groups after the sunset and in certain areas even during the noon time, as the sacred groves were regarded as mysterious. But now-a-days children and youth go to the sacred groves for playing as most of the local playgrounds are encroached legally and illegally by the people and are being used for other purposes. Moreover, younger generation doesn't pay much attention to the religious and cultural beliefs associated with the sacred groves and consider them as superstition.

The mode of thinking has changed considerably, the human population pressure has increased, and various developmental activities have been taken up in the past few decades and all this has caused destruction/degradation of forests to a considerable extent and even the sacred groves have been adversely affected. Many of the sacred groves in the urban area are now highly degraded due to encroachment, destruction of vegetation and urbanization, and one can find only a few trees standing alive in the sacred groves or near the temples. Reconstruction or modernization of temples in many sacred groves along with the temple halls at the expense of vegetation of the groves has also led to their degradation to some extent.

It is amply clear that myths and beliefs associated with the sacred groves which used to be followed strictly in earlier days, have been eroded during the last few decades and the groves no longer enjoy the same status and privilege as they used to in the past. Moreover, the advent of Hinduism also contributed to the erosion of traditional beliefs of the Meiteis. Beliefs and taboo are the constructive tools for conserving the sacred groves, and erosion of beliefs and taboo has led to deterioration of groves (Vartak and Gadgil 1981). At the same time the influence of Christianity added a new dimension in religion and culture which also acted as an important factor in causing the degradation of sacred groves. One unfortunate matter that hinders the conservation of sacred grove is that the village people living nearby the sacred groves are poor and less educated. They depend on the grove to meet their vital domestic necessities, such as fuel wood, vegetables, medicinal plants etc. Totey and Verma (1996) argued that the rural poor depend upon biological resources for meeting 90% of their day-to-day needs. Therefore, until and unless viable option is provided to these people for sustaining their economic condition, any step for the conservation of the sacred groves will not be successful.

Considering the various dimensions of the sacred groves in Manipur it is clear that these pockets of forestlands are no longer free from anthropogenic pressure. However, an advantageous feature is that the human interference in these groves is fairly regulated by religious prescriptions and proscriptions.

Common taboos and beliefs associated with the sacred grove of Manipur are as follows:

* Cutting of any trees and destroying the groves are prohibited.
* Shoes and accessories of leather are not allowed at the entrance of the gate leading to the deities' temples. as these are made from animal skin and believed to be impure.
* Women are not allowed to enter the grove at certain particular place and particular time.

* It is believed that if anyone offended the entity of the grove, deities will punish by bringing illness and misfortune to him or her.
* People pray to the sacred plant species with some offerings like- Paan, flowers, fruits, coin, flag (*firal*) etc.

Description of the study site, climate and soil

Selection of sacred groves for detailed study

Among the different ethnic groups, Meitei is the dominant community of Manipur state accounting for 52% of the total population. Meiteis are the inhabitants of Manipur valley and majority of them live in the Imphal East and Imphal West districts of Manipur and they maintain most of the sacred groves of the state. Meiteis have preserved these forest patches dedicating them to the local deities. Such forest patches are conserved by the local people largely on the basis of religious beliefs and cultural practices. Villagers or the people of the locality believe that any sort of damage to sacred forest is a sin.

Based on the inventory and preliminary survey, four sacred groves were selected in Imphal East and Imphal West districts (Figure III.1) for the purpose of detailed studies on floristic composition, ethnobotany, population structure, regeneration status, phenology, growth etc. Their selection was done taking into consideration their size, vegetation and location. The selected sacred groves are: Konthoujam Lairembi, Mahabali (Mongba Hanba), Langol Thongak Lairembi and Heingang Marjing and they all have sub-tropical forests as their dominant vegetation.

The above sacred groves are situated between 23° 50′ - 25° 41′ N latitudes and 93° 2′ - 94° 47′ E longitudes. Two groves namely Konthoujam Lairembi and Mahabali, are located in valley and the other two groves (Langol

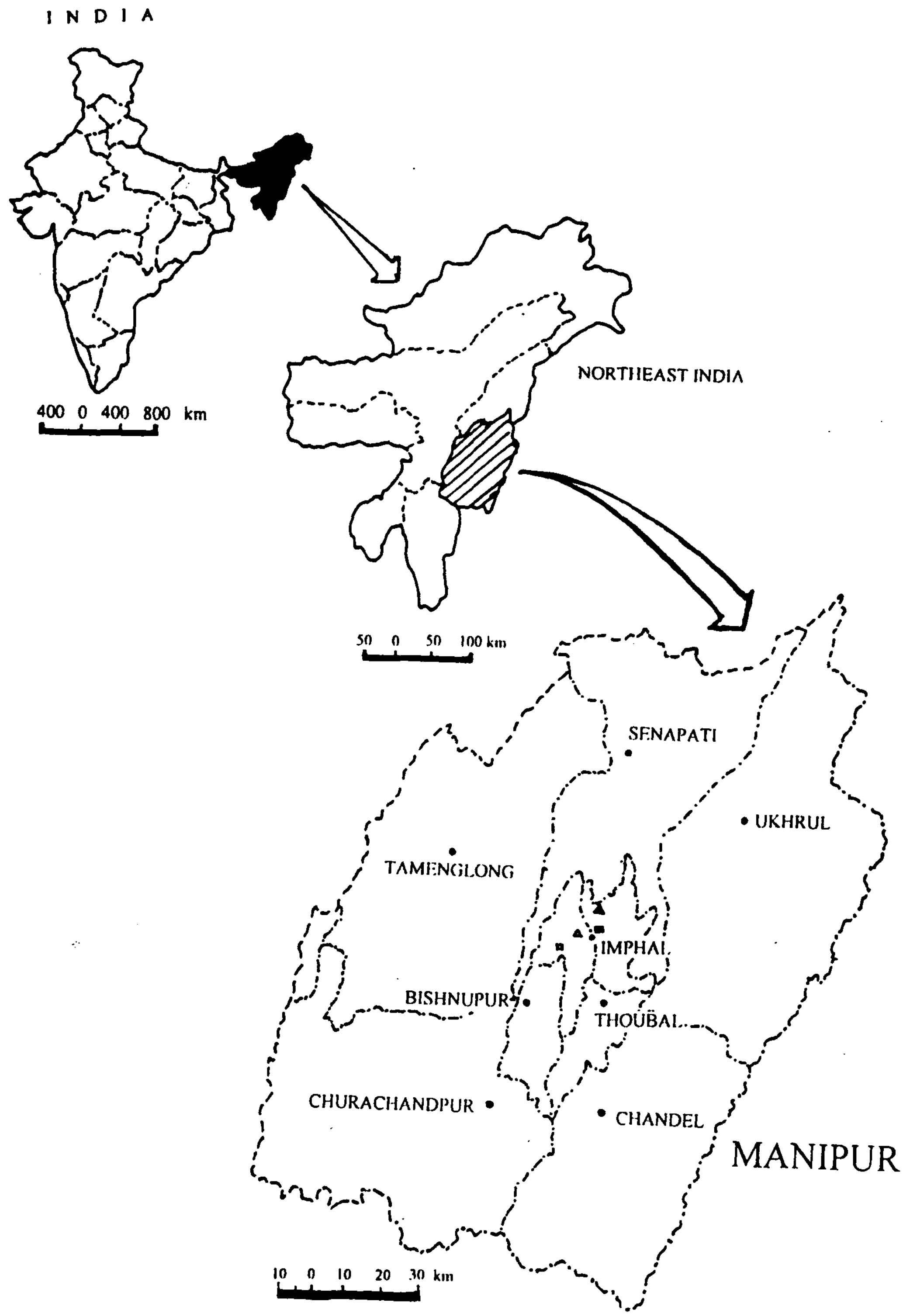

Figure III.1. Map of Manipur showing the location of four sacred groves selected for detailed study.

□ - Konthoujam Lairembi sacred grove

■ - Mahabali sacred grove

△ - Langol Thonhal lairembi sacred grove

▲ - Heingang Marjing sacred grove

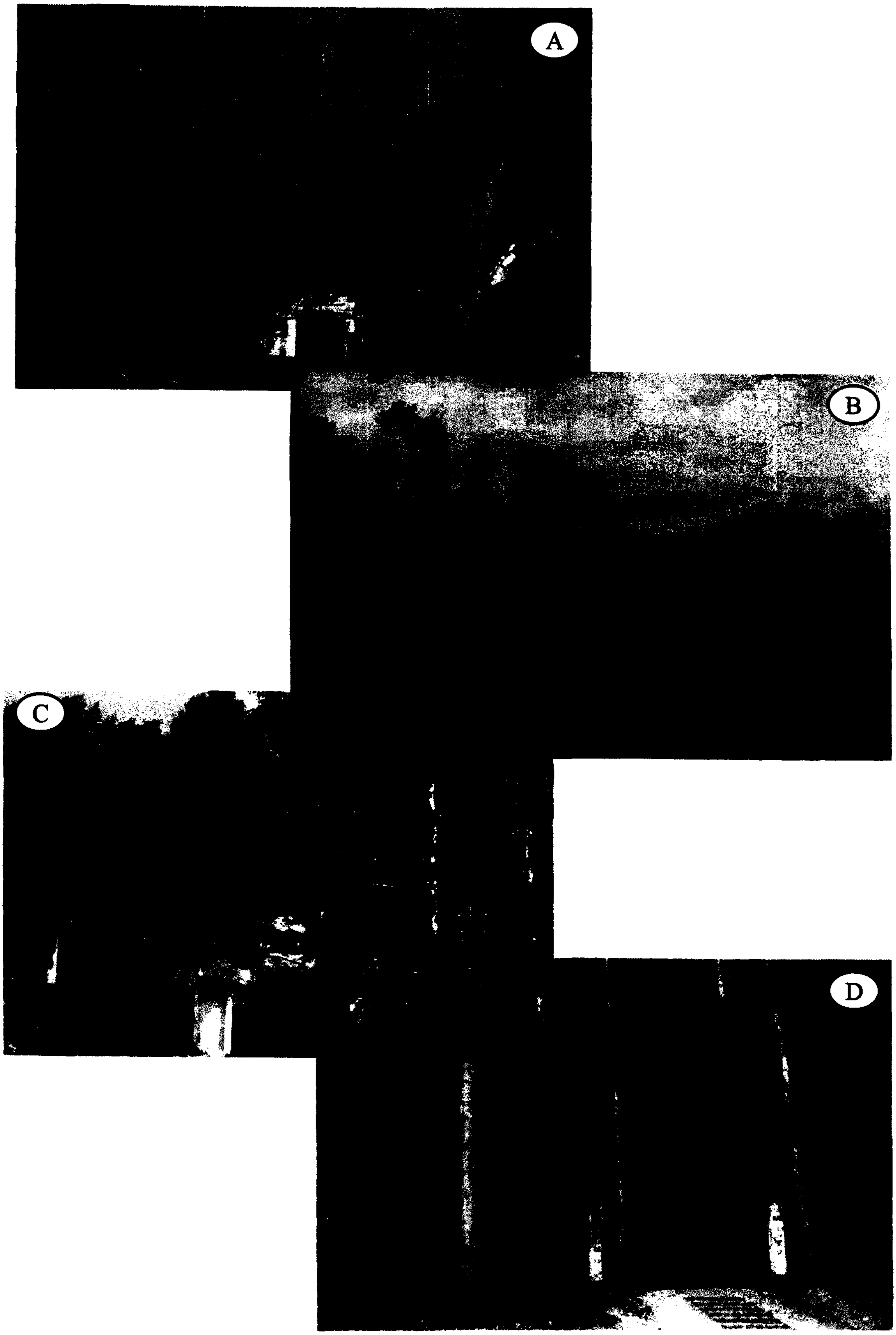

Plate 4. A view of the four sacred groves selected for the study. (A) – Konthoujam Lairembi sacred grove at Konthoujam village, (B) – Mahabali sacred grove at the bank of Imphal river, (C) – Langol Thongak Lairembi sacred grove in the range of Langol hill, and (D) – Heingang Marjing sacred grove in the range of Heingang hill.

Thongak Lairembi and Heingang Marjing) are located in hills. The locality, approximate area, altitude, aspect and position of each grove are given in table III. 1. These selected groves cover an area *c.a.* 18.6 ha.

Table III.1. General characteristics of the selected sacred groves.

Sacred grove	Locality	Area (Approx. ha)	Altitude (m)	Aspect and Position
Konthoujam Lairembi	Konthoujam	1.41	711	West–Valley
Mahabali	Imphal	5.05	710	Central Valley
Langol Thongak Lairembi	Langol	5.05	800	North -West– Hill base
Heingang Marjing	Heingang	7.08	834	North– Hill base

Detail description of the selected sacred groves

Konthoujam Lairembi sacred grove

The deity, *Tampha Lairembi* resides in the Konthoujan sacred grove, situated in the Konthoujam village, about 11 km west of the valley area of Imphal city. It lies at 711 m altitude, covering an area of approximately 1.41 hectare. The grove harbours rich medicinal and rare plant species. Few sacred trees are also found in this grove. A very distinctive feature of the grove is joining of 11 *Ficus* trees and a strong myth and legends are connected with the shape formed by the joining of these fig trees. Few decades back a good number of Rhesus monkey (*Macaca mulatta*; Zimmermann, 1780) were frequently found in this grove, but now-a-days, not a single individual of this monkey is seen in this grove. It may be due to the presence of human habitation on the fringes of the grove. However, the floristic component has still retained its richness.

The local people protect the grove and no one is allowed to cut any tree. However, an occasional collection of dry wood is permitted. The deity of the grove is worshipped once in a year in the month of April – May on a grand scale with the impressive ritual and cultural programmes. The occasional performance of rites and rituals also take place from time to time. People worship deities for the prosperity and welfare of the village, to increase the productivity of crops, to protect them from the calamities, sickness and invasion of enemies.

Mahabali (Mongba Hanba) sacred grove

It is situated in the heart of Imphal city to the west of Shri Govindaji temple (Konung) at 710 m altitude covering approximately an area of 5.05 hectares. Sacred place of *Mongba hanba*, a deity of Meiteis is located in this grove. Hanumanji temple of this grove is a famous one and people gather there for worship especially on every Tuesday. Besides the Meiteis, Hindus also go there for the worship. Every celebration of Hindu religion is performed in this grove. People from many parts of the state, representing the Meiteis, Hindus and a few tribal communities go to the grove for worshipping. The grove is the remnant of the forest, that once existed on the bank of the Imphal river. The forest of the grove consists of a variety of trees, shrubs, herbs and epiphytes. The wire fencing and brick wall surround the grove on three sides, but it is open on the river side. A few tribals living nearby the grove and other local inhabitants extract and acquire their food and medicinal plants from this sacred forest. Besides, it is of aesthetic and tourist value. Very old trees of

Ficus species are found in the grove. It is also the repository of various valuable medicinal plants. A few medicinal plants that are not common in other parts of the locality occur in this grove. Moreover, it is the shelter for more than 300 individuals of Rhesus monkey (*Macaca mulatta*). These monkeys not only depend on forest food but also fondly consume gram, puff rice, fruits, and flowers etc. that are offered by people who come for worship. People believe that eating the food items that are left over by these monkeys, improves the health of the people. This grove also serves as the home for many arboreal mammals and birds.

Langol Thongak Lairembi sacred grove

It is situated in the Langol hill ranges about 5 km northwest of Imphal city covering an area of *ca*. 5.05 ha. The altitude ranges from 800 m at the foot hills to 1050 m at the peak. The forest is dominated by the *Pinus kesiya*. The deity, *Langol Ashithel Ema Thongak Lairembi* resides in this grove. Ceremony for pleasing the deity is held in the month of April, by performing the day-long rituals (*Lai-chaklong-katpa*). People climb up this sacred hill for worship on the 1st day of the New Year of the Manipuri calendar, which falls in the month of April.

The anthropogenic activities such as, construction of quarters (game village) and collection of fire-wood by ever-increasing number of people in the adjoining areas have been impacting the sacred grove adversely.

Heingang Marjing sacred grove

The deity, *Ebudhou Marjing* dwells in the Heingang Marjing sacred grove, located in the Heingang village, to the north of Imphal city, covering an area of ca. 7.08 hectares. The Manipuri old literature trace the mythological belief that Ebudhou Marjing was the initiator of Polo game in Manipur and the world. Sacred stones in the grove are the icon of the deity, which are worshipped. The grove is rich in plant diversity and dominated by *Pinus kesiya*. During the autumn season dry pine needles are collected by the local people for making the mattress, which are sold in the market. These act as source of income for the poor people. Many arboreal bird species are also found in this grove. Caretaker of the grove stays within the grove to guard the sacred grove and to perform rituals when people visit it for worship. Cutting of tree is not allowed from the grove, though there is occasional collection of dry wood by the local people.

Climate

The climate of the study area is monsoonic with warm moist summer and cool dry winter. During the study period, the mean maximum temperature varied from 22^{0}C (January) to 30^{0}C (August) and mean minimum temperature varied from 5^{0}C (January) to 23^{0}C (July). The average relative humidity ranged from 58% (March) to 82% (October). The mean monthly rainfall was minimum in December (2.5 mm) and maximum in June (236 mm). The average annual rainfall was 1482 mm. The average data on temperature, rainfall and relative humidity are shown in figure III. 2. On the basis of the temperature and rainfall variations, the year can be divided into four distinct seasons: (i) spring season (March to mid-May), (ii) warm-rainy season (mid-May to September), (iii) autumn season (October to November), and (iv) winter season (December to February).

The spring season is characterized by occasional shower and gradual increase in temperature over the preceding winter months. During this season in most of the trees flushing takes place. The lowest relative humidity of the year is recorded during this season. The mean maximum temperature was 27.1^{0}C during March, 24.8^{0}C during April and 28.4^{0}C during May. The mean

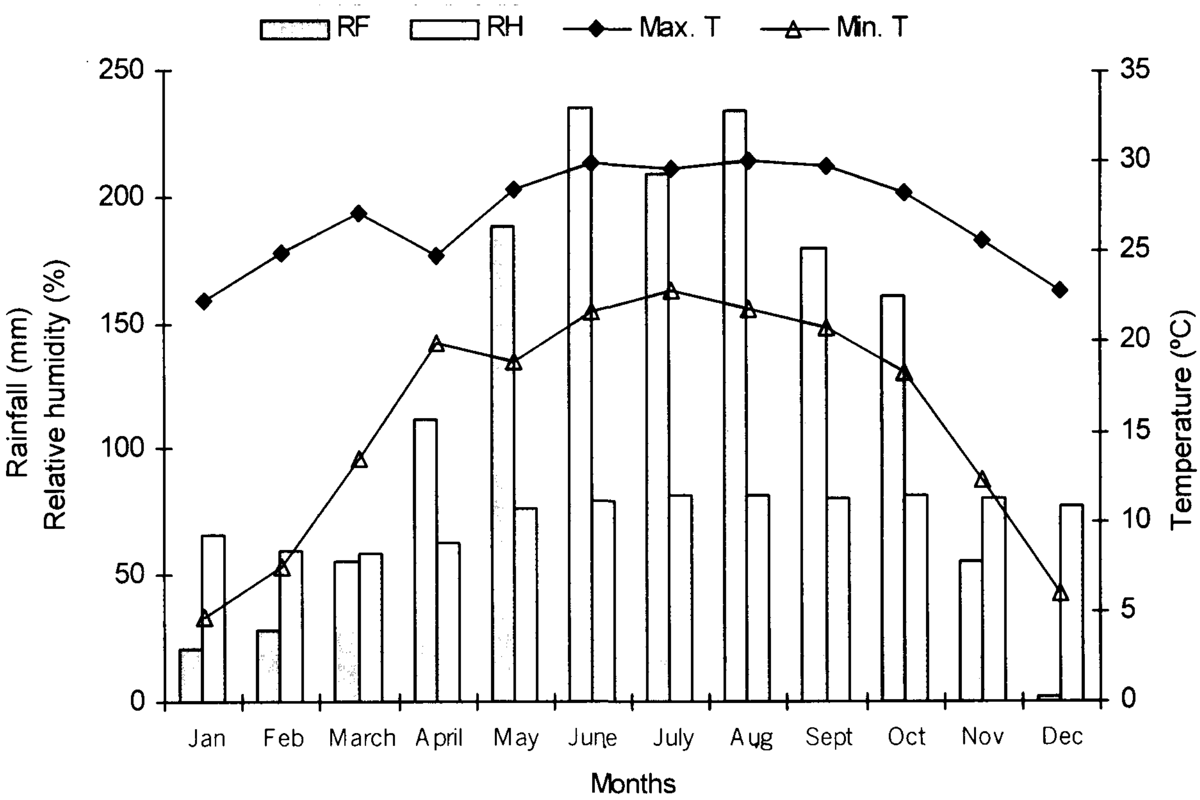

Figure III. 2. Mean monthly rainfall (RF), relative humidity (RH) and temperature (T) of the study area during January 2000 to December 2002.

minimum temperature was 13.4^0C during March, 19.8^0C during April and 18.9^0C during May. The hottest period is June to September having mean monthly temperature of 29.76^0C.

The period between mid-May to September is warm and associated with heavy rainfall, widespread cloudiness, high humidity and variable surface winds. About 71% of the annual rainfall is received during this season. The mean maximum temperature during this season may reach *ca.* 30^0C in July-August, and the mean minimum temperature between 18.9^0C (end of May) to 22.8^0C (July). The relative humidity ranged from *ca.* 74.5% to *ca.* 84%. Some rainfall is received even during October. During October the temperature gradually decreases and the rainfall also ceases towards the end of this month.

The winter season is characterized by cold nights, and sunny but windy days, low temperature and low relative humidity. The mean minimum temperature during the season is 6.08^0C (Jan.) and mean maximum temperature is 23.3^0C. Occasional showers are also received and gusty winds blow during this season. The relative humidity is quite low during this season reaching as low as 35% (February).

Soil

The soil of the two sacred groves situated in the plains is blackish in colour while it is yellowish red to reddish brown in the other two sacred groves which are located in hilly area. The soil is alluvial in nature and its texture is loamy sand. The physico-chemical characteristics of soils of the four selected groves are given in Table III. 2.

Table III. 2. Physico-chemical characteristics of soils of the selected sacred groves.

	Sacred grove			
Parameters	Konthoujam Lairembi	Mahabali	Langol Thongak Lairembi	Heingang Marjing
pH	5.68	6.59	5.4	5.88
Water holding capacity (%)	44.67	40.32	42.1	38.84
Soil moisture (%)	39.45	39.18	38.4	32.96
Soil texture				
Clay%	2.00	3.00	10.00	5.50
Silt %	20.00	18.00	21.50	17.25
Sand %	78.00	79.00	68.50	77.25
Organic carbon (%)	5.37	5.23	4.85	4.88
TKN (%)	0.04	0.04	0.02	0.01

The soil is acidic with pH ranging from 5.4 (Langol Thongak Lairembi sacred grove) to 6.59 (Mahabali sacred grove). Soil moisture content is highest in Konthoujam Lairembi sacred grove (39.45%) and lowest in Heingang Marjing sacred grove (32.96%). The water holding capacity ranged from 38.84% (Heingang Marjing sacred grove) to 44.67% (Konthoujam Lairembi sacred grove). The organic carbon content ranged from 4.85% (Langol Thongak Lairembi sacred grove) to 5.37% (Konthoujam Lairembi sacred grove). The total kjeldhal nitrogen (TKN) ranged from 0.01% (Heingang Marjing sacred grove) to 0.04% (Konthoujam Lairembi and Mahabali sacred groves). In general the soils are poor in nitrogen.

Floristic composition of the four selected sacred groves

The growing need of industrialization, urbanization and rural subsistence in different spheres due to increased human population in the past few decades have resulted directly or indirectly in sudden and often far reaching disturbances in natural ecosystems (Dayal and Shah 1993, Lal 1990, Myers 1993, Raizada 1983, Sandler 1993, Southgate *et al.* 1993) and converted them into man-made plantation forest, mainly of timber trees (Pandey and Shukla 1999). In India, dense forest cover has been reduced to 1/3 of what is ecologically desired (Madhavan 1990, Maithani 1990, Rawat 1993). The practices of grazing and trampling, and large-scale collection of fuelwood and minor forest products may alter the habitats of many species (Westman 1990). Some of the sacred groves have become degraded and much depleted in species content on account of these anthropogenic factors. The dynamics of their vegetation structure needs to be studied in detail in order to formulate strategies for their conservation. Vegetation structure of any plant community depends upon its floristic composition (Gleason 1926). Knowledge of species composition and distribution is a prerequisite to the understanding of the major anatomical features of the community (Dansereau 1960). The floristic composition and species diversity of vegetation reflect the gene pool and adaptation potential of plant community (Odum 1971). The analysis of vegetation in different communities of the world has been done by a number of ecologists (Cao *et al.* 1996, Cao and Zhang 1997, Curtis 1959, Fremstad 1979, Greig-Smith 1983, Hegazy *et al.* 1998, Knight 1975, Koroleva 1994, Lieberman *et al.* 1996, Masaki *et al.* 1992, Uhl and Murphy 1981). The floristic composition of the sacred groves occurring in different parts of India has been studied by many workers (Balasubramanyan and Induchoodan 1996, Boraiah *et al.* 2003, Hajra 1975, Jamir 2000, Khan *et al.* 1997, Kumar and Swamy 2003, Mishra *et al.* 2004, Pandey 2003, Tambat *et al.* 2001, Tiwari *et al.* 1998b, Tripathi *et al.* 2003, Upadhaya 2002, Upadhaya *et al.* 2003, Vasanth *et al.* 2001).

Vegetation, species diversity and floristic relations along an altitudinal gradient of different forests have been studied by several workers (Aiba and Kitayama 1999, Givnish 1999, Granzowdela Cerda *et al.* 1998, Killen *et al.* 1998, Mutangah and Agnew 1996, Pande *et al.* 2002, Rawat 2001, Shehzad *et al.* 1999). Some studies have focused on the vegetation of natural forests of different climatic zones of India. The quantitative and qualitative analyses of forest vegetation were done in Central Himalaya (Adhikari *et al.* 1991, Khan 1996, Ralhan *et al.* 1982, Saxena and Singh 1982a, b, Upreti *et al.* 1985), eastern Himalayas (Nayak *et al.* 1991, Uma Shankar 2001), Western Ghats (Parthasarathy and Karthikeyan 1997a, Parthasarathy 1999, 2001), Eastern Ghats (Kadavul and Parthasarathy 1999, Kadavul 2002), and in tropical dry evergreen forests in south India (Visalakshi 1995). The information is also available on the forest vegetation of north-east India, of Assam (Bhatnagar 1966), Meghalaya (Khan *et al.* 1987, Pandey *et al.* 2003, Singh and

Ramakrishnan 1982, Rao *et al.* 1990, Tripathi and Khan 1992, Tripathi 2002, Tripathi *et al.* 2002), Arunachal Pradesh (Beniwal and Haridasan 1992a, b, Bhuyan *et al.* 2003) and Manipur (Kikim 1999, Yadava and Singh 1988, Yadava *et al.* 1991). However, such studies on the sacred groves of Manipur are lacking.

The present chapter deals with the floristic composition, vegetation profile and quantitative analysis of the vegetation of the four selected sacred groves of Manipur viz., Konthoujam Lairembi sacred grove, Mahabali (Mongba Hanba) sacred grove, Langol Thongak Lairembi sacred grove and Heingang Marjing sacred grove.

Methods

The vegetation profile in each sacred grove was sketched taking an area of 50 m x 4 m in each study groves (Kikim 1999). Height, girth, branching pattern and canopy size and shape of all the woody species were recorded. The vegetation was classified in different vertical strata viz., upper layer, > 10 - 35 m; middle layer, > 5 - 10 m; shrub layer, > 1- 5 m; and herb layer, <1 m height (Kikim 1999).

Phytosociological studies were carried out during 2001-2002 by quadrat method. Forty quadrats of 10 m x 10 m were laid randomly in each grove for recording the phytosociological parameters relating to trees. Twenty quadrats of 5 m x 5 m for shrubs and 20 quadrats of 1 m x 1m size for herbs were laid within the same 10 m x 10 m quadrats that were laid for the study of trees. All the individuals of tree species within the quadrat were measured and grouped as trees (≥ 30 cm girth at breast height of 1.3 m), saplings (< 30 cm collar circumference at the base and > 20 cm in height) and seedlings (≤ 20 cm height). For buttressed trees measurements were made above the buttress. For each tree species density (trees ha^{-1}) and basal area values were calculated. Quantitative analysis of vegetation for frequency, density and dominance was done following Misra (1968). The life form to which a plant species belonged was determined based on the position of the perennating buds, and all the species were assigned to different life forms. The percentage of species belonging to each life form was calculated (number of species in any life form/ total number of species of all life forms x 100) to determine the biological spectrum of each sacred grove.

Regeneration status of species was determined based on population size of seedlings and saplings (Bhuyan *et al.* 2003, Khan *et al.* 1987, Uma Shankar 2001): good regeneration, if seedlings>saplings>adults; fair regeneration, if seedlings>or ≤ saplings ≤ adults; poor regeneration, if the species survives only in sapling stage, but no seedlings (saplings may be <, > or = adults). If a species is present only in adult form it is considered as not regenerating. Species is considered as 'new' if the species has no adults but only seedlings or saplings. Relative importance of shrubs and herbs was calculated by summing up the relative frequency, relative density and relative abundance, while in the case of tree species IVI values were computed by summing up the relative frequency, relative density and relative dominance.

The similarity index (Sorensen 1948), species diversity index (Shannon and Weiner 1963) by using IVI values as given by Magurran (1988), concentration of dominance of the community (Simpson 1949), species richness index (Menhinick 1964), evenness index (Peilou 1969) and β diversity (Whittaker 1960) were calculated using the formula as given by the authors mentioned above.

Similarity index (Sorensen 1948) was calculated as follows:

$$\text{Similarity index} = \frac{2C}{A + B} \times 100$$

Where C is the number of species common to two releves, A is the total number of species in releve A, and B is the total number of species in releve B

Shannon -Weiner diversity index (Shannon and Weiner 1963)

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

Where, H' – Shannon -Weiner diversity index

pi is the proportion of individuals in the *i*th species i.e *(ni/N)*

(ni/*N*) is the total number of individuals of all the species, *ni* – importance value index of the species and *N* – importance value index of all the species

Simpson's index (Simpson 1949) was calculated as follows:

$$Cd = \sum_{i=1}^{s} (pi)^2$$

Where *pi* is the same as for the Shannon -Weiner diversity index (Shannon and Weiner 1963)

Species richness index (Menhinick 1964) was calculated as follows:

$$\text{Species richness index} = S/\sqrt{N}$$

Where S – total number of species and N – number of individuals

Evenness index E was calculated as follows:

$$E = H'/ \ln S$$

Where H' – Shannon -Weiner diversity index and S – Total number of species

β diversity was estimated following Whittaker (1960) as follows:

$$\beta = S/\alpha\ -1$$

Where S is the total number of species encountered in the two groves, counting each species only once and α is the mean species richness of the two groves.

Results

Vegetation profile

The vegetation profile diagrams of the four sacred groves are shown in figure IV.1a-d. In all the four sacred groves four layers of vertical stratification were observed. Based on the morphological classes, the plant species of Konthoujam sacred grove are arranged in four strata i.e., topstorey, understorey, shrub and herb layer. *Artocarpus lakoocha, Ficus benjamina*, *Ficus glomerata* and *Lannea coromandelina* formed the topstorey. The understorey consists of *Ligustrum robustum*, *Marlea begoniaefolia* and *Saprosma* sp., while the shrub layer is mainly composed of *Clerodendrum viscosum*, *Lantana camara* and *Mussaenda roxburghii*. The herb layer is composed of *Ageratum conyzoides*, *Bonnaya brachiata*, *Curcuma* sp., *Eclipta prostrata* etc. The height of the plant species belonging to topstorey ranged

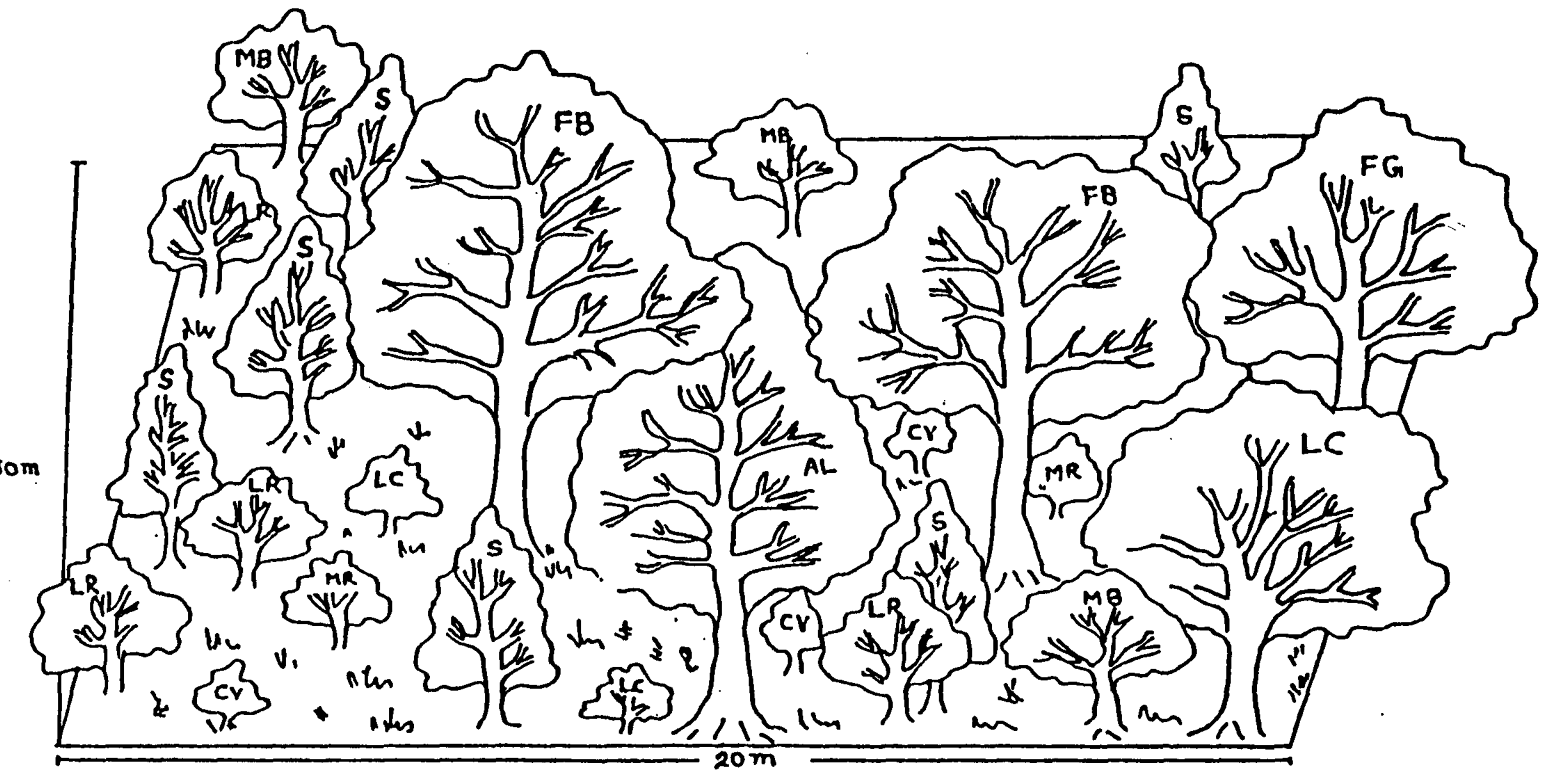

Figure IV. 1a. Vegetation profile diagram of Konthoujam Lairembi sacred grove. Indication of species: Topstorey trees, AL - *Artocarpus lakoocha*, FB - *Ficus benjamina*, FG - *Ficus glomerata* and LC -*Lannea coromandelina*. Understorey trees, LR - *Ligustrum robustum*, MB - *Marlea begoniaefolia and* S – *Saprosma* sp. Shrub layer, CV - *Clerodendrun viscosum*, LC - *Lantana camara* and MR - *Mussaenda roxburghii*.

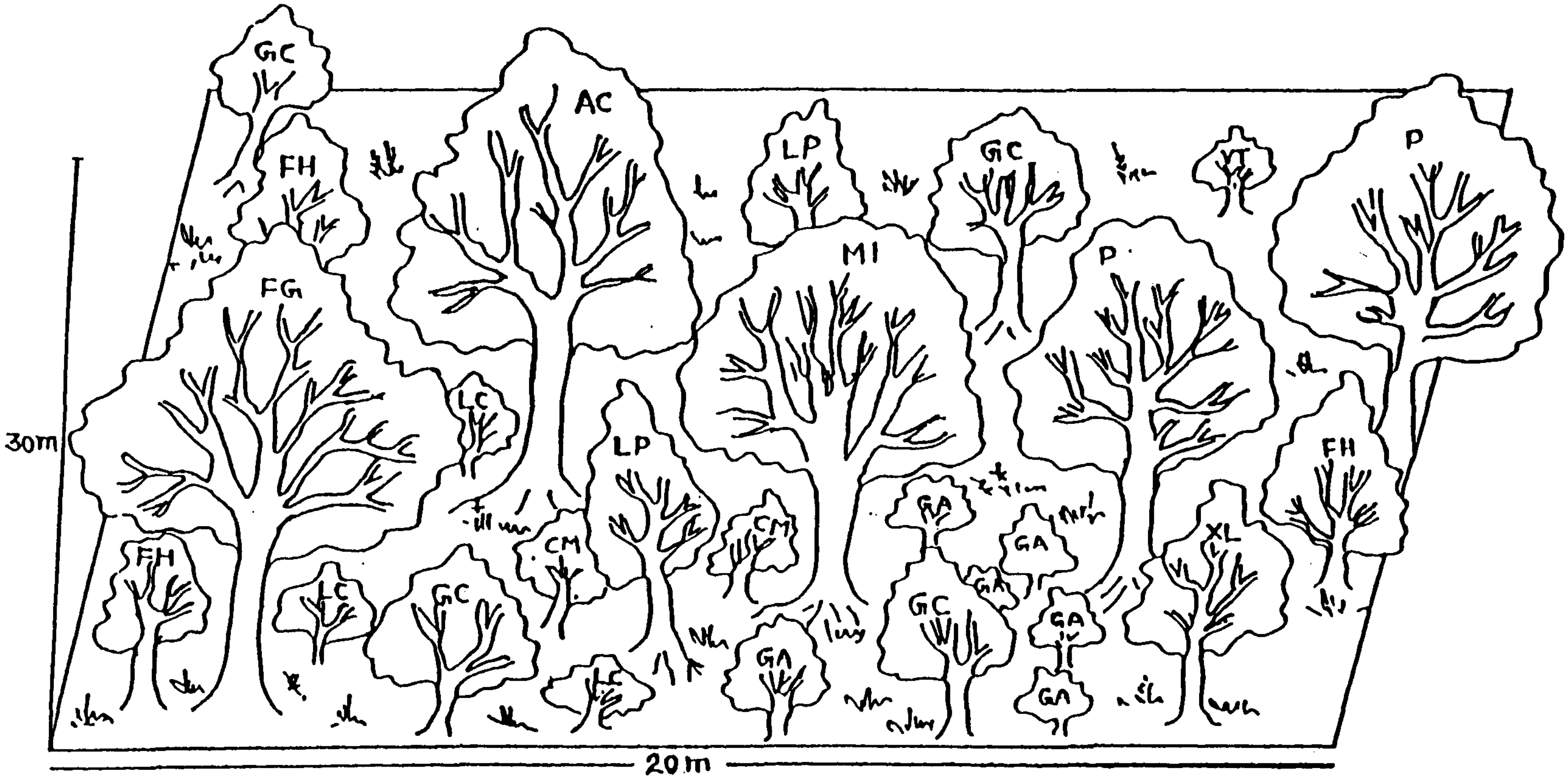

Figure IV. 1b. Vegetation profile diagram of Mahabali sacred grove.
Indication of species: Topstorey trees, AC - *Anthocephalus chinensis*, FG - *Ficus glomerata*, P - *Persea* sp., and MI - *Mangifera indica*. Understorey trees, GC - *Gardenia campanulata*, FH - *Ficus hispida*, LP - *Litsea polyantha* and XL - *Xylosma longifolia*. Shrub layer, CM - *Callicarpa macrophylla*, GA - *Glycosmis arborea*, LC - *Lantana camara* and VT - *Vitex trifolia*.

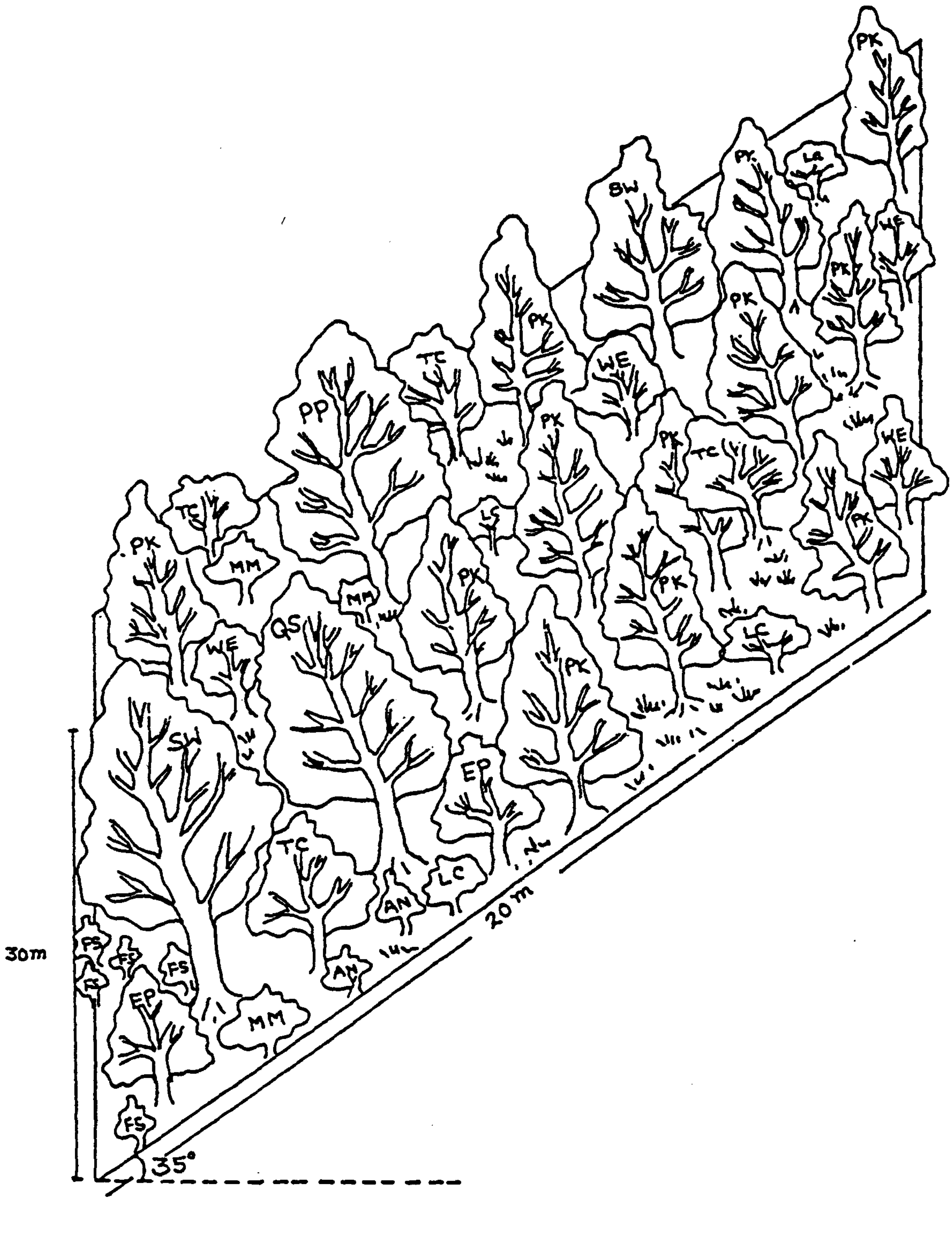

Figure IV.1c. Vegetation profile diagram of Langol Thongak Lairembi sacred grove.
Indication of species: Topstorey trees, PP - *Pasania polystachya*, PS - *Pinus kesiya*, QS -*Quercus serrata* and SW - *Schima wallichii*. Understorey trees, EP - *Eugenia praecox*, TC - *Terminalia citrina* and WE - *Wendlandia exrerta*. Shrub layer, AN - *Artemisia nilagirica*, FS - *Ficus silhetensis*, LC - *Lantana camara* and MM - *Melastoma malabathricum*.

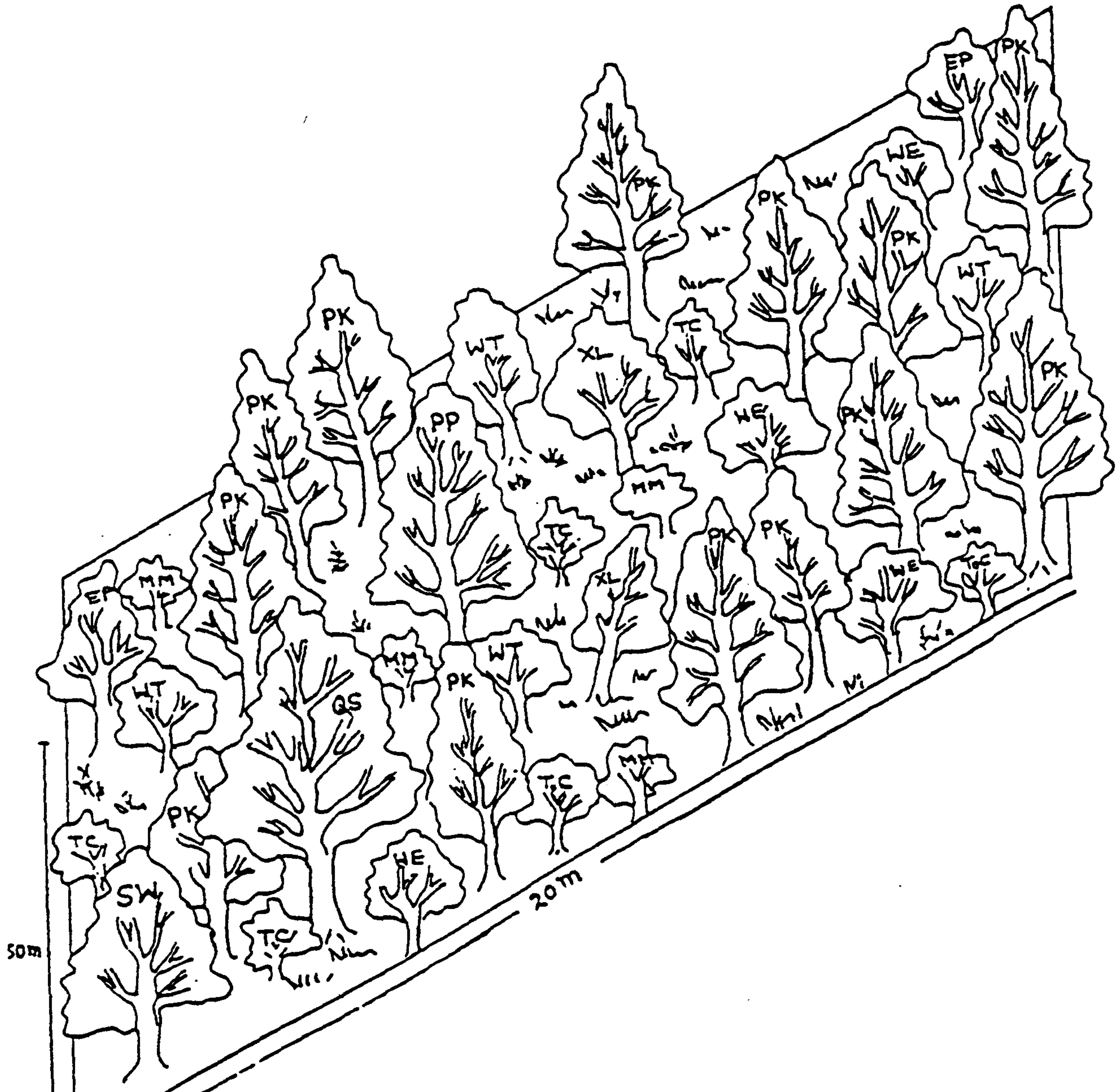

Figure IV. 1d. Vegetation profile diagram of Heingang Marjing sacred grove. Indication of species: Topstorey trees, PP - *Pasania polystachya*, PK - *Pinus kesiya*, QS - *Quercus serrata* and SW - *Schima wallichii*. Understorey trees, EP - *Eugenia praecox*, WE - *Wendlandia exrerta*, WT - *Wendlandia tinctoria* and XL - *Xylosma longifolia*. Shrub layer, MM - *Melastoma malabathricum*, TC - *Triumfetta cana*, and ToC - *Tournefortia candallii*.

between 17 to 35 m and the crowns of different species are close to each other (Figure IV.1a).

In the Mahabali sacred grove, the topstorey and understorey of the forest are formed by 5 species each and shrub layer consists of 4 species. The topstorey species are *Anthocephalus chinensis*, *Ficus glomerata*, *Persea* sp. and *Mangifera indica* while the understorey species are *Ficus hispida*, *Gardenia campanulata*, *Litsea polyantha* and *Xylosma longifolia*,. The shrub layer is formed by *Callicarpa macrophylla*, *Glycosmis arborea*, *Lantana camara* and *Vitex trifolia*. The herb layer is composed of *Bassella alba*, *Dactyloctenium aegyptium*, *Habenaria* sp. *Houttuynia cordata* and *Stephania hernandifolia*. Maximum number of the species of the understorey attained the height of 5-10 m (Figure IV.1b). The canopy of the topstorey layer is sparse while the understorey is comparatively dense.

Stratification in Langol Thongak Lairembi sacred grove also reveals four layers of strata. The topstorey is occupied by *Pinus kesiya*, *Schima wallichii*, *Pasania polystachya* and *Quercus serrata* with an average height of 12-18 m (Figure IV.1c). *Eugenia praecox, Terminalia citrina* and *Wendlandia exrerta* are the prominent species of the understorey. *Artemisia nilagirica Ficus silhetensis*, *Lantana camara*, and *Melastoma malabathricum* form the shrub layer. *Eupatorium cannabinum, Imperata cylindrica*, *Lygodium microphyllum* and *Mikania micrantha* form the herb layer. The canopy is more or less closed.

In the Heingang Marjing sacred grove *Pasania polystachya*, *Pinus kesiya*, *Quercus serrata* and *Schima wallichii* occupied the topstorey. The understorey is formed by *Wendlandia tinctoria*, *Wendlandia exrerta*, *Xylosma longifolia* and *Eugenia praecox*. The shrub layer is composed of *Triumfetta cana*, *Melastoma malabathricum* and *Tournefortia candallii*, while the herb level is composed of *Adiantum* sp., *Blumea hieracifolia*, *Gynura cusimbua*, and *Pteris ensiformis*. Tree canopy is more or less closed. In this grove the height of the top storey ranged between 18-21m (Figure IV.1d).

Plant families, genera and species

In the four sacred groves of Manipur a total of 173 species representing 145 genera under 70 families with 2 unidentified tree species were ~~was~~ recorded. Of this, 81 were woody species (≥ 30cm gbh) representing 59 genera under 33 families. Among these woody taxa, one species was woody liana of Mimosaceae family. Twenty four species were shrubs belonging to 14 families and 23 genera, 62 species were herbs representing 34 families and 58 genera, and 6 species were pteridophytes representing 3 genera under 3 families. The families, genera and species of the four sacred groves are given in table IV. 1. Maximum number of species was found in the family Asteraceae and Rubiaceae (11 each) followed by Mimosaceae and Verbenaceae having 8 species each. With regard to tree species content, Rubiaceae was the dominant family with 8 species in the four sacred groves, and co-dominant family was Mimosaceae with 8 species followed by Anacardiaceae and Moraceae with 7 species each. The family Verbenaceae with 7 shrub species was the dominant family for shrubs. Asteraceae having 9

Table IV. 1. Family, genera and species enumerated in the four sacred groves of Manipur.

Family	No. of genera	No. of species
Acanthaceae	3	3
Adiantaceae	1	3
Amaranthaceae	2	2
Anacardiaceae	5	7
Apiaceae	2	2
Araceae	2	2
Araliaceae	2	2
Asclepidiaceae	1	1
Asteraceae	11	11
Basellaceae	1	1
Betulaceae	1	1
Bignoniaceae	1	1
Bombacaceae	1	1
Boraginaceae	2	2
Brassicaceae	1	1
Caesalpiniaceae	2	3
Caprifoliaceae	1	1
Caryophyllaceae	1	1
Combretaceae	1	1
Commelinaceae	1	1
Convolvulaceae	1	1
Cornaceae	1	1
Cucurbitaceae	1	1
Cyperaceae	1	1
Dioscoreaceae	1	2
Elaeocarpaceae	1	1
Euphorbiaceae	5	6
Fagaceae	3	3
Flacourtiaceae	2	2
Iridaceae	1	1
Juglandaceae	1	1
Lamiaceae	1	1
Lauraceae	3	6
Liliaceae	2	2
Malvaceae	2	2

Family	No. of genera	No. of species
Melastomaceae	1	1
Meliaceae	3	3
Menispermaceae	1	1
Mimosaceae	5	8
Moraceae	2	7
Myrsinaceae	2	2
Myrtaceae	4	5
Oleaceae	2	2
Orchidaceae	2	3
Oxalidaceae	1	1
Palmae	1	1
Papilionaceae	2	2
Pinaceae	1	1
Piperaceae	1	1
Plantaginaceae	1	1
Poaceae	7	7
Polygonaceae	2	2
Pteridiaceae	1	1
Ranunculaceae	1	1
Rhamnaceae	1	1
Rosaceae	3	3
Rubiaceae	8	11
Rutaceae	2	2
Santalaceae	1	1
Saurauiaceae	1	1
Schizaeaceae	1	2
Scrophulariaceae	1	1
Solanaceae	3	3
Theaceae	1	1
Tiliaceae	1	1
Ulmaceae	2	2
Verbenaceae	7	8
Violaceae	1	1
Vitaceae	2	2
Zingiberaceae	2	2

herbaceous species was the dominant family for herbs followed by Poaceae which had 7 species belonging to 7 genera. Thirty-four families were represented by 1 genera and 1 species each while 17 families were represented by 2 genera and 2 species each.

Biological spectrum

The biological spectra of the four sacred groves, prepared on the basis of Raunkiaer's life form system, were similar to the normal spectrum of the tropical rain forest (Figure IV. 2). When compared with the normal spectrum, the biological spectrum of the Konthoujam Lairembi sacred grove showed higher percentage of phanerophytes (74%). In the Mahabali sacred grove too the percentage of phanerophytes was higher (68%) while cryptophytes had more or less same proportion (5%) as found in the normal spectrum. The percentage of phanerophytes (68%) in the Langol Thongak Lairembi grove was higher than the normal biological spectrum. The Heingang Marjing sacred grove also showed higher percentage of phanerophytes (70.6%), but cryptophytes contributed more or less same proportion (5%).

Species richness, density, basal area, species diversity, concentration of dominance, evenness index and similarity index

The overall species richness in the four sacred groves was recorded highest in the Konthoujam Lairembi sacred grove which had 81 species and 70 genera belonging to 42 families. Out of the 81 species, 44 were the woody

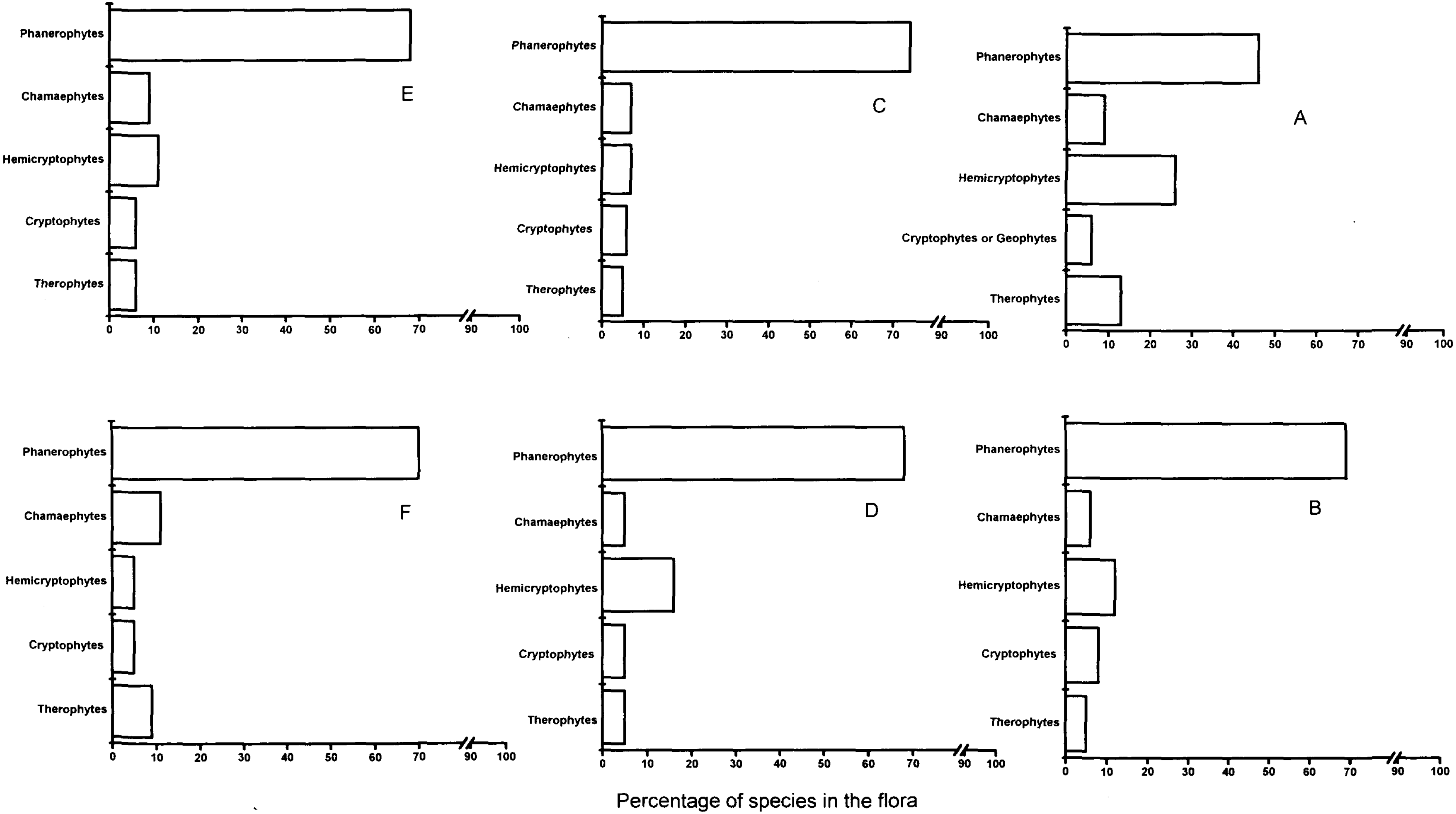

Figure IV. 2. Raunkiaer's normal spectrum (A) and biological spectra of different sacred groves - composite biological spectrum of all four sacred groves (B). Biological spectrum of Konthoujam Lairembi sacred grove (C), Mahabali sacred grove (D), Langol Thongak Lairembi sacred grove (E) and Heingang Marjing sacred grove (F).

species belonging to 36 genera under 22 families along with one unidentified species. Ten species of shrubs belonging to 10 genera under 7 families were recorded in this grove. The grove is rich in ground vegetation having 26 species of herbs representing 24 genera belonging to 20 families (Table IV. 2).

Fifty six species each were enumerated in the Mahabali and Heingang Marjing sacred groves. The Mahabali sacred grove recorded 40 genera under 34 families (Table IV. 2) while 51 genera in 38 families were recorded in the Heingang Marjing sacred grove (Table IV. 2). Twenty woody species of 17 genera in 11 families were recorded in the Mahabali sacred grove. Ten species of shrubs belonging to 6 families were found in the grove. The ground vegetation was represented by 26 species of herbs of 25 genera belonging to 23 families.

Thirty woody species (1 unidentified) of 22 genera in 17 families were encountered in the Heingang Marjing sacred grove, out of a total of 56 species belonging to 40 genera in 34 families. Only 7 species of shrubs belonging to 7 genera and 5 families, and 19 species of herbs belonging to 17 genera and 13 families were found in this grove.

The Langol Thongak Lairembi sacred grove had 53 species of 46 genera belonging to 32 families (Table IV. 2). Out of the 53 species, the woody species were 24 in number and they belonged to 21 genera and 16 families. The shrubs were represented by 9 species of 9 genera in 7 families, while the herbs were having 20 species of 19 genera in 12 families.

Table IV. 2. *Species richness (SR), species richness index (SRI), diversity index (H'), concentration of dominance (Cd) and evenness index (E) for the four sacred groves.*

	Sacred groves												Total	Variance of means (Tree species)
	Konthou-jam Lairembi	Mahabali	Langol Thongak Lairembi	Heingang Marjing	Konthou-jam Lairembi	Mahabali	Langol Thongak Lairembi	Heingang Marjing	Konthou-jam Lairembi	Mahabali	Langol Thongak Lairembi	Heingang Marjing		
	Trees (≥30cm gbh)				Shrubs				Herbs					
Species richness	45	20	24	30	10	10	9	7	26	26	20	19	173	120.25*
No. of genera	36	17	21	22	10	10	9	7	24	25	19	17	145	68.67*
No. of families	22	11	16	17	7	6	7	5	19	23	12	13	70	20.33*
Species richness index	2.37	1.21	1.2	1.36	0.78	0.78	0.77	0.55	0.79	0.67	0.72	0.53	2.14	0.32^{ns}
Shannon diversity index	3.17	2.48	1.79	2.12	2.25	2.15	2.17	1.89	3.13	3.03	2.77	2.83	–	0.35^{ns}
Simpson dominance index	0.07	0.59	0.36	0.28	0.11	0.14	0.12	0.16	0.05	0.06	0.08	0.06	–	0.05^{ns}
Pielou, Eveness index	0.83	0.55	0.56	0.62	0.98	0.93	0.99	0.97	0.96	0.93	0.92	0.94	–	0.02^{ns}
Stand density (Stems ha^{-1})	359	680	995	1218	3260	3300	2700	3240	539500	745000	389500	650000	2339752	140318.00*
Stand basal area (m^2 ha^{-1}) (trees + saplings)	43.83	87.78	38.01	58.32	–	–	–	–	–	–	–	–	227.94	494.41*

* Significant at 0.0005 level; ^{ns} not significant.

Species richness index varied from grove to grove. The tree species richness index was highest in the Konthoujam Lairembi sacred grove (2.37) and lowest in the Langol Thongak Lairembi sacred grove (1.20). The species richness index of shrubs ranged from 0.55 (Heingang Marjing sacred grove) to 0.78 (Konthoujam Lairembi and Mahabali sacred groves). However, species richness index of herbs varied from 0.53 (Heingang Marjing sacred grove) to 0.79 (Konthoujam Lairembi sacred grove). The species richness and species richness index of the vegetation followed the order: trees > herbs > shrubs. Details of species richness, diversity index, evenness index, density and basal area are presented in table IV. 2.

The highest stand density of woody species (1218 stems ha^{-1}) was recorded in the Heingang Marjing sacred grove and lowest in the Konthoujam Lairembi sacred grove (359 stems ha^{-1}), while the basal area was recorded highest in the Mahabali sacred grove (85.54 m^2 ha^{-1}) followed by the Heingang Marjing sacred grove (54.99 m^2 ha^{-1}) and Konthoujam Lairembi sacred grove (40.52 m^2 ha^{-1}) and minimum in Langol Thongak Lairembi sacred grove (35.51 m^2 ha^{-1}) as shown in table IV. 2. The presence of matured good-sized individuals having larger girth contributed to the high basal cover in the Mahabali sacred grove (Figure IV. 3). Density of shrub layer and ground vegetation was highest in the Mahabali sacred grove, which had 3,300 individuals of shrubs and 7,45,000 individuals of herbs per hectares, while the lowest density was recorded in the Langol Thongak Lairembi sacred grove (2,700 ha^{-1} for shrubs and 3,89,500 ha^{-1} for herbs).

Shannon–Weiner index of species diversity for tree species ranged from 1.79 in the Langol Thongak Lairembi sacred grove to 3.17 in the Konthoujam Lairembi sacred grove (Table IV. 2). For the shrub layer, the species diversity varied from 1.89 (Heingang Marjing sacred grove) to 2.25 (Konthoujam Lairembi sacred grove), while the highest value of species diversity for herbs was recorded in the Langol Thongak Lairembi sacred grove (2.77) and lowest in the Konthoujam Lairembi sacred grove (3.13).

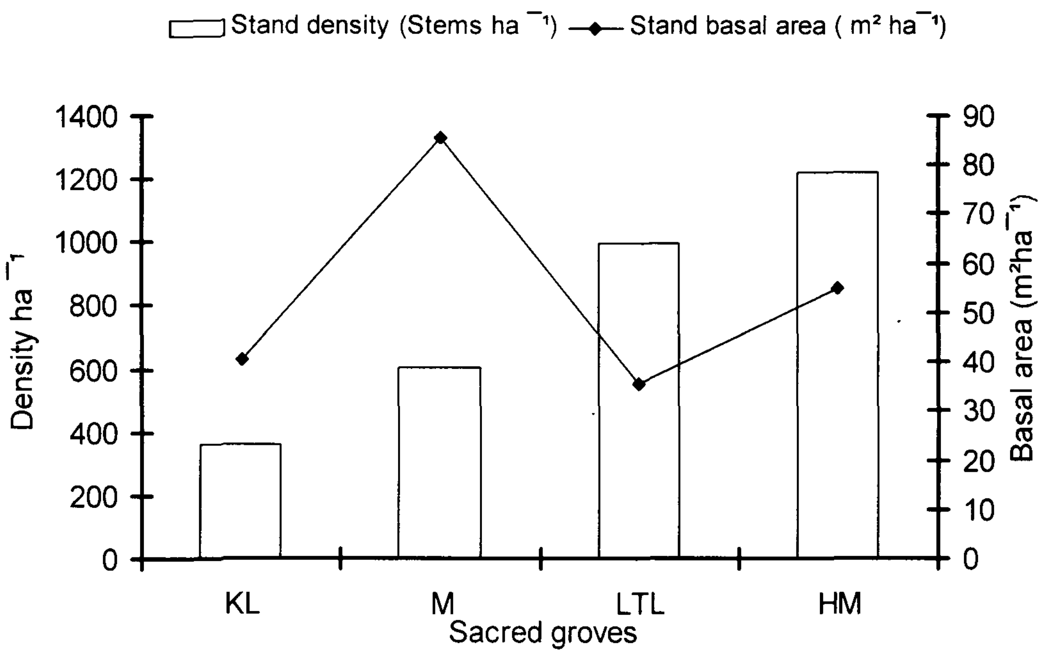

Figure IV. 3. Stand density and basal area of woody species in the four sacred groves. KL - Konthoujam Lairembi sacred grove; M - Mahabali sacred grove; LTL - Langol Thongak Lairembi sacred grove and HM - Heingang Marjing sacred grove.

The value of concentration of dominance for tree species recorded highest in the Mahabali sacred grove (0.59) and lowest in the Konthoujam Lairembi sacred grove (0.07). For shrubs, it was highest in the Heingang Marjing sacred grove (0.16) and lowest in the Konthoujam Lairembi sacred grove (0.11). For the herb layer the highest concentration value was in the

Langol Thongak Lairembi sacred grove (0.08) and lowest in the Konthoujam Lairembi sacred grove (0.05). The lowest values of concentration of dominance for tree, shrub and herb species were found in the Konthoujam Lairembi sacred grove (Table IV. 2).

The evenness index value for tree, shrub and herb species is given in table IV. 2. The value ~~of~~ for tree species ranged from 0.55 (Mahabali sacred grove) to 0.83 (Konthoujam Lairembi sacred grove). For shrubs and herbs the values were almost similar. For shrubs the values ranged from 0.93 (Mahabali sacred grove) to 0.99 (Langol Thongak Lairembi sacred grove), while for herbs the value was maximum in the Konthoujam Lairembi sacred grove (0.96) and minimum in the Langol Thongak Lairembi sacred grove (0.92).

The similarity index among the four sacred groves varied greatly (Table IV. 3). The highest similarity index (44.04%) was found between the Langol Thongak Lairembi and the Heingang Marjing sacred groves, and the lowest value was found between the Mahabali and Heingang Marjing sacred groves (14.29%). While considering the similarity index values based on the tree, shrub and herb species separately, it was found that the similarity in terms of tree species content was maximum (Similarity index value: 51.8%) between the Langol Thongak Lairembi and Heingang Marjing sacred groves.

Table IV. 3. Similarity [based on Sorensen similarity index (%)] among the four selected sacred groves.

Sacred groves	Mahabali	Langol Thongak Lairembi	Heingang Marjing
Konthoujam Lairembi	28.57	26.87	24.82
Mahabali	100	16.51	14.29
Langol Thongak Lairembi		100	44.04

The similarity index values between these two groves in terms of shrubs and herb species were 50% and 30.8%, respectively (Table IV. 4). The Mahabali and Langol Thongak Lairembi sacred groves were most dissimilar in tree species content (similarity index value: 8.2%), while the Mahabali and Heingang Marjing sacred groves showed least similarity (similarity index value: 13.3 %) for herb species. In terms of shrub species content, least similarity index value (23.5%) was recorded between the Konthoujam Lairembi and the Heingang Marjing sacred groves and also between the Mahabali and Heingang Marjing sacred groves with the same similarity index value (23.5%).

Table IV. 4. Similarity [based on Sorensen similarity index (%)] among the tree, shrub and herb species occurring in the selected sacred groves (T - Trees, S - Shrubs, H - Herbs).

Sacred groves		Mahabali			Langol Thongak Lairembi			Heingang Marjing		
		T	S	H	T	S	H	T	S	H
Konthoujam Lairembi	T	36.92	-	-	23.19	-	-	24	-	-
	S	-	30	-	-	42.11	-	-	23.53	-
	H	-	-	19.23	-	-	26.09	-	-	22.22
Mahabali	T	-			8.16	-	-	12	-	-
	S				-	31.58	-	-	23.53	-
	H				-	-	17.39	-	-	13.33
Langol Thongak Lairembi	T	-			-			51.85	-	-
	S							-	50	-
	H							-	-	30.77

β diversity

The maximum value of beta diversity (0.9) for trees was observed between Mahabali and Langol Thongak Lairembi sacred groves. In terms of shrub species content, the *β* value was found maximum between the Mahabali and Heingang Marjing sacred groves and also between the Konthoujam Lairembi and Heingang Marjing sacred groves showing the same value (0.76). The Langol Thongak Lairembi and the Heingang Marjing sacred groves showed least *β* diversity value for the tree, shrub and herb species (Table IV. 5).

Table IV. 5. Beta diversity (*β*) among the tree, shrub and herb species occurring in the selected sacred groves (T - Trees, S - Shrubs, H - Herbs).

Sacred groves		Mahabali			Langol Thongak Lairembi			Heingang Marjing		
		T	S	H	T	S	H	T	S	H
Konthoujam Lairembi	T	0.6	-	-	0.77	-	-	0.76	-	-
	S	-	0.7	-	-	0.58	-	-	0.76	-
	H	-	-	0.8	-	-	0.7	-	-	0.78
Mahabali	T		-		0.9	-	-	0.88	-	-
	S				-	0.68	-	-	0.76	-
	H				-	-	0.78	-	-	0.91
Langol Thongak Lairembi	T		-			-		0.48	-	-
	S							-	0.5	-
	H							-	-	0.4

Dominance and rarity

Dominance of tree species was assigned based on the calculated IVI values. Dominant species in the groves located in the plain area are quite different. In the Konthoujam Lairenbi sacred grove, *Ficus benjamina* (IVI: 59.3), *Saprosma* sp. (IVI: 29.7), *Mangifera indica* (IVI: 17.7) and *Ligustrum robustum* (IVI: 15.4) were the dominant species, while *Persea* sp. (IVI: 52.4), *Ficus hispida* (IVI: 44.1), *Ficus glomerata* (IVI: 43.3) and *Vanguirea spinosa* (IVI: 43.3) were dominant in Mahabali sacred grove. *Pinus kesiya*, *Schima wallichii* and *Quercus serrata* were dominant in both the groves located in hills (Table IV. 6). In Langol Thongak Lairembi sacred grove *Pinus kesiya* contributed the highest IVI value of 176.3 and co-dominant species were *Schima wallichii* (IVI: 25.6) and *Pasania polystachya* (IVI: 16.8) whereas, in Heingang Marjing sacred grove *Pinus kesiya* showed maximum IVI value (153.7), followed by *Quercus serrata* (26.7) and *Schima wallichii* (18.7). The species having ≤2 individuals were considered as rare. Maximum number of rare species (13) was found in Konthoujam Lairembi and 12 in Heingang Marjing sacred grove. There were 9 rare species in Langol Thongak Lairembi and 5 rare species in Mahabali sacred grove.

Girth class-wise tree density, basal area and species richness

The highest stand density and species richness of the four groves were recorded in the lowest girth class (30–60 cm). Stand density and species richness consistently decreased with increase in girth of the tree species from 30-60 cm to >210 cm (Figure IV. 4a). In the Langol Thongak Lairembi, and Heingang Marjing sacred groves no tree was recorded in the girth class 180-210 cm. The highest contribution of stand density per girth class to the total

Table IV. 6. Density (plants ha^{-1}) and importance value indices (IVI) of tree species and relative importance of shrub and herb species occurring in the four selected sacred groves of Manipur.

Scientific name	Habit	Konthoujam Lairembi sacred grove		Mahabali sacred grove		Langol Thongak Lairembi sacred grove		Heingang Marjing sacred grove	
		Density/ha	IVI	Density/ha	IVI	Density/ha	IVI	Density/ha	IVI
Adenanthera pavonina Linn.	T	1	0.6	—	—	—	—	—	—
Albizia lebbeck Benth.	T	—	—	3	2.6	—	—	—	—
Albizia lucida Benth.	T	—	—	—	—	17.5	5.7	5	1.9
Albizia odoratissima (Linn.f.) Benth.	T	6	3.9	—	—	5	2.5	15	6.0
Albizia procera Benth.	T	—	—	—	—	—	—	5	2.1
Albizia stipulata (Roxb.) Boivin	T	—	—	—	—	2.5	1.2	17.5	5.9
Alnus nepalensis D.Don	T	—	—	—	—	—	—	2.5	1.1
Anthocephalus chinensis Walp.	T	—	—	3	2.2	—	—	—	—
Aphanamixis polystachya (Wall.) Parker	T	1	0.7	—	—	—	—	—	—
Aralia sp.	T	—	—	—	—	10	3.2	—	—
Ardisia sp.	T	—	—	—	—	—	—	5	2.0
Artocarpus lakoocha Roxb.	T	13	10.9	8	4.8	—	—	—	—
Bauhinia purpurea Linn.	T	—	—	—	—	2.5	1.4	—	—
Bauhinia variegata Linn.	T	5	2.9	—	—	—	—	—	—
Bischofia javanica Blume	T	—	—	10	5.0	—	—	—	—
Bombax ceiba Linn.	T	—	—	—	—	5	2.4	—	—
Caryota urens Linn.	T	2	1.3	25	10.2	—	—	—	—
Castanopsis hystrix DC.	T	1	0.9	—	—	—	—	—	—
Celtis timorensis Linn.	T	3	2	3	3.4	—	—	—	—
Chukrasia tabularis Andr. Juss.	T	3	1.6	—	—	—	—	—	—
Cordia grandis Roxb.	T	2	1.8	—	—	—	—	—	—
Delonix regia (Boj.) Raf.	T	2	1.3	—	—	—	—	—	—
Elaeocarpus sp.	T	—	—	—	—	—	—	2.5	0.9
Engelhardtia colebrookiana Lindl.	T	—	—	—	—	—	—	35	11.3
Entada scandens Benth.	T	1	0.7	—	—	—	—	—	—
Erythrina sp.	T	1	0.7	—	—	—	—	—	—
Eucalyptus citriodora Hook.	T	—	—	—	—	—	—	2.5	1.0

Eugenia sp.	T	2	1.2	—	—	—	—	—	—
Eugenia praecox Roxb.	T	3	2.3	—	—	10	4.0	30	8.3
Ficus benghalensis Linn.	T	3	5.3	—	—	—	—	—	—
Ficus benjamina Linn.	T	13	59.3	—	—	—	—	—	—
Ficus glomerata Roxb.	T	6	5.3	38	43.4	—	—	—	—
Ficus hispida Linn. f.	T	3	2.1	115	44.1	—	—	—	—
Ficus religiosa Linn.	T	—	—	3	2.7	—	—	—	—
Ficus semicordata Linn.	T	—	—	—	—	—	—	17.5	5.4
Flacourtia jangomas (Lour.) Raeusch	T	—	—	—	—	—	—	7.5	3.1
Gardenia campanulata Roxb.	T	4	2.5	98	29.8	—	—	—	—
Gmelina arborea Linn.	T	7	4.6	—	—	—	—	—	—
Heptapleurum hypoleucum Kurz	T	6	4.1	—	—	—	—	—	—
Holigarna longifolia Roxb.	T	—	—	—	—	—	—	12.5	4.5
Khajok*	T	—	—	—	—	—	—	2.5	0.9
Lannea coromandelica (Houtl.)	T	8	4.6	—	—	—	—	—	—
Lannea grandis Linn. f	T	12	9.4	8	3.3	—	—	—	—
Ligustrum robustum Blume	T	25	15.4	—	—	—	—	—	—
Litsea citrata Blume	T	10	7.9	—	—	7.5	3.8	27.5	7.8
Litsea polyantha Juss	T	19	12.5	15	7.6	15	6.7	10	3.9
Litsea sebifera Thumb.	T	—	—	—	—	—	—	15	5.6
Litsea sp. (1)	T	3	1.8	—	—	—	—	—	—
Litsea sp. (2)	T	—	—	13	6.7	—	—	—	—
Mallotus philippensis (Lamk.) Muell. - Arg.	T	18	10.9	10	5.7	2.5	1.4	5	1.9
Mangifera indica Linn.	T	16	17.7	15	14.4	—	—	—	—
Mangifera sp.	T	—	—	—	—	3	1.2	7.5	2.3
Marlea begoniaefolia Roxb.	T	11	7.1	18	7.4	—	—	—	—
Melia azedarach Linn.	T	2	1.3	—	—	2.5	1.3	—	—
Oroxylum indicum Vent.	T	19	12.7	—	—	—	—	5	2.6
Parkia roxburghii G. Don	T	—	—	—	—	5	2.5	—	—
Pasania polystachya (Wall) Schottky	T	—	—	—	—	47.5	16.8	10	2.8
Persea sp.	T	—	—	85	52.4	—	—	—	—
Phyllanthus emblica Linn.	T	—	—	—	—	2.5	1.2	5	1.3

Pinus kesiya Royle ex. Gordon	T	—	—	—	—	690	176.3	705	153.7
Prunus sp.	T	—	—	—	—	—	—	7.5	2.1
Quercus serrata Thumb.	T	—	—	—	—	40	14.9	127.5	26.7
Rhus semialata Murray	T	3	2.2	—	—	7.5	3.7	—	—
Rubia sp. (1)	T	2	1.6	—	—	—	—	—	
Rubia sp. (2)	T	6	3.6	—	—	—	—	—	—
Santalum sp.	T	—	—	—	—	7.5	1.8	—	—
Saprosma sp.	T	54	29.7	—	—	—	—	—	—
Schima wallichii (DC.) Korth.	T	16	12	—	—	53	25.6	82.5	18.7
Spondias pinnata (Linn.f.) Kurz	T	1	0.6	—	—	—	—	—	—
Syzygium jambos Linn. (Alston)	T	1	0.6	—	—	—	—	—	—
Syzygium sp.	T	—	—	—	—	30	9.4	—	—
Terminalia citrina (Gaertn.) Flem.	T	—	—	—	—	12.5	5.1	—	—
Trema orientalis (L.) Blume	T	6	4.5	—	—	—	—	5	2.0
Uha*	T	15	10.8	—	—	—	—	—	—
Vanguria spinosa Roxb.	T	17	11.3	110	43.3	—	—	—	—
Viburnum sp.	T	—	—	—	—	2.5	2.5	—	—
Wendlandia exrerta DC.	T	—	—	—	—	—	—	2.5	0.9
Wendlandia tinctoria DC.	T	—	—	—	—	15	5.3	22.5	7.4
Xylosma longifolia Clos	T	3	2.2	23	7.8	—	—	20	5.5
Zanthoxylum rhetsa Roxb.	T	4	2.9	—	—	—	—	—	—
Ziziphus jujuba Lam.	T	—	—	5	3.1	—	—	—	—
Artemisia nilagirica (C.B. Clarke) Pamp.	S	—	—	—	—	320	34.4	380	37.4
Callicarpa macrophylla Vahl	S	260	25.6	200	24.5	360	37.2	—	—
Cestrum nocturnum	S	—	—	160	19.1	—	—	—	—
Clerodendrum serratum (L.) Sprengel	S	—	—	—	—	—	—	200	24.9
Clerodendrum viscosum Vent.	S	300	28.0	—	—	—	—	—	—
Datura suaveolens Willd.	S	—	—	160	20.5	—	—	—	—
Duranta repens Linn.	S	180	21.3	—	—	—	—	—	—
Eupatorium odoratum Linn.	S	—	—	—	—	200	26.5	—	—
Ficus silhetensis Miq.	S	—	—	—	—	320	36.1	—	—

Glycosmis arborea (Roxb.) DC.	S	—	—	1180	76.0	—	—	—	—
Jasminum sp.	S	680	51.4	420	36.6	220	26.9	—	—
Lantana camara Linn.	S	560	42.9	580	46.6	440	44.0	380	37.4
Maesa indica (Roxb.) A. DC.	S	420	36.7	—	—	200	25.2	460	42.4
Melastoma malabathricum Linn.	S	—	—	—	—	480	47.1	360	36.6
Mussaenda roxburghii Hook.f.	S	200	21.5	—	—	—	—	—	—
Phlogacanthus thyrsiflorus Nees	S	140	17.1	—	—	—	—	—	—
Rubus moluccanus Linn.	S	—	—	80	12.5	—	—	—	—
Sida rhombifolia Linn.	S	300	32.3	—	—	—	—	—	—
Solanum torvum Swartz	S	—	—	80	13.8	—	—	—	—
Thespesia macrophylla Blume	S	—	—	—	—	160	22.4	—	—
Tournefortia candallii Clarke	S	—	—	—	—	—	—	500	46.3
Triumetta cana Blume	S	—	—	220	26.5	—	—	960	75.0
Vitex trifolia Linn.	S	—	—	220	23.8	—	—	—	—
Xanthium strumarium Linn.	S	220	23.2	—	—	—	—	—	—
Adiantum lunulatum Burn. f	P	9500	7.3	—	—	—	—	34500	17.6
Adiantum sp.	P	44000	20.0	—	—	32000	22.7	85500	30.1
Adiantum venustum G. Don	P	—	—	—	—	—	—	35500	17.5
Lygodium japonicum (Thumb.) Sw.	P	—	—	—	—	19000	15.7	31000	16.7
Lygodium microphyllum Swartz.	P	32500	17.0	39 000	14.9	61500	35.5	—	—
Pteris ensiformis Burm.f.	P	—	—	—	—	—	—	64000	24.5
Achyranthes aspera Linn.	H	18000	11.2	—	—	—	—	—	—
Ageratum conyzoides Linn.	H	40500	19.1	—	—	37000	25.4	31500	15.2
Anaphalis contorta (D.Don.) Hook. f.	H	—	—	—	—	10000	10.9	—	—
Argyreia argysophyllous	H	—	—	17000	9.1	—	—	—	—
Bassella alba Linn.	H	—	—	51500	19.7	—	—	—	—
Blumea hieracifolia Hook.	H	—	—	—	—	—	—	64000	25.4
Bonnaya brachiata Linn.	H	13000	8.8	—	—	3000	5.1	—	—
Cardamine hirsuta Linn.	H	11500	8.2	—	—	—	—	—	—
Centella asiatica (Linn.) Urban	H	7500	6.3	—	—	—	—	—	—

Cissus discolor Blume	H	6000	5.4	—	—	—	—	—	—
Coix lacryma-jobi Linn.	H	—	—	—	—	4500	6.8	—	—
Colocasia esculenta (L.) Scott.	H	7500	6.5	—	—	—	—	—	—
Commelina benghalensis Linn.	H	6000	5.6	—	—	—	—	—	—
Costus speciosus (Koenig) Sm.	H	9000	7.1	—	—	—	—	—	—
Crocosmia sp.	H	—	—	—	—	—	—	7500	6.5
Curcuma sp.	H	10500	7.9	—	—	—	—	—	—
Cymbopogon flexuosus Stapf.	H	—	—	—	—	14500	13.3	—	—
Cynodon dactylon Pers.	H	—	—	15000	8.7	—	—	—	—
Cyperus rotundus Linn.	H	22500	12.8	—	—	—	—	—	—
Dactyloctenium aegyptium Beauv.	H	—	—	117000	32.5	—	—	—	—
Dioscorea alata Linn.	H	—	—	5500	4.4	2500	5.4	—	—
Dioscorea bulbifera Linn.	H	—	—	4000	3.6	—	—	—	—
Drymaria cordata Willd.	H	39000	18.3	8000	5.5	—	—	—	—
Eclipta prostrata (Linn.) Linn.	H	51500	22.4	—	—	—	—	—	—
Eupatorium cannabinum Linn.	H	—	—	—	—	105000	53.1	—	—
Euphorbia hirta Linn.	H	—	—	—	—	—	—	15000	9.5
Euphorbia sp.	H	—	—	—	—	10500	11.1	—	—
Fragaria indica T. Anderson	H	15500	10.0	19500	10.2	—	—	—	—
Galinsoga parviflora Cav.	H	7500	7.2	—	—	9000	9.8	—	—
Gomphrena decumbens	H	23500	13.2	5500	4.4	9500	10.2	21500	13.2
Gynura cusimbua (D.Don) S.	H	—	—	—	—	—	—	40500	17.9
Habenaria sp. (1)	H	—	—	74000	23.9	—	—	—	—
Habenaria sp. (2)	H	—	—	—	—	—	—	4000	4.4
Hemidesmus indicus (L.) Schult.	H	14000	9.3	—	—	—	—	—	—
Houttuynia cordata Thunb.	H	—	—	11000	6.7	—	—	—	—
Hydrocotyle javanica Thunb.	H	—	—	15000	8.0	—	—	—	—
Imperata cylindrica (Linn.) P.Beauv.	H	—	—	—	—	29500	21.1	95000	32.5
Melothria maderaspatana (Linn.) Cogn.	H	—	—	21000	10.9	—	—	—	—
Mikania micrantha Kunth	H	—	—	77000	24.6	6000	8.1	—	—
Mucuna sp.	H	—	—	—	—	6000	10.1	—	—
Muscari commutalum Vent.	H	45500	20.5	—	—	—	—	—	—

Oxalis corniculata Linn.	H	—	—	—	—	7500	8.9	—	—
Paederia sp.	H	8500	6.8	—	—	—	—	—	—
Paederia foetida Linn.	H	9500	7.3	—	—	—	—	—	—
Panicum repens Linn.	H	68000	27.2	—	—	11500	11.5	34000	15.9
Peristrophe bicalyculata Nees.	H	—	—	8500	5.9	—	—	—	—
Phyllanthus fraternus Web.	H	—	—	52500	18.8	—	—	—	—
Piper longum Linn.	H	—	—	63500	21.6	—	—	—	—
Plantago erosa Wall.	H	—	—	8500	5.7	—	—	—	—
Polygonum orientale Linn.	H	—	—	12000	7.3	—	—	—	—
Ranunculus scleratus Linn.	H	—	—	76000	24.4	—	—	—	—
Rumex nepalensis Spreng.	H	—	—	4500	3.9	—	—	—	—
Sauromatum guttalum Schott.	H	—	—	3000	3.8	5000	7.1	—	—
Scutellaria discolor Colebr.	H	—	—	—	—	—	—	6500	5.9
Setaria glauca (Linn.) P. Beauv.	H	—	—	—	—	—	—	22500	13.9
Smilax zeylanica Linn.	H	—	—	3500	3.4	—	—	17500	10.4
Spilanthes acmella Hook.f.	H	—	—	21000	10.8	—	—	—	—
Stephania hernandifolia Walp.	H	11500	8.3	12000	7.1	—	—	—	—
Thunbergia grandiflora Roxb.	H	7500	6.3	—	—	—	—	—	—
Viola pilosa Blume	H	—	—	—		—	—	17500	10.7
Vitis sp.	H	—	—	—	—	—	—	22500	12.2
Zeuxine sp.	H	—	—	—	—	6000	8.1	—	—

* Local name; T - Tree, S- Shrub, P- Pteridophyte and H- Herb.

— indicates absence of species

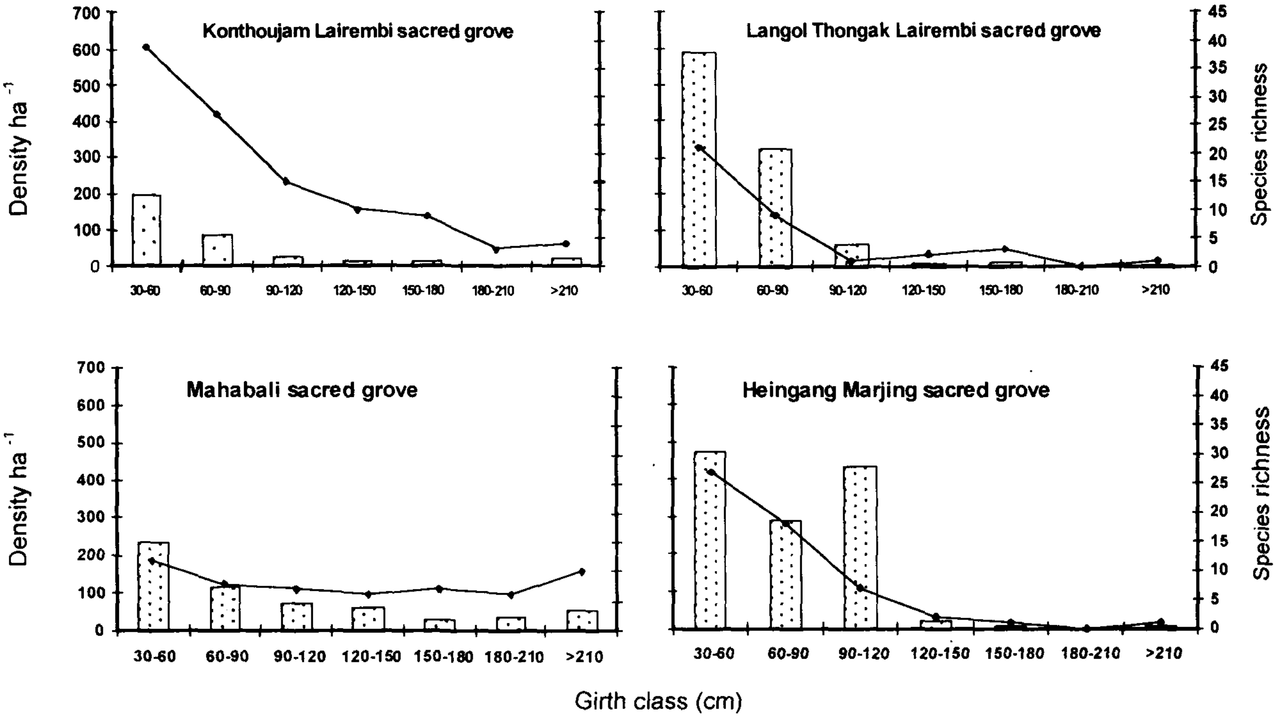

Figure IV. 4a.Density ha^{-1} ( ) and species richness (—♦—) of tree species in different girth classes in the four sacred groves.

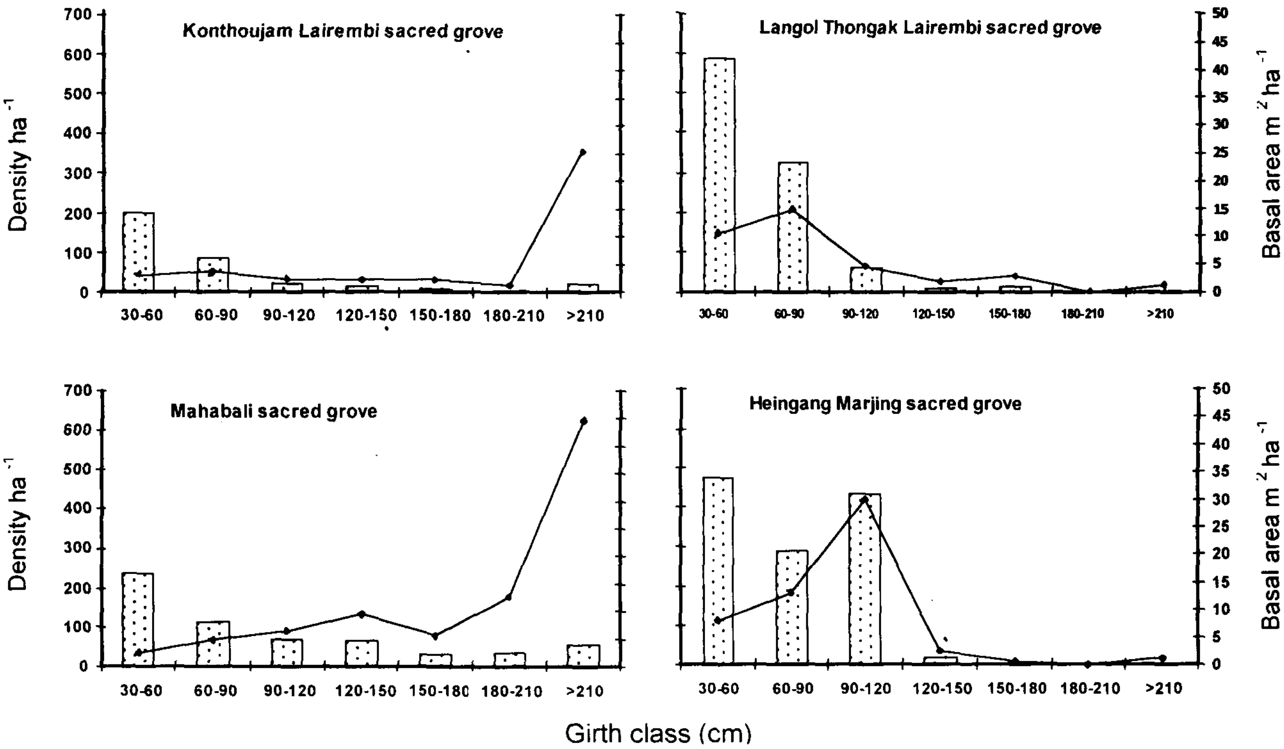

Figure IV. 4 b. Density ha^{-1} ( ) and basal area ($m^2 ha^{-1}$; —♦—) of tree species in different girth classes in the four sacred groves.

density for each grove was recorded in the 30-60 cm girth class. In all the groves, maximum stand density was observed in the lowest girth class (30-60 cm). Maximum stand density (59.05% of the total stand density) was recorded in Langol Thongak Lairembi sacred grove, followed by Konthoujam Lairembi sacred grove (55.43%), Mahabali sacred grove (39%) and Heingang Marjing sacred grove (38.81%). The basal area was maximum (44.63 m^2 ha^{-1}) in the highest girth class (>210 cm) in the case of Mahabali sacred grove and lowest in Heingang Marjing sacred grove. The pattern of basal area in the different girth classes in two groves located in the plain area showed similar pattern, and likewise the pattern shown by the two groves in the hills was similar to each other (Figure IV. 4b).

Regeneration status of tree species

In Konthoujam Lairembi sacred grove, out of the 55 species, 15% showed good regeneration, 22% fair, 22% poor and 16% were not regenerating, while 14 species (25%) were represented only by seedlings or saplings. The species falling under the last category were regarded as the new arrivals in this grove. In Mahabali sacred grove out of 38 species, 7 (19%) showed good regeneration, while 6 (16%) and 5 (13%) species exhibited fair and poor regeneration, respectively. 2 species (5%) were not regenerating and 18 species (47%) were new to this grove. Among the 38 species in Langol Thongak Lairembi sacred grove, 9 species (24%) showed poor regeneration, while 7 (18%) species each showed good and fair

Table IV. 7. Regeneration status of tree species in the four selected sacred groves of Manipur.

Species	Konthoujam Lairembi sacred grove No.of individuals/ha				Mahabali sacred grove No.of individuals/ha				Langol Thongak Lairembi sacred grove No.of individuals/ha				Heingang Marjing sacred grove No.of individuals/ha			
	Seedlings	Saplings	Trees	Status	Seedlings	Saplings	Trees	Status	Seedlings	Saplings	Trees	Status	Seedlings	Saplings	Trees	Status
Acacia auriculaeformis A. Curm ex.Benth.	—	—	—	—	—	—	—	—	—	—	—	—	3	#	#	New
Adenanthera pavonina Linn.	#	13	1	New	—	—	—	—	—	—	—	—	—	—	—	—
Albizia lebbeck Benth.	—	—	—	—	#	8	3	P	—	—	—	—	—	—	—	—
Albizia lucida Benth.	—	—	—	—	—	—	—	—	35	130	18	F	53	78	5	F
Albizia odoratissima (Linn. F.) Benth	35	93	6	F	—	—	—	—	#	23	5	P	#	5	15	P
Albizia procera Benth.	—	—	—	—	—	—	—	—	—	—	—	—	#	45	5	P
Albizia stipulata (Roxb.) Boivin	—	—	—	—	—	—	—	—	#	8	3	P	#	13	18	P
Alnus nepalensis D. Don	—	—	—	—	—	—	—	—	—	—	—	—	#	3	3	P
Anthocephalus cadamba Linn.	—	—	—	—	#	10	#	New	—	—	—	—	—	—	—	—
Anthocephalus chinensis Walp.	—	—	—	—	#	#	3	N	—	—	—	—	—	—	—	—
Aphanamixis polystachya (Wall.) Parker	#	#	1	N	—	—	—	—	—	—	—	—	—	—	—	—
Aralia sp.	—	—	—	—	—	—	—	—	#	5	10	P	—	—	—	—
Ardisia sp.	—	—	—	—	—	—	—	—	—	—	—	—	#	5	5	P
Artocarpus lakoocha Roxb.	313	#	13	F	100	38	8	G	—	—	—	—	—	—	—	—
Artocarpus heterophyllus Lamk.	—	—	—	—	—	—	—	—	#	5	#	New	—	—	—	—
Bauhinia purpurea Linn.	—	—	—	—	—	—	—	—	#	10	3	P	—	—	—	—
Bauhinia variegata Linn.	#	8	5	P	5	3	#	New	—	—	—	—	—	—	—	—
Bischofia javanica Blume	—	—	—	—	63	#	10	F	—	—	—	—	—	—	—	—
Bombax ceiba Linn.	—	—	—	—	—	—	—	—	#	8	5	P	#	5	#	New
Borassus flabellifer Linn.	—	—	—	—	20	#	#	New	—	—	—	—	—	—	—	—
Caryota urens Linn.	405	50	2	G	218	50	25	G	—	—	—	—	—	—	—	—
Castanopsis hystrix DC.	13	45	1	New	#	5	#	New	—	—	—	—	—	—	—	—
Celtis sp.	—	—	—	—	—	—	—	—	—	—	—	—	23	53	#	F
Celtis timorensis Linn.	5	18	3	F	35	38	3	F	10	#	#	New	#	23	#	New

Chukrasia tabularis Andr. Juss.	#	#	3	N	—	—	—	—	—	—	—	—	—	—	—	—
Cinnamomum sp.	28	18	#	New	—	—	—	—	—	—	—	—	—	—	—	—
Citrus maxima Merr	3	5	#	New	23	8	#	New	#	5	#	New	—	—	—	—
Cordia grandis Roxb.	#	#	2	N	—	—	—	—	—	—	—	—	—	—	—	—
Delonix regia (Boj.) Raf.	#	53	2	P	—	—	—	—	—	—	—	—	—	—	—	—
Elaeocarpus sp.	—	—	—	—	—	—	—	—	—	—	—	—	#	10	3	P
Engelhardtia colebrookiana Lindl.	—	—	—	—	—	—	—	—	25	38	#	New	65	143	35	F
Entada scandens Benth	#	#	1	N	—	—	—	—	—	—	—	—	—	—	—	—
Erythrina sp.	5	118	1	New	—	—	—	—	—	—	—	—	—	—	—	—
Eucalyptus citriodora Hook	—	—	—	—	—	—	—	—	10	10	#	New	#	3	3	P
Eugenia praecox Roxb.	808	100	3	G	435	353	0	New	515	163	10	G	635	230	30	G
Eugenia sp.	#	25	2	P	—	—	—	—	—	—	—	—	—	—	—	—
Ficus benghalensis Linn.	#	#	3	N	—	—	—	—	—	—	—	—	—	—	—	—
Ficus benjamina Linn	#	#	13	N	—	—	—	—	—	—	—	—	—	—	—	—
Ficus glomerata Roxb.	#	5	6	P	0	13	38	P	—	—	—	—	—	—	—	—
Ficus hispida Linn. f.	18	35	3	F	78	78	115	F	3	38	#	New	#	30	#	New
Ficus religiosa Linn.	—	—	—	—	#	#	3	N	—	—	—	—	—	—	—	—
Ficus semicordata Linn.	—	—	—	—	#	15	#	New	#	18	#	New	30	83	18	F
Flacourtia jangomas (Lour.) Raeusch	#	5	#	New	#	5	#	New	—	—	—	—	#	8	8	P
Gardenia companulata Roxb.	#	#	4	N	#	35	98	P	—	—	—	—	—	—	—	—
Gmelina arborea Roxb.	8	18	7	F	—	—	—	—	—	—	—	—	—	—	—	—
Grevillea robusta A. Cum	40	23	#	New	—	—	—	—	—	—	—	—	—	—	—	—
Heptapleurum hypoleucum Kurz	223	78	6	G	—	—	—	—	—	—	—	—	—	—	—	—
Holigarna longifolia Roxb.	—	—	—	—	—	—	—	—	—	—	—	—	#	10	13	P
*Khajok	—	—	—	—	—	—	—	—	—	—	—	—	#	5	3	P
Lagerstroemia flos-regine Retz.	#	38	#	New	#	5	#	New	—	—	—	—	—	—	—	—
Lannea coromandelina (Houtl.) Merr.	5	38	8	G	#	8	#	New	#	10	#	New	—	—	—	—
Lannea grandis A. Rich	#	20	12	P	#	28	8	P	—	—	—	—	—	—	—	—
Ligustrum robustum Blume	#	68	25	P	—	—	—	—	—	—	—	—	—	—	—	
Litsea citrata Blume	68	43	10	G	68	103	#	New	70	70	8	G	555	375	28	G
Litsea polyantha Juss	368	385	19	F	368	158	15	G	518	188	15	G	423	150	10	G
Litsea sebifera Thumb.	75	18	#	New	—	—	—	—	345	113	#	New	448	198	15	G

Litsea sp. (1)	#	23	3	P	—	—	—	—	—	—	—	—	—	—	—	—
Litsea sp. (2)	—	—	—	—	#	28	13	P	#	20	#	New	#	40	#	New
Mallotus philippensis (Lamk.) Muell.- Arg.	68	218	18	G	143	163	10	F	100	130	3	F	158	93	5	G
Mangifera indica Linn.	15	5	16	F	108	48	15	G	—	—	—	—	—	—	—	—
Mangifera sp.	—	—	—	—	—	—	—	—	10	33	3	F	5	8	8	F
Marlea begoniaefolia Roxb.	233	330	11	F	285	115	18	G	—	—	—	—	70	13	#	New
Melia azedarach Linn.	#	3	2	P	70	#	#	New	#	3	3	P	48	3	#	New
Morus nigra Linn.	—	—	—	—	33	40	#	New	#	15	#	New	—	—	—	—
Oroxylum indicum Vent.	158	173	19	F	—	—	—	—	—	—	—	—	#	15	5	P
Parkia roxburghii G. Don	—	—	—	—	—	—	—	—	#	13	5	P	—	—	—	—
Pasania polystachya (Wall) Schottky	—	—	—	—	—	—	—	—	128	118	48	G	8	88	10	F
Persea sp.	—	—	—	—	2063	480	85	G	—	—	—	—	—	—	—	—
Phyllanthus emblica Linn.	#	10	#	New	#	23	#	New	30	20	3	G	3	15	5	F
Pinus kesiya Royle ex. Gordon	—	—	—	—	—	—	—	—	290	8	690	F	258	133	705	F
Prunus sp.	—	—	—	—	—	—	—	—	—	—	—	—	5	25	8	F
Psidium guajava Linn.	—	—	—	—	48	20	#	New	#	5	#	New	#	3	#	New
Quercus serrata Thumb.	—	—	—	—	—	—	—	—	665	213	40	G	530	425	128	G
Rhus semialata Murray	65	#	3	F	—	—	—	—	500	145	8	G	378	33	#	New
Rubia sp. (1)	13	83	6	F	—	—	—	—	—	—	—	—	—	—	—	—
Rubia sp. (2)	#	#	2	N	—	—	—	—	—	—	—	—	—	—	—	—
Santalum sp.	—	—	—	—	—	—	—	—	#	18	8	P	—	—	—	—
Saprosma sp.	5420	548	54	G	—	—	—	—	—	—	—	—	—	—	—	—
Schima wallichii (D.C.) Horth	#	15	16	P	128	28	#	New	88	115	53	F	108	78	83	F
Spondias pinnata (Linn.f.) Kurz	#	15	1	New	—	—	—	—	—	—	—	—	—	—	—	—
Syzygium cumini (L) Skeel	#	3	#	New	—	—	—	—	—	—	—	—	—	—	—	—
Syzygium jambos Linn. (Alston).	#	#	1	N	—	—	—	—	—	—	—	—	—	—	—	—
Syzygium sp.	—	—	—	—	—	—	—	—	#	13	30	P	—	—	—	—
Tamarindus indica Linn	3	5	#	New	—	—	—	—	—	—	—	—	—	—	—	—
Terminalia citrina Roxb.ex Flem	—	—	—	—	—	—	—	—	38	73	13	F	—	—	—	—
Thevetia neriifolia Juss.ex Steud	#	5	#	New	—	—	—	—	—	—	—	—	—	—	—	—
Toona ciliata M. Roem	—	—	—	—	#	3	#	New	—	—	—	—	#	3	#	New
Trema orientalis Blume	28	43	6	F	28	53	#	New	#	10	#	New	#	#	5	N

*Uha	#	13	15	P	—	—	—	—	—	—	—	—	—	—	—	—
Vanguirea spinosa Linn.	#	48	17	P	30	43	110	F	—	—	—	—	#	8	#	New
Viburnum sp.	—	—	—	—	—	—	—	—	#	#	3	N	—	—	—	—
Wendlandia exerta DC.	—	—	—	—	—	—	—	—	—	—	—	—	#	63	3	P
Wendlandia tinctoria Roxb	—	—	—	—	—	—	—	—	38	153	15	F	168	245	23	F
Xylosma longifolia Clos	388	170	3	G	190	110	23	G	#	5	#	New	230	85	20	G
Zanthoxylum rhetsa Roxb.	#	13	4	P	—	—	—	—	—	—	—	—	—	—	—	—
Zizyphus jujuba Lam.	—	—	—	—	8	25	5	F	—	—	—	—	—	—	—	—

F - Fair regeneration, G - Good regeneration, P - Poor regeneration and N - Not regenerating.

* - Local name, - absence of species, # - Absence of seedling/sapling/tree

regeneration. Fourteen species (37%) were newly recruited to the grove, while one species (3%) did not show regeneration. In Heingang Marjing sacred grove out of 42 species, 7 species (17%) exhibited good regeneration, 11 species (26%) exhibited fair regeneration and 12 species (29%) showed poor regeneration. Eleven species (26%) were categorised as new arrivals, and one species (2%) was found not regenerating (Table IV. 7).

Discussion

The floristic survey of the four sacred groves revealed the occurrence of 173 plant species belonging to 145 genera under 70 families and two species remained unidentified. Tree species contributed maximum (47%) to the total species content of the sacred groves, herbs constituted 39% and shrubs 14%. The numbers of tree, shrub and herb species differed from grove to grove. The varied species richness of the four groves may be due to the variations in their altitude, microclimate, edaphic characteristics and biotic disturbances. The altitudinal variation affects the floristic composition as has been reported by Ganesh *et al.* (1996) in the Western Ghats. Out of the 173 plant species, 81 were woody species representing 59 genera under 33 families. The species content in these sacred groves is far greater as compared to 111 species reported to be present in the four sacred groves in the Pondicherry region of south India ~~by~~ (Ramanujam and Kumar (2003). Out of the total vascular plants, angiosperms contributed the highest (95.9%), followed by pteridophytes (3.5%) and gymnosperms (0.6%). Among the angiosperms, dicotyledons were the dominant component (92.5%) in the four groves. Gymnosperms and pteridophytes were represented by 1 and 6 species, respectively. The percentage contribution of angiosperms (95.9%) to the flora of the four sacred groves of Manipur compares favourably with the contribution of angiosperms (94%) to the total flora of the sacred groves of Meghalaya (Jamir and Pandey 2002). Though there is no sharp boundary, vegetation of the groves is restricted to the grove itself and has not expanded to the adjoining areas. It may be due to the poor natural regeneration in the peripheral area (Khiewtam 1986) or appropriate conditions for the species to establish may not be available. *Saprosma* sp. and *Ligustrum robustum* are the dominant species in the Konthoujam Lairembi sacred grove whereas *Ficus hispida* and *Vanguirea spinosa* are the dominant and co-dominant species respectively in Mahabali sacred grove. The two groves located in hills are dominated by *Pinus kesiya*. The vegetation of the groves is vertically stratified into tree, shrub and herb layers.

Profile diagrams of vegetation of the four groves revealed the existence of four strata, which are composed of different species in different groves. Ralhan *et al.* (1982) have shown 2-5 strata for the low altitude forest of the Central Himalaya whereas Adhikari *et al.* (1991) reported 2-4 strata for the high altitude forests of Kumaon in the Central Himalaya. In Konthoujam Lairembi sacred grove, the canopy cover was maximum due to the emergence of *Artocarpus lakoocha* and *Ficus benjamina*, and this allowed low penetration of light beneath the topstorey. The emergent layer of the canopy increased the depth of topstorey layer of the grove, which created heterogeneous microenvironment in the grove, thus allowing the maintenance of a diversified species composition (Cao and Zhang 1997). *Saprosma* sp. exhibited the maximum density at understory level. *Ficus glomerata* and *Persea* sp. occupied the topstorey with sparse emergent layer in Mahabali sacred grove, which allowed the easy penetration of sunlight while *Gardenia companulata* dominated the understorey layer. *Pinus kesiya* had maximum canopy coverage and contributed the highest density in the Langol Thongak Lairembi and Heingang Marjing sacred groves. Understorey layer was dominated by *Terminalia citrina* and *Wendlandia tinctoria* in Langol Thongak Lairembi sacred grove, whereas *Wendlandia tinctoria* and *Xylosma longifolia* were dominant in the Heingang Marjing sacred grove.

Ground vegetation of the groves is composed of the shrub and herb layers. *Lantana camara* was common in the shrub layer of the groves except in Heingang Marjing sacred grove. *Glycosmis arborea* was the dominant species in the shrub layer of Mahabali sacred grove due to its good regeneration through seeds. *Melastoma malabathricum* was dominant in both the groves located in hills, however, this species was not observed in the two groves located in plains. *Ficus silhetensis* and *Triunfetta cana* were the co-dominants in the Langol Thongak Lairembi, and Heingang Marjing sacred groves, respectively. The herb layer was formed by a number of annual and perennials herbs, which facilitate the functioning of the ecological processes in these sacred forests. The multi-layered structure of the groves are more effective in the protection and conservation of soil and water resources.

The subtropical forests of Manipur harbour over 2197 species of flowering plants out of 15,000 known and described species of flowering plants in India (Kikim 1999). Among the 15,000 species of flowering plants, over 5,000 species are woody species of which at least 2500 are trees (Puri 1995). Out of 173 species belonging to 145 genera and 70 families that occurred in the four sacred groves of Manipur, 166 species (95.9%) representing 138 genera under 67 families were the flowering plant species. The numbers of species, genera and families that occurred in the four sacred groves of Manipur are comparable to the numbers of species, genera and families recorded from the Kakachi forest in southern Western Ghats (Ganesh *et al.* 1996), and moist deciduous and evergreen forest of Kodayar, Western Ghats (Sundarpandian and Swamy 1997). The number of families in the forests studied by these workers is much less compared to the four sacred groves of Manipur. Thus, the sacred groves of Manipur are not only rich in plant diversity but also rich in diversity of families. The number of species recorded in sub-tropical evergreen forests of Meghalaya ranged from 159 to 176 and the number recorded in sub-tropical semievergreen forests ranged from 102-211 (Tripathi 2002). The higher numbers of species present in these groves in comparison to the Western Ghats may be attributed to high rainfall and moderate climatic conditions prevailing in Manipur.

The biological spectra of the four sacred groves of Manipur are more or less similar to the normal spectrum of phanerogamic flora of the world. This indicates that the vegetation is a relic of the tropical evergreen forests. The biological spectrum prepared on the basis of all the species of different life forms present in the four sacred groves shows 69% phanerophytes, 6% chamaephytes, 12% hemicryptophytes, 8% cryptophytes and 5% therophytes. In the groves spectrum, the phanerophytes deviate 23% from the normal spectrum. Compared to the normal spectrum, the proportion of phanerophytes was greater in the four groves (74% in Konthoujam Lairembi sacred grove, 68% in Mahabali sacred grove, 68% in Langol Thongak Lairembi sacred grove and 70% in Heingang Marjing sacred grove). Konthoujam Lairembi and Langol Thongak Lairembi sacred groves showed same proportion (6%) of cryptophytes, while Mahabali and Heingang Marjing sacred groves showed 5% of cryptophytes as against 6% found in the normal spectrum. However, the percentage of hemicryptophytes and therophytes was lower than the normal spectrum in all the studied groves. This may be due to the higher proportion of topstorey and understorey species, which were mostly phanerophytes. It appears that the conditions prevailing in Manipur were favourable for phanerophytes and not for hemicryptophytes. The Konthoujam Lairembi sacred grove exhibited the trend of biological spectrum where phanerophytes > chamaephytes = hemicryptophytes > cryptophytes > therophytes, while Heingang Marjing sacred grove exhibited the trend; phanerophytes > chamaephytes > hemicryptophytes = cryptophytes < therophytes. The spectra of the Mahabali and Langol Thongak Lairembi sacred groves showed the trend where phanerophytes > chamaephytes < hemicryptophytes > cryptophytes = therophytes. The differences in the climate and other environmental conditions in the groves located at different elevations (plains and hills) seem to favour the development of different life forms in different proportions; however biotic disturbance may also change the proportion of life forms. Pandeya (1954) and Tiwari (1955) concluded that the biological spectrum of a region reflects the most operative feature of the environment and the climate of the region. The basic nature of Raunkiaer's biological spectrum has also been examined by Fekete and Lacza (1971) with emphasis on how it can become a tool in phytogeography and plant ecology.

The species richness of different life forms, such as trees, shrubs and herbs, is one of the major considerations in recognizing the importance of an area for conservation. Among the forest types, tropical forests are rich in species diversity (Paijmans 1970, Richards 1952). Species richness recorded in the four sacred groves of Manipur falls within the range, 35-90 species per hectare. Species occurrence and dominance differ from grove to grove according to the preferences of the species towards the prevailing micro environmental conditions. The species richness of the vegetation followed the trend where the tree layer>herb layer>shrub layer which is similar to that reported by Singh *et al.* (1995). The highest species richness for tree species was found in Konthoujam Lairembi sacred grove (45 species) and lowest in Mahabali sacred grove (20 species). However, the number of species recorded in these groves was quite low as compared with the 84 species per 0.4 ha in humid tropical forest of silent valley in the Western Ghats of India (Singh *et al.* 1981). As reported by Procter *et al.* (1983) and Whitmore (1984), the number of tree species per hectare in tropical rain forests was in the range of 20 to 223 species. The number of shrub species in the groves was smaller than the herb species, however, the total number of species did not vary much among the groves. Many factors affect the species diversity in tropical forest (Connell 1971, Hubbell 1979, Janzen 1970, Parthasarathy 1999). The differences in species diversity of herbs among the groves may be due to varying density of tree species. Sparse canopy layer, which provides suitable light conditions favours the growth of herbs (Bhatnagar 1966). Saxena and Singh (1982a) also suggested that different species come up in the forest according to their preferences of light and shady environment. The species richness and species richness index in the sacred grove vegetation followed the order of trees > herbs > shrubs.

The level of disturbance due to anthropogenic interference in the forest also changes the species diversity, tree density and basal area (Mishra *et al.* 2003, Rao *et al.* 1990). Smiet (1992) also reported that basal area value could be related to the stand disturbance index. The recorded stand density of trees (359 to 1218 stems ha^{-1}) in the four groves is much higher than the reported stand density of 210 to 270 stems ha^{-1} in six sacred groves of Tamil Nadu (Kumar and Swamy 2003), 80-160 stems ha^{-1} in four groves of Pondicherry (Ramanujam and Kumar 2003) and 280 stems ha^{-1} in another sacred grove (Marakkanam sacred grove) of Pondicherry region in southern India (Visalakshi 1995). In fact, the stand density in the sacred groves of Manipur was markedly higher than the Western Ghats but lower than the value (1570 to 1785 stems ha^{-1}) reported for the montane forests of Garhwal Himalaya (Bhandari and Tiwari 1997) and Lalong and Railang sacred groves (938-1476 stems ha^{-1}) of Jaintia hills in Meghalaya (Jamir 2002, Upadhaya 2002). Stand density in the two groves located in the plain area, Konthoujam Lairembi grove and Mahabali grove, falls within the range of 245-859 stems (>30 cm gbh) per hectare reported for tropical forests (Ashton 1964, Bhuyan *et al.* 2003, Campbell *et al.* 1992, Richards 1952). The stand density of the two groves located in hills (995 and 1218 stems ha^{-1}) was higher than the groves located in the plain area and the oak forest of Manipur (Srinivas 1992) which ranged from 181 to 219 stems ha^{-1}. However, it was lower than the stand density (1813 to 2825 stems ha^{-1}) of Shiroy hills of Manipur (Yadava and Singh 1988). The density of shrubs recorded in the groves was also within the range (1800 to 7000 per ha) of old growth tropical plantations (Pande *et al.* 1988). The gradients of elevation, environmental factors, and habitat and soil characteristics may eventually lead to the variations in species diversity and density. Species diversity is often correlated with rainfall and nutrient status (Hartshorn 1980). The overall comparison shows that the groves exhibited comparatively higher density and species diversity than the Western Ghats which may be attributed to the differences in environmental conditions.

The values of basal area (35.51 to 85.54 m^2 ha^{-1}) of the groves are much higher than that of the reported range of 11 to 68 m^2 ha^{-1} for tropical forests (Parthasarathy *et al.* 1992, Visalakshi 1995), and the vegetation of dry tropics 17-40 m^2 ha^{-1} (Murphy and Logo 1986), however, it is close to the
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Ialong and Railang sacred groves of Meghalaya, where it ranged from 36.52 m^2 ha^{-1} and 71.44 m^2 ha^{-1}, respectively. The recorded range of basal area in the groves is greater than the Shiroy hills forest (32.9 to 34.53 m^2 ha^{-1}, Yadava and Singh 1988) and oak forests in Manipur (53.98 to 61.8 m^2 ha^{-1}, Srinivas 1992). The strikingly high basal area (85.54 m^2 ha^{-1}) obtained in

Mahabali sacred grove is close to the basal area (73.6 m^2 ha^{-1}) at Gum Gum, Sabah (Burgess 1961) which reflects the presence of matured good-sized native or primary forest species having larger girth. The lowest basal area recorded in Langol Thongak Lairembi sacred grove may be due to the dominance of *Pinus kesiya* having narrow range of girth class.

Different life forms, such as trees, shrubs and herbs, have different diversity patterns (Grubb 1977). Diversity indices for trees, shrubs and lianas are always maximum in natural forest, however, any disturbances may lead to the decline of diversity. On the other hand, diversity of herbaceous layer could be comparatively greater in the moderately disturbed forests. Difference in species diversity between communities generally results from variations in site quality (Denslow 1980a). Shannon-Weiner diversity indices are generally high for tropical forests which range from 0.81-4.1 for the Indian subcontinent (Bhuyan *et al.* 2003, Parthasarathy *et al.* 1992, Singh *et al.* 1984, Visalakshi 1995). The values of the present study fall within the reported range for tropical forests, and are markedly lower than those reported by Knight (1975) for young (5.06) and old (5.4) stands.

The average value for the concentration of dominance was reported by Knight (1975) to be 0.06, while in tropical forests in India the values lie within the range of 0.21 to 0.92 (Bisht 1989, Parthasarathy *et al.* 1992, Visalakshi 1995). Thus, the values for these groves fall within the range as reported for tropical forests elsewhere. The species diversity indices showed the trend, herbs>trees>shrubs, while the concentration of dominance values showed opposite trend (shrubs>trees>herbs). High diversity and low concentration of dominance may be due to the different level of biotic influences in the groves. In general, species diversity and concentration of dominance showed inverse relationship (Joshi and Behera 1991, Murthy and Panthak 1972, Singh and Mishra 1969).

The Similarity index (Sorensen 1948) was calculated in order to understand the extent of similarity between the groves. Langol Thongak Lairembi and Heingang Marjing sacred groves showed relatively greater similarity as the similarity index between them was 44%, which was the maximum value obtained in the present study. This indicates that these two groves had somewhat similar edaphic and biotic conditions. Mahabali and Heingang Marjing sacred groves showed least similarity (similarity index 14.3%) among all the groves. All the four groves of the present study showed a remarkable degree of dissimilarity in their species composition of trees, shrubs and herbs. Only four species were common to the four groves, and these were *Gomphrena decumbens* (a herb), *Lantana camara* (a shrub) and 2 trees species namely, *Litsea polyantha* and *Mallotus philippensis*. The least similarity in occurrence of the species common to the groves may be due to the narrow ecological amplitude of the species and differences in the prevailing habitat conditions. Certain species were exclusive to a particular grove, for example, 23 tree species were exclusive to Konthoujam Lairembi sacred grove, 7 tree species to Mahabali sacred grove, 8 tree species to Langol Thongak Lairembi sacred grove and 13 tree species were exclusive to Heingang Marjing sacred grove. Among the shrubs, 6 species were exclusively found in Konthoujam Lairembi and Mahabali sacred groves, while

Langol Thongak Lairembi grove and Heingang Marjing sacred grove had only 3 and 2 exclusive species, respectively. The maximum (17) exclusive species were recorded in Mahabali sacred grove, followed by 15 species in Konthoujam Lairembi sacred grove, 10 species in Heingang Marjing sacred grove and 8 species in Langol Thongak Lairembi sacred grove. Murphy and Logo (1986) suggested that the differences in the species composition and physiognomy of vegetation might be due to soil characteristics. The variation in other habitat conditions may also alter the species composition.

β diversity explains the species richness of a plant community (Brokaw and Scheiner 1989, MacArthur 1965, Whittaker 1972, 1977, Wilson and Shmida 1984) and measures the extent of species replacement or biotic change along environmental gradients (Brokaw and Scheiner 1989, Whittaker 1972) which also reflect the extent of similarity and habitat diversity among the study sites. The recorded β diversity values were higher than those of the reported values by Pande (2001) for tropical dry deciduous teak forest of the Satpura plateau, Central India, but lower than the values recorded by Pande *et al.* (2002) for Western Himalaya. The calculated β diversity values elucidate that the extent of changes of species in the tree layer was highest between Mahabali and Langol Thongak Lairembi sacred groves. Different topography, edaphic and biotic factors may have contributed to the different species composition between these groves. The variation in β diversity value of the groves shows that species composition varies from one habitat to another. Pande *et al.* (1996) argued that the altitude and different aspects, significantly affect the turnover of species.

Analysis of IVI of a species can be used to recognize the pattern of association of dominant species in a community (Parthasarathy and Karthikeyan 1997a). Among the dominant species of trees in Konthoujam Lairembi sacred grove, *Saprosma* sp. with the IVI value of 29.7 contributed the maximum density (54 stems ha^{-1}). The dominant tree species, *Persea* sp. in Mahabali sacred grove with the highest IVI value (52.4) also had the maximum stem density (85 ha^{-1}). *Pinus kesiya* with the highest IVI value was the dominant species of the two groves located in the hills and contributed the highest stem density (690 stems ha^{-1} and 705 stems ha^{-1}) in Langol Thongak Lairembi and Heingang Marjing sacred groves, respectively. The highest number of rare species (12 species accounting for 40% of the total) was recorded in Heingang Marjing sacred grove followed by 9 (36%) species in Langol Thongak Lairembi sacred grove. The percentage of rare species in these groves is more or less analogous to 40% species rarity reported in Barro Colorado Island, Panama (Thorington *et al.* 1982) and in Uppangala (Pascal and Pelissier 1996), and 50% reported in New Guinea (Paijmans 1970). The species rarity in Konthoujam Lairembi sacred grove was 28.9% and in Mahabali sacred groves it was 25%. The percentage species rarity was greater in the groves located in hills compared to those in the plains. The over-all percentage species rarity in the four sacred groves, compares favourably with the species rarity reported by Poore (1968) in Malaysia, and it is greater than the values obtained by Parthasarathy and Sethi (1997) in a tropical forest at Puthupet, south India and by Kadavul and Parthasarathy (1999) in tropical forest of Kalrayan hills in the Eastern Ghats, but is lower than the value (59%) reported by Ho *et al.* (1987) from a forest in Malaysia. The liana *Entada scandens* which was found only in Konthoujam Lairembi sacred grove comes under the rare category having only one individual.

The greater contribution of seedlings, saplings and young trees to the total population indicates successful regeneration (Khan *et al.* 1987, Saxena and Singh 1984) of most of the tree species. The future community structure and regeneration potential of the species could be predicted from the relative proportion of seedlings and saplings in the total populations of various species in the forest. Natural regeneration and establishment of primary forest species are the crucial phases because their requirements are more species-specific (Gomez-Pompa *et al.* 1972, Primack 1990, Whitmore 1984). In general, regeneration of species is affected by anthropogenic factors (Barik *et al.* 1996, Khan and Tripathi 1989b, Sukumar *et al.* 1994) and natural phenomena (Welden *et al.* 1991). Occurrence of plant species that were represented only by seedlings and saplings was high in the four groves. This may be due to the invasion of new species through dispersal from other areas. Possibly, the prevailing favourable microenvironmental conditions contributed to their establishment and growth in the groves. Microsite characteristics of the forest floor and microenvironmental conditions under the forest canopy also influence the regeneration of trees by seeds (Tripathi and Khan 1990). Absence of seedlings and saplings of some of the species in the groves may be due to their poor seed germination and establishment of seedlings in the forest.

The analysis of population structure of tree species in the groves, based on the girth classes, shows that the populations of a large number of tree species are stable. It was observed that about 50% of tree species showed reduced population size in the succeeding girth classes. However, a drastic decrease in population size was observed with increase in girth beyond a particular stage. The absence of a certain girth class e.g. 180-120 cm in Langol Thongak Lairembi grove and Heingang Marjing groves may indicate an interruption in the regeneration, resulting from the changing microclimatic conditions (Bankoti *et al.* 1986). The high value of tree basal area in the highest girth class could be attributed to the presence of *Ficus* species, which had big trees with large basal area. Langol Thongak Lairembi and Heingang Marjing sacred groves recorded the lowest basal area in the highest girth class as compared to the other groves located in the plain area, which may be due to the dominance of *Pinus kesiya* trees having less girth in the groves located in the hilly area. There was a gradual decrease in species diversity and density with increase in girth class which is in conformity with the studies in the Western Ghats, India (Pascal and Pelisseir 1996, Parthasarathy and Karthikeyan 1997a), Malaysia (Manokaran and LaFrankie 1990, Newbery *et al.* 1992), Costa Rica (Lieberman *et al.* 1985, Nadkarni *et al.* 1995), New guinea (Paijmans 1970) and New Caledonia (Jeffre and Veillon 1990).

In conclusion, it may be mentioned that the four sacred groves of Manipur have a high level of plant species diversity, with the dominance of phanerophytic plants. *Pinus kesiya* dominated the two groves located in hills, while the two groves located in plain were dominated by *Saprosma* sp. and *Persea* sp. Regeneration status of the groves was generally good as indicated by the presence of adequate numbers of seedlings and saplings of the tree species.

CHAPTER V

Ethnobotanical studies on plant species of the four selected sacred groves

Ethnobotany covers the holistic relationship between plants and man. Ethnobotanical use of plants has been known since time immemorial in the history of human civilization and several plants were used to cure diseases and to maintain good health. Ethnobotanically important plants are derived from biodiversity of the world which is considered as natural irreplaceable resource, base of subsistence for the people, fulfilling many of the basic and secondary needs of the rural and urban communities in terms of medicine, food, firewood, etc. Biodiversity is the very basis of human survival and economic well being (Singh *et al.* 1994) and constitutes the resources upon which families, communities, nations and future generations depend (Dowdeswell 1995). Further, biological resources have the critical character of being renewable, and so, with proper management they can be used sustainably (McNeely *et al.* 1990), ensuring their use for our future generations. India is a treasure land of biodiversity having large variety of plant and animal species, and comprises 2 of the 25 global biodiversity hotspots. It is extremely rich in medicinal plants which comprise about 7,500 species, amongst nearly 17,000 flowering plant species it harbours (Ved *et al.* 2001). In India around 70% of medicinal plants are found in the tropical areas mostly in the various forest types spread across the Western and Eastern Ghats, the Vindhyas, Chotanagpur plateau, Aravalis, the Tarai region in the foothills of Himalayas and north-eastern region. There is an inextricable link between indigenous culture, ethnic diversity and biodiversity. The ethnic people have emotional and symbiotic relationship with biodiversity which they have been protecting and conserving since ancient times. The sacred groves and the tribal communities living around them offer a good example of this symbiotic relationship. As a result of this, sacred groves are still conserved and contain a diverse gene pool of ethnobotanically important species. Medicinal plants that occurred abundantly in extensive areas are disappearing fast due to the lack of human care, urbanization, development activities and population explosion. However, the sacred groves found in various regions of India are still conserving the medicinal plants by providing suitable habitat for their sustainable natural regeneration. The good old tradition of informal management of forests, such as sacred groves, has certainly contributed to the conservation of useful species. Also the people have tended to 'discover' medicinal values more often among plants unique to sacred groves than those found in other landscapes (Boraiah *et al.* 2003). Thus, it is essential to have a proper documentation of such plants. It is also necessary to know the potential and values of medicinal plants for the improvement of health and hygiene through eco-friendly systems. Several works on medicinal plants in relation to their utilization and conservation have been conducted in many parts of India (Airi *et al.* 2000, Bhakat and Pandit 2003, Biswas *et al.* 2003, Chandrashekara *et al.* 2001, Dhar 2002, Srinivasmurthy *et al.* 2003, Sumit and Dhar 2002).

The ethnic people of Manipur (*Meitei* community) are quite aware of the uses of plant species having ethnobotanical values. Sacred groves of Manipur, existing in ~~varied~~ different locations, harbour rich diversity of species having high potential of medicinal plants. In Manipur, plants have been the source of medicine from time immemorial to treat different ailments and are associated with various folklore and rituals, which are performed by *maiba* (traditional herbal healers or priest). A critical analysis of the definition of traditional medicine given in the WHO Technical Report (Anonymous 1978) clarifies the point. The definition reads: "The traditional medicine is the sum total of all knowledge and practices, whether explicable or not, used in diagnosis, prevention and elimination of physical, mental or social imbalance and relying exclusively on practical experience and observation handed down from generation to generation, whether verbally or in writing." The inventorization of uses of medicinal plants in Manipur has not been done precisely. History reveals that there has been a good description of medicinal plants and herbal treatment for many diseases in the beginning of the 14th century. A number of works on ethnobotany of Manipur has been done and some comprehensive account of its folklore is available (Korshantabi 1992, Kumar 1990, Singh 1996, Singh 1997a, b, c, Singh and Singh 1996, Singh *et al.* 1992, Singh *et al.* 2001, Singh *et al.* 2002, Singh *et al.* 2003, Sinha 1986). But, so far, no work has been conducted to study the enthobotanical uses of plant species found in sacred groves of Manipur.

Methodology

Ethnobotanical information

An ethnobotanical survey was carried out between 2001-2002 to collect information on the uses of plants that occurred in the selected sacred groves of Manipur. Ethnobotanical data were collected based on semi-structured interviews with selected knowledgeable elders (Cotton 1996, Martin 1995). The information on medicinal plants was also gathered from the medicine-men known as '*Maibas*' to whom the knowledge was passed on from their ancestors. Published literature and books were also consulted to acquire information about the ethnobotanical uses of the plant species. While collecting data, main emphasis was laid on the medicinal uses of plants rather than other uses. Other ethnobotanical studies like the collection of information through folklore, oral tradition, etc., were made as per Jain and Rao (1977).

Vegetation sampling

The vegetation survey was carried out during 2001 and 2002 in four selected sacred groves of Manipur namely, Konthoujam Lairembi, Mahabali, Langol Thongak Lairembi and Heingang Marjing sacred groves and the relevant information on the vegetation of these groves are presented in chapter IV. Information on ethnobotanical importance of the plant species were extracted from the details given in chapter IV.

Conservation status of plants

Information on conservation status of different plant species were recorded from the available literature of the Manipur State Biodiversity Strategy and Action Plan (2002) prepared for the project relating to the National Biodiversity Strategy and Action Plan, Govt. of India.

Results

Ethnobotanical importance of plants

The ethnobotanical survey revealed that out of the 173 species recorded from the 4 sacred groves, (Table V.1), 125 species (72%) representing 109 genera and 59 families, have the ethnobotanical importance. There are 11 species belonging to Asteraceae and 8 species to Verbenaceae. The families Anacardiaceae, Moraceae, Poaceae, and Rubiaceae were represented by 6 species each. The family Euphorbiaceae was represented by 5 species, whereas Lauraceae and Rosaceae were represented by 3 species each. The other families were represented by 2 or 1 species. *Marlea begoniaefolia* and *Panicum repens* are used in rituals only, leaves of *Litsea citrata,* and *Quercus serrata* are used in sericulture and seeds of *Muscari commutalum* are used as bead in necklace. *Artemisia nilagirica*, *Duranta repens* and *Maesa indica* are used as insecticides, and *Wendlandia exerta* is used as vegetable.

Table V. 1. Details of the enumerated species having ethnobotanical importance, their regeneration mode and conservation status.

Species: Scientific name	Species: Local name	Family	Importance/Value	Plant parts used	Application	Route of application	Regeneration mode	Conservation status
Trees								
Adenanthera pavonina Linn.	Rata-chandan	Mimosaceae	Used as medicine	Seed & root	For causing and preventing abortion of child, against cough & fever	Oral	Seed	–
Albizia lebbeck Benth.	Kiyam-lei	Mimosaceae	Used as medicine and for rituals	Leaves, seed, bark & root	Eye troubles, bronchitis, leprosy, paralysis and helminth infections, piles & dental problems.	Eye & oral	Seed	–
Albizia odoratissima Benth.	Uyil	Mimosaceae	Used as medicine and for fish poisoning	Leaves & bark	Cough, cutaneous infection, leprosy & invertebrate ulcers	Skin & oral	Seed	–
Albizia procera Benth.	Luwang-khoi	Mimosaceae	Used as medicine and for fish poisoning	Plant & bark	Stomach, intestinal diseases, rheumatism & haemorrage	Oral	Seed	–
Albizia stipulata (Roxb.) Boivin	Khok	Mimosaceae	Used as medicine and for fish poisoning	Bark & leaves	Cutaneous infections	Oral	Seed	–
Alnus nepalensis D. Don	Pareng	Betulaceae	–	–	–	–	Seed	Threatened
Anthocephalus chinensis Walp.	Keli	Rubiaceae	Used as medicine	Bark	Tonic and febrifuge	–	Seed	–
Aphanamixis polystachya (Wall.) Parker	Hei-ranggoi	Meliaceae	Used as medicine and for rituals	Fruit	Liver complaints & leucorrhoea	Oral	Seed	Endangered
Artocarpus lakoocha Roxb.	Hari-konthong	Moraceae	Used as medicine	Bark & ripe fruit	Antiseptic, constipation & fever	Skin & oral	Seed	–
Bauhinia purpurea Linn.	Chingthrou	Caesalpinaceae	Used as medicine	Bark	Poisonous bite, leucorrhoea, menstrual disorder & leprosy	Skin & oral	Seed	–
Bauhinia variegata Linn.	Chingthrou	Caesalpinaceae	Used as medicine	Bark, root & buds	Leucorrhoea., cutaneous troubles, diarrhoea, dysentery & piles.	Oral	Seed	–
Bischofia javanica Blume	Uthum naroubi	Euphorbiaceae	Used as medicine	Leaves & bark	Sores & throat troubles	Oral	Seed	–

Bombax ceiba Linn.	Tera	Bombacaceae	Used as medicine	Bark, flower & young fruit	Skin diseases, female diseases & snake bite	Oral & skin	Seed	Rare & Vulnerable
Celtis timorensis Linn.	Heikreng	Ulmaceae	Used as medicine and for rituals	Leaf	Dysentery & jaundice	Oral	Seed	–
Chukrasia tabularis Andr. Juss.	Tairen-manbi	Meliaceae	Used as medicine	Young leaves & bark	Astringent	Oral	Seed	–
Cordia grandis Roxb.	Lamuk	Boraginaceae	Used as medicine	Fruits	Urinary infections	Oral	Seed	–
Entada scandens Benth	Kangkhil	Mimosaceae	Used as medicine	Bark & seed	Stomach ulcer, fever & headache	Oral	Seed	–
Eucalyptus citriodora Hook.	Nasik	Myrtaceae	Used as medicine	Leaves	Cough, cracking, loosing of limbs & hair lotion	Oral, skin & shampoo	Seed	–
Ficus benghalensis Linn.	Khonang-bot	Moraceae	Used as medicine	Young prop roots & bark	Obstruction of urine flow, exudation of puss, piles	Oral & chewed	Seed	–
Ficus benjamina Linn.	Khongang-loirung	Moraceae	Used as medicine	Leaves & tender shoot	Ulcer, dysentery & cough	Oral	Seed	–
Ficus glomerata Roxb.	Hei-bong	Moraceae	Used as medicine	Root, fruit & wood latex	Dysentery, diabetes, lung diseases & skin irritation	Oral & skin	Seed	–
Ficus hispida Linn. f.	Ashi-heibong	Moraceae	Used as medicine	Leaves, bark & fruit, seeds	Ringworms, dysentery & intestinal worm infection	Oral & chewed	Seed	–
Ficus religiosa Linn.	Sana-khongnag	Moraceae	Used as medicine	Bark	Boils & gonorrhoea	Oral	Seed	–
Ficus semicordata Linn.	Hei-yit	Moraceae	Used as medicine	Bark	Dysentery & liver complaints	Oral	Seed	–
Flacourtia jangomas (Lour.) Rausch	Hei-troy	Flacourtiaceae	Used as medicine	Fruit	Bleeding gum and toothache & diabetes	Oral	Seed	–
Gardenia companulata Roxb.	Lam- heibi	Rubiaceae	Used as medicine	Fruits	Diabetes	Oral	Seed	–
Gmelina arborea Linn.	Wang	Verbenaceae	Used as medicine	Root, leaves, flower & plant	Gonorrhoea, cough, fever, boils affections, blood diseases & poisonous bite	Oral	Seed	–
Heptapleurum hypoleucum Kurz	Chom	Araliaceae	Used as medicine	Root	Boils affections	Skin	Seed	–
Holigarna longifolia Roxb.	Kherai	Anacardiaceae	Used as medicine, Poisonous plant	Bark	Poisonous and vesicant	Oral	Seed	–
Lannea coromandelina (Houtl.)	Akman	Anacardiaceae	Used as medicine	Leaves, bark & fruit,	Ulcers, eyesores, toothache, and elephantiasis	Oral & skin	Seed	–

Litsea citrata Blume	Nongnang-kori	Lauraceae	Used for silkworm	Leaves	–	–	Seed	–
Litsea Polyantha Juss	Tumid-la	Lauraceae	Used as medicine	Leaves, bark & seed	*Diarrhoea*, *rheumatism* body pain & fractured bones for animals	Oral & skin	Seed	–
Litsea sebifera Thunb.	Thang-hidak	Lauraceae	Used as medicine	Leaves & bark	Cut and injuries for early suppuration & muscular sprain	Skin	Seed	–
Mallotus philippensis (Lamk.) Muell. & Arg.	Ureiromlaba	Euphorbiaceae	Used as medicine and for rituals	Fruit & seed	Cutaneous diseases & skin diseases	Oral & skin	Seed	–
Mangifera indica Linn.	Heinou	Anacardiaceae	Used as medicine and for rituals	Fruit	Constipation	Oral	Seed	–
Mangifera sp.	Hei-nou	Anacardiaceae	Used as medicine and for rituals	Fruit	Constipation	Oral	Seed	–
Marlea begoniaefolia Roxb.	Kokan	Cornaceae	Used in rituals	Leaves	During the lunar or solar eclipse	–	Seed	–
Melia azedarach Linn.	Seijrak	Meliaceae	Used as medicine	Leaves, flowers, gum, seed & bark	Nervous headache, removing lice, skin diseases, insect repellent, spleen enlargement, rheumatism & ascariasis	Oral & skin	Seed	–
Oroxylum indicum Vent.	Shamba	Bignoniaceae	Used as medicine	Leaves & bark	Epilepsy, muscular sprains & general weakness	Oral & skin	Seed	–
Parkia roxburghii G. Don	Yong-chak	Mimosaceae	Used as medicine and vegetables	Tender pod & bark	Intestinal disorder, bleeding piles, diarrhoea & dysentery	Oral	Seed	–
Pasania polystachya (Wall) Schottky	Shaii	Fagaceae	–	–	–	–	Seed	Threatened
Phyllanthus emblica Linn.	Hei-kru	Euphorbiaceae	Used as medicine	Fruit	Dyspepsia & jaundice	Oral	Seed	–
Pinus kesiya Royle ex. Gordon	U-chal	Pinaceae	Used as medicine and rituals	Plant	Cough, headache vertigo & mental disorder	Oral & skin	Seed	–
Prunus sp.	Hei-rou	Rosaceae	Used as medicine	Bark	Diabetes	Oral	Seed	–
Quercus serrata Thunb.	Uyung	Fagaceae	Used for silkworm	Leaves	–	–	Seed	–
Rhus semialata Murray	Hei-mang	Anacardiaceae	Used as medicine	Shoots, Leaves & fruit	Intestinal worms, diarrhoea, kidney and urinary complaints, dyspepsia, stomach ulcer &	Oral & shampoo	Seed	–

					hair lotion			
Schima wallichii (DC.) Korth	Usoi	Theaceae	Used as medicine and vegetables	Bark	Expelling worms from intestines & against gonorrhoea	Oral	Seed	Threatened
Spondias pinnata (Linn.f.) Kurz	Hei-nning	Anacardiaceae	Used as medicine	Bark & leave	Dysentery, muscular sprain and backache & dyspepsia.	Oral & skin	Seed	–
Syzygium jambos Linn. (Alston).	Gulap-jat	Myrtaceae	Used as medicine, a sacred tree	Fruit	Deficiency of calcium, vitamin B complex & phosphorous	Oral	Seed	–
Terminalia citrina Roxb.ex Flem.	Manahi	Combretaceae	Used as medicine	Bark & fruit	Masticatory for mild purgative & old skin ulcers	Oral & skin	Seed	–
Trema orientalis (L.) Blume	Yaon	Ulmaceae	Used as medicine	Root	Diarrhoea, presence of blood in urine & epilepsy	Oral	Seed	–
Vanguirea spinosa Roxb.	Heibi	Rubiaceae	Used as medicine	Leaf	Intestinal worm & hoarseness	Oral & skin	Seed	–
Wendlandia exerta DC.	Pheija-laba	Rubiaceae	Used as vegetables	Tender shoot & inflorescences	–	–	Seed	–
Wendlandia tinctoria DC.	Pheija	Rubiaceae	Used as medicine and vegetables	Tender shoot & inflorescences	Cramps & cholera	Oral	Seed	–
Xylosma longifolia Clos	Nongleisang	Flacourtiaceae	Used as medicine	Young leaves & plant	Piles, killing lice & dizziness, hoarseness & regulation of blood circulation	Steam on skin, skin and oral	Seed & vegetative parts	–
Zanthoxylum rhetsa Roxb.	Ngang	Rutaceae	Used as medicine	Seed & bark	Baldness & toothache	Skin & oral	Seed	–
Shrubs								
Artemisia nilagirica (C.B. Clarke) Pamp	Laibak-ngou	Verbenaceae	Used as medicine and insecticides	Leaves	Stomach ulcer, hair lotion & insect repellent	Oral & skin	Seed	–
Callicarpa macrophylla Vahl	Modol-panamana	Verbenaceae	Used as medicine	Leaves	Rheumatic joints	Skin	Seed	–
Clerodendrum serratum (L.) Sprengel	Moirang khanam	Verbenaceae	Used as medicine	Leaves, root & stem	Cough, fever, dysentery, asthma, bronchitis, rheumatism & dyspepsia	Oral	Seed	–
Clerodendrum viscosum Vent.	Kuthap	Verbenaceae	Used as medicine and vegetables	Leaves, roots & flower	Diabetes, regulation of blood pressure, ascarids, tumour & poisonous bite	Oral & skin	Seed	–
Datura suaveolens Willd.	Sagol-hidak	Solanaceae	Used as medicine and for rituals	Leaves	Dizziness, muscular sprain & dysentery	Oral & skin	Seed	–

Duranta repens Linn.	Samban-lei	Verbenaceae	Used as insecticide	Fruit	Lethal to mosquito larva	–	Seed	–
Eupatorium odoratum Linn.	Kam-bleirei	Asteraceae	Used as medicine	Leaves	Gonorrhoea	Oral	Seed	–
Glycosmis arborea (Roxb.) DC.	Yong-komla	Rutaceae	Used as medicine	Root & leaf	Fever, lever complaints, skin troubles, cough, rheumatism, anaemia, jaundice & hair lotion	Oral, skin & shampoo	Seed	–
Lantana camara Linn.	Nongbanlei	Verbenaceae	Used as medicine	Leaves	Constipation, fever & stopping bleeding	Oral & skin	Seed & vegetative parts	–
Maesa indica (Roxb.) A. DC.	–	Myrsinaceae	Used as medicine and insecticides	Fruit & root	Anthelmintic & syphilis	Oral	Seed	–
Melastoma malabathricum Linn.	Yachubi	Melastomaceae	Used as medicine	Leaves & bark	Skin troubles, diarrhoea, dysentery & leucorrhoea	Skin & oral	Seed	–
Mussaenda roxburghii Hook.f.	Hanurei	Rubiaceae	Used as medicine	Leaves	Lotion for hair	Shampoo	Seed	–
Phlogacanthus thyrsiflorus Nees.	–	Acanthaceae	Used as medicine	Inflorescence	Skin diseases	Skin	Seed	–
Rubus moluccanus Linn.	–	Rosaceae	Used as medicine	Leaves. Fruit & Root	Astringent, nocturnal micturition of children & fistula	Oral	Seed	–
Sida rhombifolia Linn.	Uhal	Malvaceae	Used as medicine	Plant	Urinary disorder, rheumatism, tuberculosis & snake bite	Oral	Seed	Endemic & Vulnerable
Solanum torvum Swartz	Shing khangga	Solanaceae	Used as medicine	Leaves & fruit	Cough & tonsil complaints	Oral	Seed	–
Tournefortia candollii C.B.Clarke	Hameibon	Boraginaceae	Used as medicine and vegetables	Root & inflorescences	Employed to bathe the convalescing babies	Bathing	Seed	–
Vitex trifolia Linn.	Urikshibi	Verbenaceae	Used as medicine	Leaves	Rheumatic swelling, rheumatism, sinus, hydrocele & piles	Skin, oral, nasal & steam	Seed	–
Xanthium strumarium Linn.	Samprakpi	Asteraceae	Used as medicine	Leaves	Fever & cough	Oral	Seed	–
Pteridophytes								
Adiantium venustum G. Don	–	Adiantaceae	Used as medicine	Whole plant	Bronchitis, tumours, biliousness, inflammatory diseases of the chest & opthalmia	Oral	Frond	–

Lygodium japonicum (Thunb) Sw.	Lei-uri	Schizaeaceae	Used as medicine	Whole plant	Heart complaints	Oral	Frond	–
Pteris ensiformis Burm.f.	Lai changkhrang	Pteridaceae	Used as medicine	Frond	Dysentery & glandular swelling of neck	Oral & skin	Frond	–
Climbers								
Cissus discolor Blume	Kongyouyen-laba	Vitaceae	Used as medicine and vegetables	Leaves	Skin diseases, poxes, & urinary disorder	Oral	Seed & vegetative parts	–
Dioscorea alata Linn.	Haa	Dioscoreaceae	Used as medicine and vegetables	Tuber	Leprosy, piles, gonorrhoea & blood pressure	Oral & chewed	Seed & vegetative parts	–
Dioscorea bulbifera Linn.	Lam-haa	Dioscoreaceae	Used as medicine	Tuber	Cough, dysentery, piles & ulcers	Oral	Seed & vegetative parts	Vulnerable
Melothria maderaspatana (Linn.) Cogn.	Lam-thabi	Curcubitaceae	Used as medicine	Shoot, leaves & seed	Toothache, jaundice, vertigo & biliousness	Oral	Seed	–
Mikania micrantha Kunth	Uri-hingchabi	Asteraceae	Used as medicine	Fresh leaves	Ring worm & skin diseases	Skin	Seed	–
Paederia foetida Linn.	Oi-num	Rubiaceae	Used as medicine and vegetables	Leaves, bark & root	Stomach disorders, dysentery, piles & bone fracture	Oral & skin	Seed	–
Smilax zeylanica Linn.	Keisum	Liliaceae	Used as medicine and vegetables	Root	Venereal diseases, rheumatic swelling & sores	Oral & skin	Seed	–
Stephania hernandifolia Walp	Thangga-uri angouba	Menispermaceae	Used as medicine	Tuber & leaves	High fever, diarrhoea & urinary complaints	Oral	Seed & vegetative parts	–
Thumbergia grandiflora Roxb.	Sambal Kundop	Acanthaceae	Used as medicine	Leaves	Stomach complaints & cough	Oral	Seed	–
Herbs								
Achyranthes aspera Linn.	Khujum-pere	Amaranthaceae	Used as medicine	Leaves & tender shoot	Piles, menstrual disorder & skin-sores	Oral & skin	Seed	–
Ageratum conyzoides Linn.	Khongjai-napee	Asteraceae	Used as medicine	Leaves	Fresh injuries & hair lotion	Skin & shampoo	Seed	–
Anaphalis contorta (D.Don.) Hook. F	Phunin	Asteraceae	Used as medicine	Seed & young shoot	High blood pressure & intestinal disorder	Oral	Seed	Rare & Vulnerable
Bassella alba Linn.	Urok-shumbal	Basellaceae	Used as medicine	Leaves	Boils & muscular pain	Skin/ steam	Seed	–

Blumea hieracifolia Hook.	Ching-terapaibi	Asteraceae	Used as medicine	Leaves	Injuries for stopping bleeding	Skin	Seed	Rare & Vulnerable
Bonnaya brachiata Linn.	Kihom -maan	Scrophulariaceae	Used as medicine	Whole plant	Urinary stone case	Oral	Seed & vegetative parts	Rare & Vulnerable
Cardamine hirsuta Linn.	Chantruk man	Brassicaceae	Used as medicine	Whole plant	Urinary problems	Oral	Seed	–
Centella asiatica (Linn.) Urban	Peruk	Apiaceae	Used as medicine and vegetables	Leaves	Stomach ulcers, urinary troubles, digestive complaint, dysentery & skin diseases	Oral & skin	Seed & vegetative parts	–
Coix lacryma-jobi Linn.	Channing	Poaceae	Used as medicine	Seed	Menstrual disorders & gout	Oral	Seed	–
Colocasia esculenta (L.) Scott.	Paan	Araceae	Used as medicine and vegetables	Petiole	Fresh cut & injuries	Skin	Seed & vegetative parts	–
Commelina benghalensis Linn.	Wangdem-khoibi	Commelinaceae	Used as medicine	Whole plant	Boils, burns, cough & muscular sprains	Skin & oral	Seed & vegetative parts	–
Costus speciosus (Koenig) Sm.	Khongban-takhelei	Zingiberaceae	Used as medicine	Root, rhizome & stem	Urinary problems & ear-ache	Oral & ear drop	Seed & vegetative parts	–
Curcuma sp.	Yaitha-man	Zingerberaceae	Used as medicine	Inflorescences & rhizome	Dizziness & headache	Skin	Seed & vegetative parts	–
Cymbopogon flexuosus Stapt	Haona	Poaceae	Used as medicine	Leaves	Cut, injuries & scratches on skin & hair lotion	Skin & shampoo	Seed	–
Cynodon dactylon Pers.	Tingthou	Poaceae	Used as medicine and for rituals	Whole plant	Fresh cut, injuries, cough & menstrual disorder	Skin & oral	Seed & vegetative parts	–
Cyperus rotundus Linn.	Sengban Kakthum	Cyperaceae	Used as medicine	Rhizome & tuber	Cough, fever, dyspepsia & stomach and irritation of bowels	Oral	Seed & vegetative parts	–
Dactyloctenium aegyptium Beauv.	Pungphai	Poaceae	Used as medicine and for rituals	Fresh plant & grains	Fever & small pox	Oral	Seed & vegetative parts	–
Drymaria cordata Willd.	Tandan napi	Caryophyllaceae	Used as medicine	Plant & leaves	Cough, dysentery & muscular sprain	Oral & skin	Seed & vegetative parts	–
Eclipta prostrata (Linn.) Linn.	Uchi-sumban	Asteraceae	Used as medicine	Leaves	Cough, fever & toothache	Oral	Seed	–

Eupatorium cannabinum Linn.	Langtheri-manbi	Asteraceae	Used as medicine	Whole plant	Cut & injuries	Skin	Seed	–
Euphorbia hirta Linn.	Pakhang leiton	Euphorbiaceae	Used as medicine and vegetables	Whole Plant	Worm diseases of children, skin diseases, mouth-sore, dysentery, bronchial affections & asthma.	Oral	Seed	–
Fragaria indica Linn.	Heirong-kak	Rosaceae	Used as medicine	Whole plant	Stone formation in urinary tracts and kidney	Oral	Seed & vegetative parts	–
Galinsoga parviflora Cav.	Hameng Sam-pakpi	Asteraceae	Used as medicine	Leaves	Fever, diarrhoea, dysentery & boils	Oral & skin	Seed	–
Gynura cusimbua (D.Don) Moore	Tera-paibi	Asteraceae	Used as medicine	Stem & leaves	Fresh wounds for stopping bleeding, quick healing & stomach ulcers	Skin & oral	Seed	–
Hemidesmus indicus (L.) Schult.	Kwa-manbi	Asclepiadaceae	Used as medicine	Root	Rheumatism, urinary diseases & skin troubles	Oral	Seed & vegetative parts	–
Houttuynia cordata Thunb.	Toning-khok	Saurauriaceae	Used as medicine and vegetables	Leaves & rhizome	Dysentery, muscular sprain & stomach ulcers	Oral	Seed & vegetative parts	–
Hydrocotyl javanica Thunb.	Awa-peruk	Apiaceae	Used as medicine	Whole plant	Stomach ulcer, urinary troubles, digestive complaints, dysentery & skin diseases	Oral & skin	Seed	–
Imperata cylindrica (Linn.) P. Beauv.	Imom	Poaceae	Used as medicine	Root	Diarrhoea, dysentery, gonorrhoea & to stop bleeding	Oral & skin	Seed	–
Muscari commutalum Vent.	Napi	Liliaceae	Used as medicine and ornamentals	Leaves	Cough	Oral	Seed	–
Oxalis corniculata Linn.	Yensil	Oxalidaceae	Used as medicine	Whole plant	Stomach complaints, piles, colic, dysentery & hair lotion	Oral & shampoo	Seed	–
Panicum repens Linn.	Kang mapan	Poaceae	Used in rituals	Inflorescences	–	–	Seed	–
Peristrophe bicalyculata Nees.	Khuman-langthrei	Acanthaceae	Used as medicine	Shoot & leaves	Cough, fever, liver enlargement & stomach pain	Oral	Seed	–
Phyllanthus fraternus Web.	Chakpa-heikru	Euphorbiaceae	Used as medicine	Whole plant	Leucoderma	Oral	Seed	–
Piper longum Linn.	Piper	Piperaceae	Used as medicine	Unripe fruit & root	Diseases of respiratory tract	Oral	Seed & vegetative parts	–

Plantago erosa Wall.	Yempat	Plantaginaceae	Used as medicine	Leaves & seed	Boils, fresh injuries, muscular sprain & fever	Skin & oral	Seed	–
Polygonum orientale Linn.	Chaokhong angouba	Polygonaceae	Used as medicine and for fish poisoning	Whole Plant	Tubercular swelling & flatulence	Oral	Seed	–
Ranunculus scleratus Linn.	Kakyel-khujil	Ranunculaceae	Used as medicine	Whole plant	Urinary disorder, blisters & skin diseases	Oral	Seed & vegetative parts	–
Rumex nepalensis Spreng.	Torong-khongchak	Polygonaceae	Used as medicine	Leaves	Colic & syphilitic ulcers	Oral & skin	Seed & vegetative parts	–
Scutellaria discolor Colebr.	Yenakhat	Lamiaceae	Used as medicine	Whole plant	Injuries, cut, wounds & menstrual disorder	Skin & oral	Seed	Rare & Vulnerable
Spilanthus acmella Murr.	Lalu-kowba	Asteraceae	Used as medicine	Flower, leaves & seed	Toothache, jaundice, sore throat, cut and injuries & to produce salivation	Oral & skin	Seed	–
Viola pilosa Linn.	Hui-khong	Violaceae	Used as medicine and vegetables	Leaves	Cough & stomach ulcers	Oral	Seed	–

The plants of medicinal uses and applications

Among the 125 plant species of ethnobotanical importance, 120 species (96%) representing 106 genera and 57 families were reported having the medicinal properties. Some medicinal plants are also used for fish poisoning (e.g. *Albizia odoratissima*, *Albizia procera*, *Albizia stipulata*, *Holigarna longifolia* and *Polygonum orientale*), in rituals (e.g. *Albizia lebbeck*, *Aphanamixis polystachya*, *Celtis timorensis*, *Mallotus philippensis*, *Mangifera indica*, *Mangifera* sp., *Pinus kesiya*, *Datura suaveolens*, *Cynodon dactylon* and *Dactyloctenium aegyptium*), and as insecticides (*Artemisia nilagirica* and *Maesa indica*). *Syzygium jambos* is a sacred tree having medicinal value. 14 species of medicinal values are also used as vegetables. Analysis of the data relating to the habits of plant species showed that 9 species (8%) were climbers, 40 species (33%) were herbs, 3 species (3%) were pteridophytes, 18 species (15%) were shrubs and 50 species (41%) were trees (Figure V. 1).

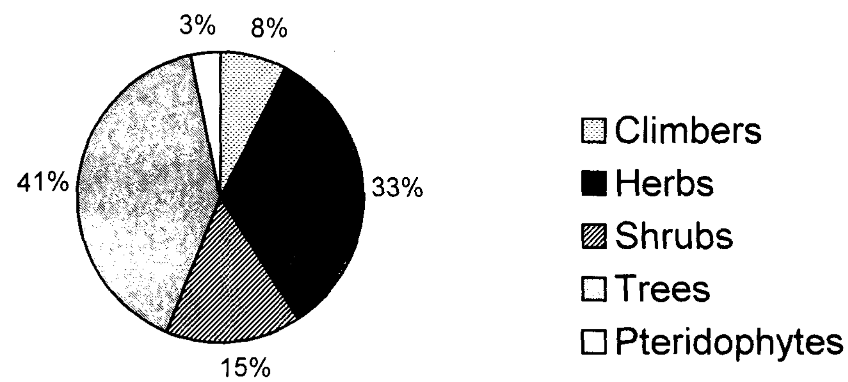

Figure V. 1. Habit-wise distribution of medicinal plants occurring in the four sacred groves of Manipur.

The medicinal plants reported from these groves are used against wide range of human ailments like, cutaneous infections, ulcers, rheumatism, intestinal diseases, bronchitis, female disorders, diarrhoea, dysentery, skin diseases, diabetes, etc. *Bauhinia purpurea*, *Bombax ceiba*, *Gmelina arborea*, *Clerodendrum viscosum* and *Sida rhombifolia* are used for the treatment of poisonous bites. *Gardenia companulata* and *Prunus* sp. are used for curing diabetes. Parts of *Bombax ceiba*, *Ficus glomerata*, *Melia azedarach*, *Melastoma malabathricum*, *Phlogacanthus thyrsiflorus*, *Cissus discolor* and *Ranunculus scleratus* are used against skin diseases. Some species like, *Bauhinia purpurea*, *Achyranthes aspera*, *Coix lacryma-jobi*, *Cynodon dactylon* and *Scutellaria discolor* are employed for the treatment of certain female disorders. Indigenous preparation of hair lotion is common in every household of Manipur, and the ingredients used are *Ageratum conyzoides*, *Oxalis corniculata*, *Mussaenda roxburghii*, *Rhus semialata* and *Eucalyptus citriodora*. Only one species (*Litsea polyantha*) is used for the treatment of bone fractures in animals.

Plant parts used and method of preparation of medicine

Leaves are the most widely used plant part, accounting for 28% of the reported medicinal plant uses, followed by bark (16%), whole plant (11%), fruits (11%), roots (10%), and seeds (7%). Some other parts e.g. tuber, rhizome, tender shoot, stem, petiole, tender pod, bud, frond, grain, wood latex and root bark of certain medicinal plants are also used occasionally which account for 17% of the total uses of the plant parts (Figure V. 2). A majority of remedies are prepared in the form of juice from freshly collected plant parts. For few remedies, medicines are prepared after drying.

Route of application

Most of the remedies are taken orally, accounting for 61% of medicinal uses, followed by 30% as external application, 4% as shampoo, 2% as chewing material and 3% in other forms (eye, bathing, stream and ear drop). The prepared medicine is also taken by mixing with other medicinal plant parts.

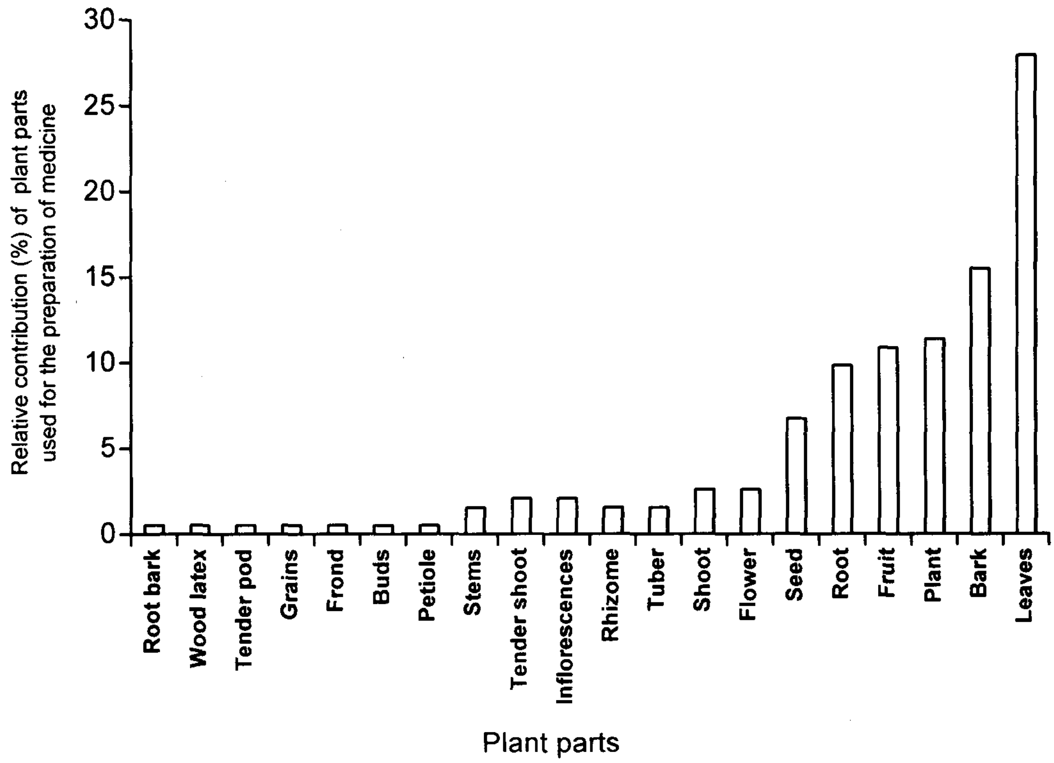

Figure V. 2. Relative contribution (%) of plant parts used for the preparation of medicine.

Conservation status and regeneration mode of the species

Out of the 173 species recorded from the four sacred groves, 11 species fall under different categories of threats: 5 species fall under the rare and vulnerable categories, 1 under vulnerable, 1 under endemic and vulnerable, 3 under the threatened and 1 in the endangered category.

Majority (82%) of the plant species of medicinal uses are regenerated through seed, 15% through vegetative parts, while 3% of the them which were pteridophytes regenerated through frond.

Discussion

The number of medicinal plants (120 species) being used by the Meitei community in Manipur is not small considering the fact that the inventory is based only on the four sacred groves. The number of medicinal plants occurring in these groves is higher than the 105 medicinal plants reported from the Chilkigarh sacred grove in West Bengal (Bhakat and Pandit 2003). People of Manipur, especially Meiteis, cultivate some of the common medicinal plants in their home gardens either for medicinal use or for use as vegetables. Most of the recorded medicinal plants are not available in market except those having the vegetable value. It was observed that the medicinal plants used by the *maibas* for the preparation of medicine were collected from the wild or a few were planted by them to meet their requirements. They use more than one species for a particular disease or disorder.

The traditional knowledge systems of the folk, oral tradition, and also published and unpublished literature are the important sources of locating potential of bioresources. The *Meitei* people even now use some of the plants, plant products, animal products, minerals etc. for domestic purposes utilizing their traditional knowledge, which had been developed by their forefathers through trial and error methods and passed on to them through oral tradition from one generation to another. Unfortunately, due to the lack of written documents, most of the traditional knowledge about medicinal plants and their uses survived only by words of mouth from generation to generation and are being slowly lost. Moreover, the herbal healers had the strong tendency to keep their knowledge secret without any documentation. Five plant species, viz. *Terminalia citrina*, *Glycosmis arborea*, *Achyranthes aspera*, *Melothria maderaspatana* and *Costus speciosus* among the 120 medicinal plants, are used especially for the treatment of dog-bite (Singh and Singh 2000). Besides medicinal values, some of the species are used as traditional soap and detergent, and hair lotion, and for rearing the silkworm. The products of *Flacourtia jangomas* and *Gardenia campanulata* are used for the preparation of traditional soap and detergents by the Meitei community of Manipur (Singh *et al.* 2002). *Ageratum conyzoides*, *Oxalis corniculata*, *Artemisia nilagirica*, *Vitex trifolia*, *Centella asiatica*, *Vanguirea spinosa* and *Phyllanthus emblica* are the species used as an ingredient for the preparation of indigenous hair lotion, locally known as "*Ching-hei*", which is used as shampoo. *Litsea polyantha*, *Litsea citrata* and *Quercus serrata* are the sericultural trees.

A few of the sacred species found in the groves are considered the favourite of the deity and are believed to be the icon of the deity. *Syzygium jambos* is a sacred tree at Konthoujam Lairembi sacred grove. Different faiths and beliefs are also associated with the sacred species and it is believed that such plants cure sickness, purify household, and purify persons before they enter the shrines. Various medicinal plants are also used as spices. An interesting information emerged through interview with the local people who inhabit the nearby groves. Many elderly people revealed that they had never consulted any doctor till date nor had taken any tablets or pills. According to them, headache, fever, cold, body pain can easily be cured with the help of medicinal plants available in the groves. They used to have daily a little amount of bitter, sour and sweet substances from the plant parts which protected them from physical problems. Many people of Manipur are still dependent on herbal medicine, though these days the people of Manipur are highly influenced by modern allopathic system of medicine.

The present study reveals that sacred groves of Manipur are endowed with a large number of medicinal plants. In fact, sacred groves represent a good model of *in situ* conservation of biodiversity and act as the gene pool of a variety of important species. The proper identification of medicinal plants has a vital role in their sustainable utilization and conservation in the groves as well as in forests. Moreover, it is essential to maintain a sustainable utilization of these plants. Collection of medicinal plants from their habitat needs a scientific approach so that their proper regeneration could take place in their natural habitats. Most of the medicinal plants are regenerated through seed and therefore, harvesting of the parts of the medicinal plants should be done only after the flowering and fruiting had taken place. Besides, harvest from the wild needs to be certified as "eco-friendly" or "good sourcing practice" i.e. sustainable (Laird 1999).

In India, some 2500 species of total vascular flora fall in one or other category of threat (Jain 1991). Of these, the most prone are the angiosperms (Daniels and Jayanthi 1996). So far there is very little official documentation of conservation status (rare, endangered, vulnerable, endemic and threatened) of species of the flora of Manipur. Conservation category recorded is based on the information compiled in the Manipur State Biodiversity Strategy and Action Plan prepared under the National Biodiversity Strategy and Action Plan, Govt. of India (2002). *Anaphalis contorta*, *Blumea hieracifolia*, *Bombax ceiba, Bonnaya brachiata* and *Scutellaria discolor* fall under the rare and vulnerable categories. *Dioscorea bulbifera* is a vulnerable species. *Alnus nepalensis*, *Schima wallichii* and *Pasania polystachya* are the threatened species. *Sida rhombifolia* fall under endemic and vulnerable category. *Aphanamixis polystachya* is an endangered species. Any irrational activity including over-exploitation will lead to the extinction of such species. Hence, conservation and protection of such species is immediately required.

The information generated from the present study regarding the medicinal plants may be helpful in formulating the conservation strategies of sacred groves by the government authorities and the concerned non-government organizations. Creating awareness among the local people regarding the conservation of these groves will be successful and easy if the potential of the medicinal plants which are used by them are clearly explained to them. Moreover, all the traditional and cultural knowledge need to be appreciated and should be integrated with the modern scientific techniques and methods while planning any programme for the conservation of biodiversity.

CHAPTER VI

Population structure of tree species occurring in the four selected sacred groves

The population structure characterized by the presence of sufficient number of seedlings, saplings and young trees depicts satisfactory regeneration behaviour of the forests. The structure of the plant communities in the forest ecosystem is largely determined by the intensity, magnitude and frequency of disturbances that take place in the forest (Armesto and Pickett 1985, Khan *et al.* 1987) and species response to gaps (Parthasarathy and Karthikeyan 1997c). Pioneer species show better recruitment and survival in the canopy opening while primary species persist in the understory areas (Brokaw 1987). Different types of disturbances cause different effects on the vegetation (Loucks *et al.* 1980, Pandey and Singh 1984, 1985). The disturbances have the negative impact disrupting the climax and making it unstable (Clements 1936), and also positive impact (Armesto and Pickett 1985, Huston 1979, Paine 1966) increasing species diversity in the community. Moreover, the prevailing microenvironmental conditions of the forests also influence the structure of the plant communities. Several authors have predicted regeneration status of tree species based on the age and diameter structure of their population (Bhuyan *et al.* 2003, Bormann and Likens 1979, Khan *et al.* 1987, Marks 1974, Pritts and Hancock 1983, Saxena and Singh 1984, Uhl *et al.* 1981, Vablen *et al.* 1979). Natural regeneration of species depends upon the production and germination of the seed and successful establishment of seedlings and saplings in the forests (Rao 1988). Complete absence of seedlings and saplings of the tree species in a forest indicates poor regeneration, while presence of sufficient number of young individuals in a given species population indicates successful regeneration (Saxena and Singh 1984). The successful regeneration of tree species depends on its ability to produce large number of seedlings, and ability of seedlings and saplings to survive and grow (Good and Good 1972). However, the presence of sufficient number of seedlings, saplings and young trees is greatly influenced by interaction of biotic and abiotic factors of the environment (Aksamit and Irving 1984, Boring *et al.* 1981, Khan *et al.* 1986, Lange and Graham 1983). The present study deals with the population structure of selected tree species in the four sacred groves of Manipur viz., Konthoujam Lairembi, Mahabali, Langol Thongak Lairembi and Heingang Marjing sacred groves.

Methods

Population structure of all the tree species occurring in each sacred grove was studied during 2001-2002 using quadrat method. Forty quadrats of 10 m x 10 m for trees, saplings and seedlings were laid randomly in each grove. Species were identified and densities of seedlings (≤ 20 cm height), saplings (< 30 cm collar circumference at the base and > 20 cm in height), and trees (≥ 30 cm girth at breast height of 1.3 m) of all the tree species were determined.

Ten important tree species, *Marlea begoniaefolia*, *Eugenia praecox*, *Litsea polyantha*, *Persea* sp., *Heptapleurum hypoleucum*, *Oroxylum indicum*, *Saprosma* sp, *Wendlandia tinctoria*, *Quercus serrata* and *Litsea sebifera* were selected from the four sacred groves for detailed study. ~~Among the 10 species, two (*Eugenia praecox* and *Litsea polyantha*) were common to the four groves~~. Population structure of the selected tree species was studied in each grove during December, 2001, May, 2002 and October, 2002 by periodic determination of densities of the individuals belonging to three different categories viz., seedlings, saplings and trees in forty randomly laid permanent quadrats of 10m x 10m size during December 2001 to October 2002. Density of all the individuals belonging to a given diameter group in the four sacred forests was also recorded during the period of study to estimate the overall diameter structure of the groves. Relative proportion (%) of the different diameter groups to the density of a given species or to total density of tree species in a stand was calculated and figures were drawn, with seedling population at the base of the bar.

Results

Tree species composition

The Konthoujam Lairembi sacred grove recorded maximum tree species having 55 species followed by Heingang Marjing sacred grove (42 species) and Mahabali and Langol Thongak Lairembi sacred groves which had 38 species each. Out of the total 96 tree species in the four groves, 10 species were selected for studying their population structure. Among them, two species (*Eugenia praecox* and *Litsea polyantha*) are common to the four studied groves. *Marlea begoniaefolia* was common in both the groves located in the plains *i.e.* Konthoujam Lairembi and Mahabali sacred groves. *Heptapleurum hypoleucum* and *Saprosma* sp. are exclusive to the Konthoujam Lairembi sacred grove, while *Persea* sp. was exclusive to Mahabali sacred grove. *Wendlandia tinctoria*, *Quercus serrata* and *Litsea sebifera* are common to both the groves located in the hills namely, Langol Thongak Lairembi sacred grove and Heingang Marjing sacred grove. The total density per hectare of all seedlings, saplings and trees taken together ranged from 6353 in the Langol Thongak Lairembi sacred grove to 12192 in the Konthoujam Lairembi sacred grove (Table VI. 1).

Population structure of tree species

The population structure of tree species in terms of the proportion of seedlings, saplings and adults in the four groves (Figure VI. 1) varied greatly. The relative proportion of seedlings ranged from 72% in Konthoujam Lairembi sacred grove to 51% in Heingnag Marjing sacred grove. The highest percentage of adults was recorded in Langol Thongak Lairembi sacred grove (16%) and lowest in Konthoujam Lairembi sacred grove (3%).

The population structure of the selected tree species in the concerned groves showed that seedlings constituted about 79% of the total density (3640 ha^{-1}) in Konthoujam Lairembi sacred grove, followed by 68% each in Mahabali sacred grove (total density 1784 ha^{-1}) and Langol Thongak Lairembi sacred grove (total density 1303 ha^{-1}) and 56% in Heingang Marjing sacred grove (total density 1586 ha^{-1}). Density - diameter distribution of the selected

Table VI. 1. Density of tree species occurring in the four sacred groves of Manipur during December, 2001.

Species	Density per hectare			
	Konthoujam Lairembi sacred grove	Mahabali sacred grove	Langol Thongak Lairembi sacred grove	Heingang Marjing sacred grove
Acacia auriculaeformis A. Curm ex.Benth.	–	–	–	3
Adenanthera pavonina Linn.	14	–	–	–
Albizia lebbeck Benth.	–	10	–	–
Albizia lucida Benth.	–	–	183	135
Albizia odoratissima Benth.	134	–	28	20
Albizia procera Benth.	–	–	–	50
Albizia stipulata (Roxb.) Boivin	–	–	10	30
Alnus nepalensis D. Don	–	–	–	5
Anthocephalus cadamba Linn.	–	10	–	–
Anthocephalus chinensis Walp.	–	3	–	–
Aphanamixis polystachya (Wall.) Parker	1	–	–	–
Aralia sp.	–	–	15	–
Ardisia sp.	–	–	–	10
Artocarpus lakoocha Roxb.	326	145	–	–
Artrocarpus hetrophyllus Lam.	–	–	5	–
Bauhinia purpurea Linn.	–	–	13	–
Bauhinia variegata Linn.	13	8	–	–
Bischofia javanica Blume	–	73	–	–
Bombax ceiba Linn.	–	–	13	5
Borassus flabellifer Linn	–	20	–	–
Caryota urens Linn	457	293	–	–
Castanopsis hystrix DC.	59	5	–	–
Celtis sp.	–	–	–	75
Celtis timorensis Linn.	26	75	10	23
Chukrasia tabularis Andr. Juss.	3	–	–	–
Cinnamomum sp.	45	–	–	–
Citrus maxima Merr	8	30	5	–
Cordia grandis Roxb.	2	–	–	–
Delonix regia (Boj.) Raf.	55	–	–	–
Elaeocarpus sp.	–	–	–	13
Engelhardtia colebrookiana Lindl	–	–	63	243
Entada scandens Benth	1	–	–	–
Erythrina sp.	124	–	–	–
Eucalyptus citriodora Hook	–	–	20	5
Eugenia praecox Roxb.	911	788	688	895
Eugenia sp.	27	–	–	–
Ficus benghalensis Linn.	3	–	–	–
Ficus benjamina Linn	13	–	–	–
Ficus glomerata Roxb.	11	50	–	–
Ficus hispida Linn. f.	56	270	40	30
Ficus religiosa Linn.	–	3	–	–
Ficus semicordata Linn	–	15	18	130

Flacourtia jangomas (Lour.) Raeusch	5	5	–	15
Gardenia companulata Roxb.	4	133	–	–
Gmelina arborea Linn.	32	–	–	–
Grevillea robusta A. Cum	63	–	–	–
Heptapleurum hypoleucum Kurz	306	–	–	–
Holigarna longifolia Roxb.	–	–	–	23
Khajok*	–	–	–	8
Lagerstroemia flos-regine Retz.	38	5	–	–
Lannea coromandelina (Houtl.)	51	8	10	–
Lannea grandis A. Rich	32	35	–	–
Ligustrum robustum Blume	93	–	–	–
Litsea citrata Blume	120	170	148	958
Litsea polyantha Juss	772	540	720	583
Litsea sebifera Thumb.	93	–	458	660
Litsea sp. (1)	26	–	–	–
Litsea sp. (2)	–	40	20	40
Mallotus philippensis (Lamk.) Muell. & Arg.	303	315	233	255
Mangifera indica Linn	36	170	–	–
Mangifera sp.	–	–	45	20
Marlea begoniaefolia Roxb.	574	418	–	83
Melia azedarach Linn.	5	70	5	50
Morus nigra Linn	–	73	15	–
Oroxylum indicum Vent.	349	–	–	20
Parkia roxburghii G. Don	–	–	18	–
Pasania polystachya (Wall) Schottky	–	–	293	105
Persea sp.	–	2628	–	–
Phyllanthus emblica Linn.	10	23	53	23
Pinus kesiya Royle ex. Gordon	–	–	988	1095
Prunus sp.	–	–	–	38
Psidium guajava Linn	–	68	5	3
Quercus serrata Thumb.	–	–	918	1083
Rhus semialata Murray	68	–	653	410
Rubia sp. (1)	101	–	–	–
Rubia sp. (2)	2	–	–	–
Santalum sp.	–	–	25	–
Saprosma sp.	6022	–	–	–
Schima wallichi (D.C.) Horth	31	155	255	268
Spondias pinnata (Linn.f.) Kurz	16	–	–	–
Syzygium cumini (L) Skeel	3	–	–	–
Syzygium jambos Linn. (Alston).	1	–	–	–
Syzygium sp.	–	–	43	–
Tamarindus indica Linn	8	–	–	–
Terminalia citrina Roxb.ex Flem	–	–	123	–
Thevetia neriifolia Juss.ex Steud	5	–	–	–
Toona ciliata M. Roem	–	3	–	3
Trema orientalis Blume	76	80	10	5
Uha*	28	–	–	–
Vanguirea spinosa Linn.	65	183	–	8
Viburnum sp.	–	–	3	–

Wendlandia exerta DC.	–	–	–	65
Wendlandia tinctoria Roxb.	–	–	205	435
Xylosma longifolia Clos	561	323	5	335
Zanthoxylum rhetsa Roxb.	17	–	–	–
Zizyphus jujuba Lam.	–	38	–	–
Total	**12192**	**7273**	**6353**	**8255**

* - Local name
Variance of means of density/ha of the four groves = 6601477.23, Significant at the 0.0005 level.

tree species (Figure VI. 2a to b) in the four groves indicates the higher population of seedlings than the saplings and trees except for *Marlea begoniaefolia* and *Litsea polyantha* in Konthoujam Lairembi sacred grove, *Eugenia praecox* in Mahabali sacred grove, and *Wendlandia tinctoria* in Langol Thongak Lairembi sacred grove and Heingang Marjing sacred grove. *Saprosma* sp. in Konthoujam Lairembi sacred grove had maximum (89%) seedling population and *Wendlandia tinctoria* in Langol Thongak Lairembi sacred grove recorded minimum proportion of seedling population (16-34% of the total population).

During May (beginning of the rainy season in Manipur) seedling population of all the selected species in the studied groves was greater as compared to the other seasons except for *Litsea polyantha* in Konthoujam Lairembi and Mahabali sacred groves, *Litsea sebifera* in Langol Thongak Lairembi sacred grove, and *Litsea sebifera* and *Wendlandia tinctoria* in Heingang Marjing sacred grove which showed maximum seedling population in December. In general, seedling population size decreased substantially after the rainy season.

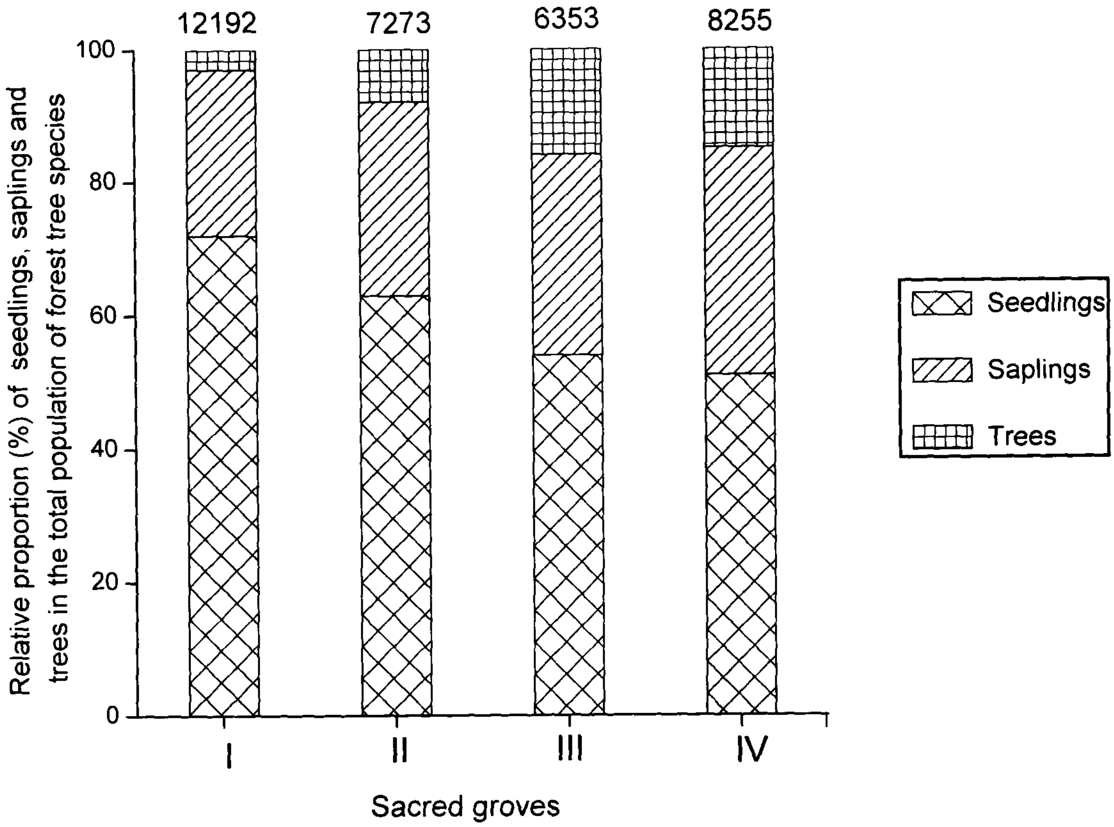

Figure VI. 1. Population structure of all the tree species taken together in the four sacred groves of Manipur in December 2001. Total density of a particular grove is shown at the top of the corresponding bar.
I -Konthoujam Lairembi sacred grove; II -Mahabali sacred grove; III - Langol Thongak Lairembi sacred grove and IV - Heingang Marjing sacred grove.

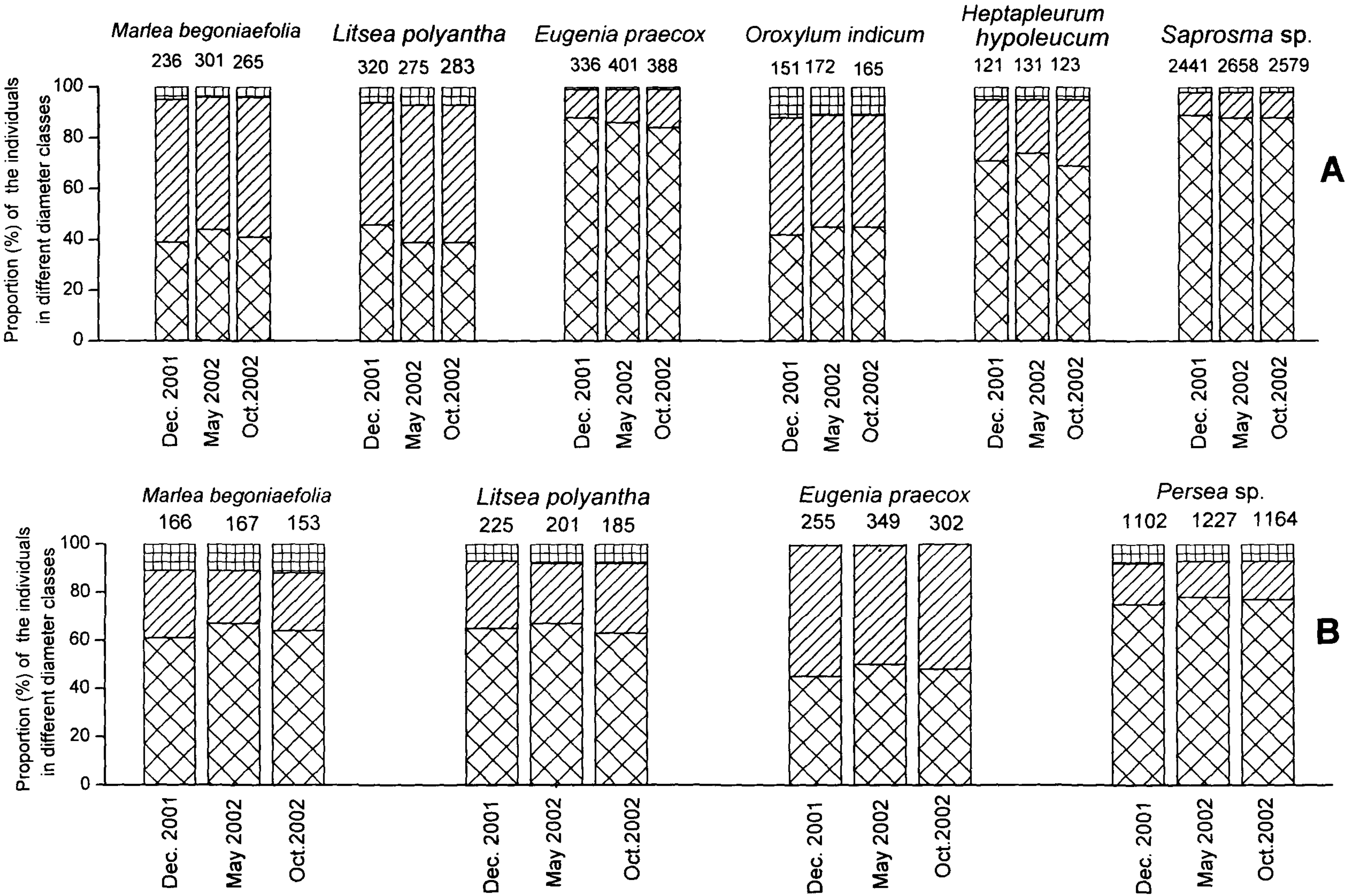

Figure VI. 2a. Population structure of the selected tree species in the Konthoujam Lairembi sacred grove (A) and Mahabali sacred grove (B). Percentages of the total density as seedlings ( ), saplings ( ), and trees ( ) are given. Total density of a particular species is shown at the top of the corresponding bar.

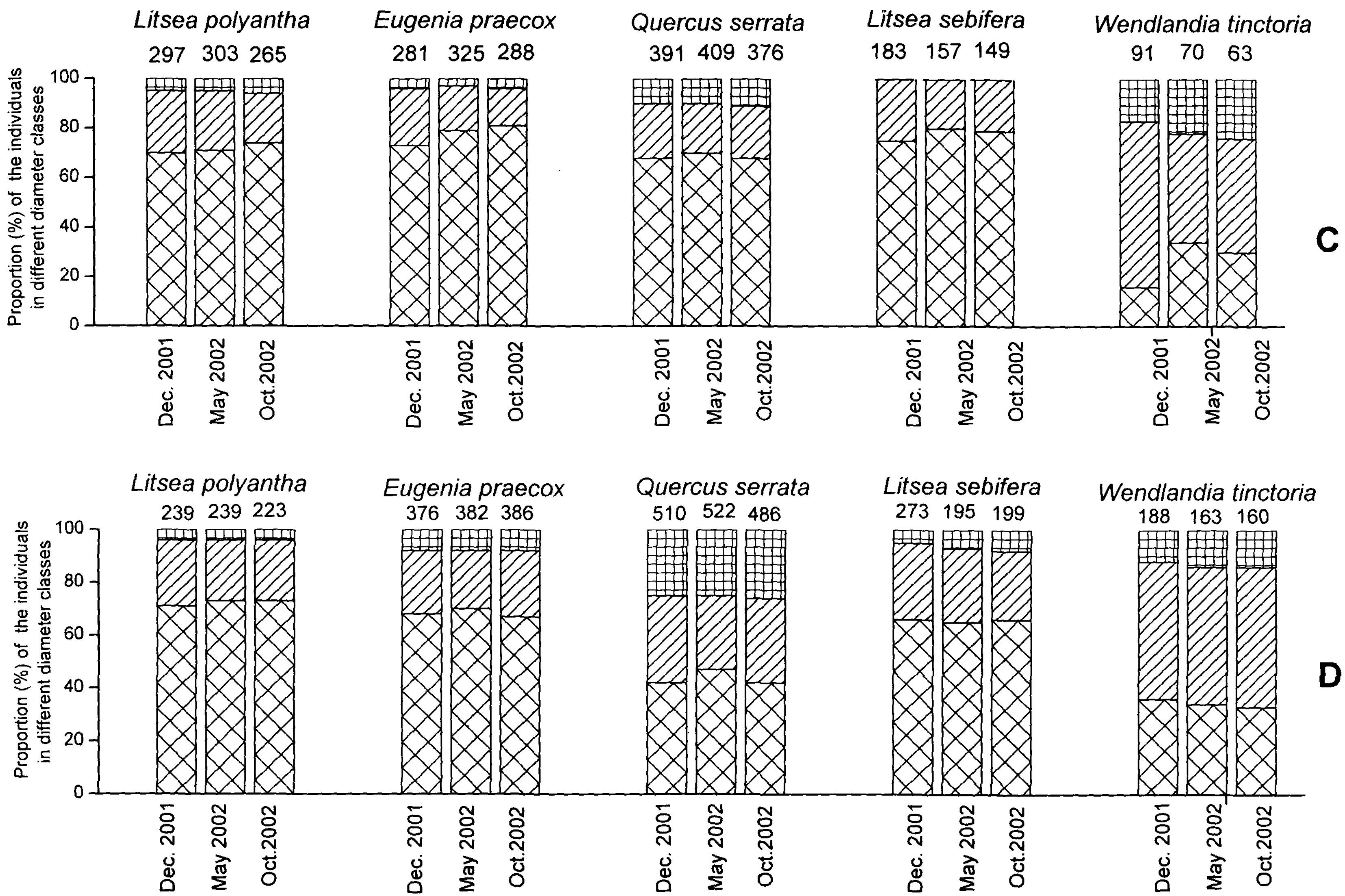

Figure VI. 2b. Population structure of the selected tree species in the Langol Thongak Lairembi sacred grove (C) and Heingang Marjing sacred grove (D). Percentages of the total density as seedlings ( ), saplings ( ), and trees ( ) are given. Total density of a particular species is shown at the top of the corresponding bar.

Sapling population did not show marked seasonal variation in density. Sapling population of *Marlea begoniaefolia* and *Litsea polyantha* in Konthoujam Lairembi sacred grove and *Wendlandia tinctoria* in Langol Thongak Lairembi and Heingang Marjing sacred groves was higher than the seedling population. As compared to the saplings and trees, the seedlings were more abundant in the four groves. Total sapling density per hectare was 645 in Konthoujam Lairembi sacred grove, 499 in Heingang Marjing, 422 in Mahabali and 331 in Langol Thongak Lairembi sacred grove.

Tree population of *Saprosma* sp. and *Eugenia praecox* in Konthoujam Lairembi sacred grove was very low. No adult individuals of *Eugenia praecox* were recorded in the Mahabali sacred grove and the same was true for *Litsea sebifera* in the Langol Thongak Lairembi sacred grove.

Discussion

The overall population structure of tree species in the four groves showed that contribution of seedlings to the total population was highest followed by saplings and trees. The differences in relative proportion of seedlings, saplings and trees among the four groves may be due the interactive influence of an array of biotic and abiotic factors. In Konthoujam Lairembi sacred grove, seedling populations of the top canopy species were negligible, however, the sub canopy layer species contributed greater seedling population. According to Jones *et al.* (1994) seedling layer in various forests, differs in composition from their respective overstories. Tall height with relatively close canopy layer of the grove may favour the germination of seeds and establishment of the seedlings and saplings. According to Espelta *et al.* (1995), canopy closure seems to promote seedling germination through changes in the environmental conditions on the forest floor, which might be related to decreasing radiation and water evaporation. Klinka *et al.* (1990) also reported that climatic conditions are more favourable under the forest canopy than in the clear cuts.

Variations in the population structure of the selected tree species in the four groves may be attributed to the differences in their habitat and prevailing microenvironmental factors. The presence of greater number of seedlings may be ascribed to the creation of microsites, which facilitates the germination of large number of tree seeds. Many workers have reported that tree species are able to survive and grow at reduced light intensities under the forest canopy (Atzet and Waring 1970, Emmingham and Waring 1973, 1977, Minore 1998, Strothman 1970). On the contrary, many workers have shown that open canopy may favour germination and seedling establishment through increased solar radiation on the forest floor and consequently increase in surface temperature, and reduced competition from the canopy layer (Khan *et al.* 1987, Kollar 1972, Noble and Slatyer 1980, Oliver 1981, Srinivas 1992).

The reduction of seedling population of the selected tree species in the four groves during the dry winter season may be due to adverse effects of soil moisture stress and unfavourable temperatures on survival of tree seedlings. Similar results have also been reported by several workers (Kumar *et al.* 1994, Perira and Kozlowski 1977, Rao and Singh 1985, Schulte and Marshall

1983). Khan *et al.* (1986) also reported that survival of tree seedlings was lowest during the winter season in tropical deciduous and sub-tropical forests of Meghalaya state in India.

The low sapling population of the selected species in the four groves despite the presence of high number of seedlings (except in case of *Marlea begoniaefolia* and *Litsea polyantha* in Konthoujam Lairembi sacred grove and *Wendlandia tinctoria* in Langol Thongak Lairembi and Heingang Marjing sacred groves) may be attributed to the adverse impact of environmental factors prevalent during the sapling growth. The greater populations of saplings of *Marlea begoniaefolia*, *Litsea polyantha* (Konthoujam Lairembi sacred grove) and *Wendlandia tinctoria* (Langol Thongak Lairembi and Heingang Marjing sacred grove) than their seedlings could not be explained, however, it may be due to the poor seed set and seed germination. The greater number of saplings clearly indicates that these species will persist and may determine the composition of future vegetation of the groves (Jayasingham and Vivekanantharaja 1994, Swaine and Hall 1988). Swaine and Hall (1988) stated that higher number of saplings alone may not represent future composition, because over a period environmental changes could nullify the effect. However, in the absence of catastrophic events the saplings will gradually form future crowns.

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The absence of adult individuals of *Eugenia praecox* and *Litsea sebifera* in Mahabali and Langol Thongak Lairembi sacred groves, respectively, and the presence of their saplings and seedlings indicates that these two species are the new colonizers in these groves and have managed to reach there through seed dispersal. Many studies have emphasized the importance of various specific factors for the successful establishment of saplings, including woody debris (Arnborg 1942, Harmon and Franklin 1989, Hytteborn *et al.* 1987), microtopography (Beatty 1984), soil depth (Bratton 1976), diseases (Augspurger 1984a), vertebrate and predators (Ganesh and Davidar 1997), fire (Kikim and Yadava 1998) and fine scale irradiance patterns (Ustin *et al.* 1984).

Regeneration of the forest trees is an indicator of the well being of the forest. Studies relating to the regeneration of species have attempted to analyse the effects of anthropogenic factors and other environmental stresses. It has been reported that regeneration of the species is greatly affected by fire (Stocker 1981, Sukumar *et al.* 1994) and logging (Guariguata and Dupuy 1997). The regeneration of species is also affected by natural phenomenon such as light gaps (Welden *et al.* 1991). It has been argued that degradation reduces species number, stem density and regeneration potential of the forests (Murali *et al.* 1996). Successful regeneration of any type of species can only occur if the right amount of growing space becomes available for the establishment and subsequent growth of seedlings (Klinka *et al.* 1990). Degree of stability of tropical forests may have important implications for the maintenance of biodiversity (Phillips and Gentry 1994), although moderate levels of disturbance may enhance levels of forest diversity (Connell 1978).

The overall population structure of selected tree species based on classes reveals that seedling populations dominate the tree species populations and the fluctuation in population density in various seasons is linked with the prevailing environmental factors. Recruitment of all the species increased during the rainy season attaining peak during June, which is the wettest month. Similar observations have been reported in tropical dry forest at Pinkwae, Ghana (Lieberman and Li 1992, Swaine *et al.* 1990).

The results of studies on population structure reveals that the populations of seedlings and saplings of tree species should not face any type of biotic threat so that the natural regeneration can be encouraged in these groves in order to maintain the species and genetic diversity.

CHAPTER VII

Tree Phenology, and survival and growth of seedlings of a few selected tree species in the four sacred groves

The ecological significance of phenological research lies in the fact that it constitutes a synthetic approach for assessing the plant response to the prevailing environment. The knowledge of phenology encompasses the relationship between climatic and periodic phenological events in plants, and helps in a better evaluation of functioning of the ecosystem. Phenological observations provide a background information on functional rhythms of plants and plant communities (Beatly 1974, Frankie *et al.* 1974, Lieth 1974, Opler *et al.* 1980). For the better understanding of ecological adaptations of individual species as well as community level interactions, studies on phenological phases of trees such as growth periodicity, flowering and fruiting, plant-herbivore interactions and ecosystem properties (Reich and Borchert 1982, Reich *et al.* 1991, Wright 1991) are important. The general phenological aspects of leafing, flowering and fruiting in tropical tree species are well studied (Borchert 1983, Daubenmire 1972, Frankie *et al.* 1974, Opler *et al.* 1980, Putz 1979, Singh and Singh 1992, Sun *et al.* 1996). In India, studies on phenological pattern have been reported from central Himalaya (Ralhan *et al.* 1985a, b., Sundriyal 1990), southern India (Murali and Sukumar 1994) and north-eastern India (Barik *et al.* 1996b, Bhuyan *et al.* 2003, Boojh and

Ramakrishnan 1981a, Khan *et al.* 2002, Shukla and Ramakrishnan 1982a). However, little information is available on the phenological pattern of tree species in the forests of Manipur (Kikim and Yadava 2001).

The study of seedling ecology of tree species is necessary for a proper understanding of population dynamics of forest tree species and forests as a whole. Indeed, in the life cycle of trees, the most drastic population changes occur during the stages of seed setting, seed germination and seedling establishment (Augspurger 1984b, De Steven 1991a, b, Harcombe 1987, Harper 1977, Jones *et al.* 1994, Li *et al.* 1996, Schupp 1990, Seiwa 1998, Shibata and Nakashizuka 1995, Streng *et al.* 1989, Zagt and Werger 1998). Denslow (1980a) suggested that the probability that a tree species would persist is a function of its seedling establishment rate. Tree seedling dynamics is affected by various environmental factors (Augspurger 1984a, Bongers *et al.* 1988, Burslem *et al.* 1995) such as soil moisture (Ashton *et al.* 1995, Potvin 1993), micro-scale disturbances (Clark and Clark 1989, McCarthy and Facelli 1990, Kobayashi and Kamitani 2000), canopy cover (Crow 1992, Denslow and Guzman 2000, Harrington 1991, Streng *et al.* 1989, Titus 1990, Titus and del Moral 1998) and thickness of leaf litter layer (Clark and Clark 1989, Facelli 1994, Molofsky and Augspurger 1992, Seiwa 1997, Seiwa and Kikuzama 1996). Some of the biotic factors such as herbivory (Forget 1997, Ida and Nakagoshi 1996, Khan and Tripathi 1991, Seiwa 1998, Wada 1993), fungal infection (Forget 1997, Khan and Tripathi 1991, Sahashi *et al.* 1994) and inter-species competition (Callaway 1992, Nakashizuka 1988) have also been reported to affect seedling demography to a great extent. Brokaw (1987) and Grubb (1977) suggested that most of the observed patterns in tree seedling population behaviour in forest are caused by temporal and spatial variations in environmental factors that are influenced both by endogenous and exogenous disturbances.

Tropical tree species vary widely in their light requirements (Richards 1952, Whitmore 1975) and differ in regeneration pattern due to gaps (Denslow 1980b). Gaps are known to be important for the successful regeneration of many tree species (Clark and Clark 1992, Denslow and Hartshorn 1994, Hartshorn 1978, Kadambi 1941, Rao *et al.* 1997), and contribute to the maintenance of forest diversity (Brandani *et al.* 1988, Enright *et al.* 1993, Orians 1982, Pickett 1983). The effect of gaps in the forest canopy on the process of seedling development and growth has been intensively studied during the past two decades (Bongers and Popma 1988, Brokaw 1985a, 1987, Brown and Jennings 1998, Denslow *et al.* 1990, Fetcher *et al.* 1983, Hubbell *et al.* 1999, Hubbell and Foster 1986, Swaine and Whitmore 1988, Webb 1998, Whitmore 1978) in order to find out suitable habitats for the high light demanding species (Hubbell and Foster 1990), to promote growth rates (Coley 1983, Poorter 1998) and to reduce the dominance of competitively superior species (Connell 1978, Huston 1979). The recruitment, survival and growth pattern of tree seedlings in forest understorey and treefall gaps in the tropical forests have also been studied in different parts of the world (Denslow 1980a, Fox 1977, Nagamatsu *et al.* 2002, Ricklefs 1987).

In natural forests, several studies have been conducted by many workers on phenology of tree species, and survival and growth of tree seedlings in understorey and gaps of the forests. But very limited information is available on such studies in sacred groves of India especially in the north east (Barik *et al.* 1996a). Moreover, no such studies have been reported so far from the sacred groves of Manipur. The present study on the phenological events of the selected tree species, and survival and growth of naturally emerged seedlings of a few selected tree species in the understorey and gaps of the four sacred groves of Manipur will fill in this gap in knowledge.

Methods

Based on the pattern of leafiness, all the woody species recorded in the four sacred groves were grouped into two major classes, viz. evergreen and deciduous. Evergreen species continually produce atleast small amount of new leaves throughout the year and do not show heavy leaf fall and don't become completely leafless at any time during the year, whereas deciduous species become completely leafless for atleast a brief period of the year. Phenological observations were made seasonally on 11 selected tree species (*Oroxylum indicum*, *Saprosma* sp., *Marlea begoniaefolia*, *Vanguirea spinosa*, *Persea* sp., *Quercus serrata*, *Terminalia citrina*, *Pasania polystachya*, *Eugenia praecox*, *Wendlandia tinctoria* and *Schima wallichii*) in the four selected sacred groves.

Three gaps were recorded in each of the two groves located in the hills i.e. Langol Thongak Lairembi and Heingang Marjing grove and two gaps in

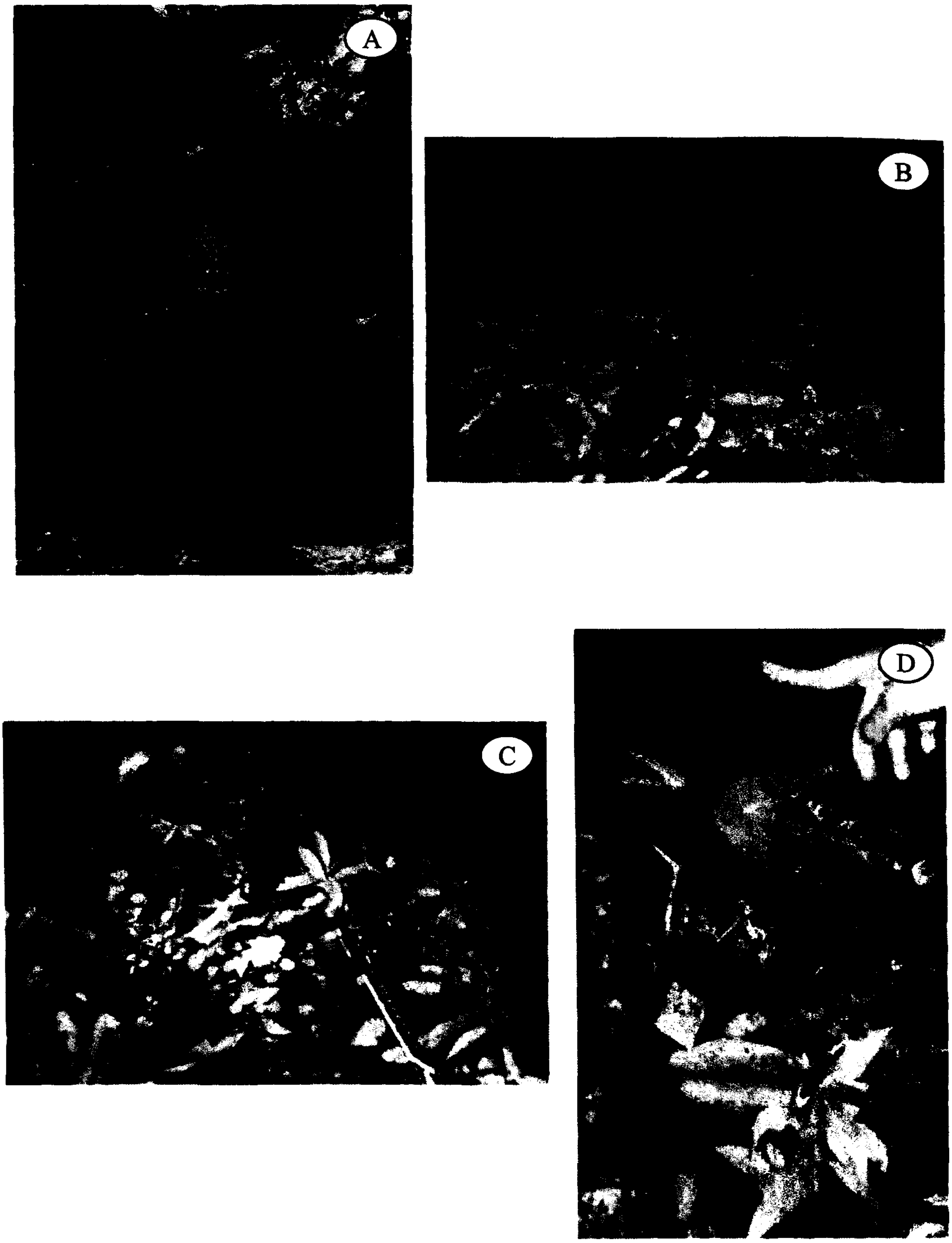

Plate 5. Seedling survival and growth in the understorey and gaps of the groves. (A) – Treefall in Mahabali sacred grove: a cause for the creation of natural gaps. (B), (C) and (D) – Tagged seedlings of *Litsea sibefera*, *Eugenia praecox* and *Heptapleurum hypolecum,* respectively for determining their relative growth rates.

Mahabali grove while no gap was available in Konthoujam Lairembi grove. The area of gaps varied from 30.55 m^2 to 266.73 m^2. Different microenvironmental variables such as light intensity, soil moisture, water holding capacity (%), soil texture and soil pH were determined in the understorey and gaps. Light intensity was measured with digital lux meter at three different times during the day (8.00 a.m., 12 noon and 4 p.m.) in different seasons and means were calculated. Soil texture was determined by hydrometer method. Water holding capacity of the soil was measured following Keens-up method, while soil pH was measured by a digital pH meter. Values for different variables in the understorey and gaps are given in Table VII. 1.

For studying the growth and survival, seedlings of nine important tree species viz., *Eugenia praecox*, *Heptapleurum hypoleucum*, *Litsea polyantha*, *Litsea sebifera*, *Marlea begoniaefolia*, *Oroxylum indicum*, *Persea* sp., *Quercus serrata* and *Saprosma* sp. were selected from the four sacred groves. Among the 9 species, two (*Eugenia praecox* and *Litsea polyantha*) were present in all the four groves. *Marlea begoniaefolia* was common to Konthoujam Lairembi sacred grove and Mahabali sacred grove. *Persea* sp. was exclusive to Mahabali sacred grove, while *Heptapleurum hypoleucum*, *Oroxylum indicum* and *Saprosma* sp. were exclusive to Konthoujam Lairembi sacred grove. *Litsea sebifera* and *Quercus serrata* were common to Langol Thongak Lairembi and Heingang Marjing sacred groves.

20-25 seedlings (< 20 cm height) of each of the above nine tree species were randomly selected from the understorey and gaps. The selected

Table VII. 1. Environmental variables in the understorey and gaps in the four selected sacred groves.

Variables	Konthoujam Lairembi sacred grove*	Mahabali sacred grove			Langol Thongak Lairembi sacred grove			
	Understorey	Under-storey	Gaps 1	Gaps 2	Under-storey	Gaps 1	Gaps 2	Gaps 3
Area of gaps (m^2)	–	–	131	81	–	76	25.91	51.75
Light Intensity (Lux)	5243 - 5380	6857 - 7400	84367 - 88233	83700 - 88667	6093 - 6410	79500 - 90000	76300 - 80833	79933 - 82667
pH	5.68	6.59	6.42	6.73	5.4	5.36	5.32	5.38
Water holding capacity (%)	44.67	40.32	48.65	47.76	42.1	42.54	42.78	42.57
Soil Moisture Content (%)	39.45	39.18	39.46	38.89	38.4	38.29	39.01	38.74
Organic Carbon (%)	5.37	5.23	4.97	4.76	4.85	4.88	4.72	4.93
TKN (%)	0.04	0.04	0.04	0.37	0.02	0.03	0.02	0.02
Soil texture - Clay%	2	3	4	3	10	11	10	9.5
Silt %	20	18	16	17	21.5	21	23	21.5
Sand %	78	79	80	80	68.5	68	67	69

Variables	Heingang Marjing sacred grove			
	Under-storey	Gaps 1	Gaps 2	Gaps 3
Area of gaps (m^2)	–	30.55	66.73	32.84
Light Intensity (Lux)	5470 - 5633	88900 - 91100	88533 - 99767	91833 - 93700
pH	5.88	6.02	5.99	6.02
Water holding capacity (%)	38.84	39.52	38.91	39.04
Soil Moisture Content (%)	32.96	33.12	32.78	31.46
Organic Carbon (%)	4.88	4.89	5.02	4.96
TKN (%)	0.01	0.01	0.01	0.01
Soil texture - Clay%	5.5	5.15	4.95	4
Silt %	17.25	16.85	17.50	18
Sand %	77.25	78	77.55	78

* No gap was available during the study period in Konthoujam Lairembi sacred grove.

seedlings were of uniform growth and healthy in appearance without any evidence of damage or injury. The selected seedlings were labelled with an individually numbered aluminium tag and their growth and survival were monitored seasonally over a period of 1 year (June 2002 to June 2003) at four month interval. Stem height and leaf area of all the tagged seedlings were measured in June (t_0), October (t_1), February (t_2) and June (t_3). The periods from t_0 to t_1, t_1 to t_2 and t_2 to t_3 represented rainy, winter and summer seasons, respectively. Monthly data on temperature, relative humidity and rainfall are given in Figure VII. 2 (Chapter III). Leaf area of each seedling was measured by leaf area meter (*LICOR 3000A*). Relative growth rates of the individual seedlings in terms of height (RGRH) and total leaf area (RGRA) were calculated as per Hunt (1982).

$$RGR\ (t_{n-1} - t_n) = [\ln S(t_n) - \ln S(t_{n-1})]\ t_n - t_{n-1}{}^{-1}$$

Where, S = the plant size, i.e. height (cm) or total leaf area (cm^2) and t = time (months).

Calculated RGRH and RGRA during the period t_0 to t_1 have been presented as $RGRH_1$ and $RGRA_1$, during t_1 to t_2 as $RGRH_2$ and $RGRA_2$ and from t_2 to t_3 as $RGRH_3$ and $RGRA_3$, respectively.

Results

Vegetation type

81 woody species were enumerated from the four sacred groves (details in chapter IV). Out of 45 species recorded from Konthoujam Lairembi sacred grove, 10 species showed marked leaf fall during a particular time of

the year and were assigned to deciduous category, while 35 species always showed atleast small amount of new leaves emerging throughout the year and these were assigned to the category of evergreen species. In Mahabali sacred grove, out of the 20 species, 4 revealed the characteristics of deciduousness, while 16 species showed the evergreenness. Total number of woody species in Langol Thongak Lairembi sacred grove was 24, out of which 7 species were deciduous and 17 species were evergreen. 30 species were recorded from Heingang Marjing sacred grove and out of these, 9 species were deciduous and 21 species were evergreen. Percentage of leafing activity of the species in each grove is given in table VII. 2. Majority of the species in the four groves were evergreen in nature.

Table VII. 2. Vegetation type of the four sacred groves of Manipur (based on woody species).

Sacred groves	Total number of species	Leafing activity	% of leafing activity of species	Vegetation type
Konthoujam Lairembi	45	Leafing through the year	78	Evergreen
		Marked leaf drop and flushing	22	
Mahabali	20	Leafing through the year	80	Evergreen
		Marked leaf drop and flushing	20	
Langol Thongak Lairembi	24	Leafing through the year	71	Evergreen
		Marked leaf drop and flushing	29	
Heingang Marjing	30	Leafing through the year	70	Evergreen
		Marked leaf drop and flushing	30	

Leaf fall activity

During the cool and dry winter months (from November extending up to April for some species) many species shed their leaves. The leaf fall was comparatively low in other months and it was almost negligible during the wet season. *Eugenia praecox*, *Marlea begoniaefolia*, *Oroxylum indicum*, *Pasania polystachya*, *Persea* sp., *Quercus serrata*, *Saprosma* sp., *Schima wallichii* and *Terminalia citrina* shed their leaves during cool and dry winter months. *Terminalia citrina* and *Quercus serrata* start leaf shedding from November and become leafless during January to March. In *Vanguirea spinosa* and *Wendlandia tinctoria* the leaf shed starts during August and September and it continues up to January (Table VII. 3).

Leaf flushing activity

Buds remain dormant throughout the cool and dry season, normally up to February. With the rise in temperature, the bud bursting activity begins. In general, the leaf bud formation, bud burst or flushing take place from January to July. However, leaf flushing was periodic and most apparent during March to April before the onset of rains. Peak leaf flushing for most of the species was observed during these months except for *Wendlandia tinctoria* in which the flushing begins from January and *Pasania polystachya* which starts leaf flushing from February. *Saprosma* sp., *Persea* sp. and *Wendlandia tinctoria* showed double determinate leaf flushes in July and August, during mid - wet season(TableVII.3).

Table VII. 3. Phenological records of the selected tree species in the four sacred groves of Manipur.

	Leaf flushing		Leaf fall		Flowering		Fruiting	
Name of species	Months	Behaviour	Months	Behaviour	Months	Behaviour	Months	Behaviour
Eugenia praecox	March - April	PexM	Nov. - Jan.	PE	April - June	PexA	June - July	Pbr
Marlea begoniaefolia	March - April	PexM	Dec. - Feb.	PE	March - May	PexA	Aug. - Sept.	Pbr
Oroxylum indicum	March - April	PexM	Nov.- Jan.	PE	March - May	PexS	Aug. - Oct.	PexL
Pasania polystachya	Feb. - May	PexM	Jan. - March	PE	April - June	PexA	Oct. - Dec.	PexL
Persea sp.	March - April Aug. - Sept.	PexM	Nov. - Feb.	PE	April - June	PexA	Aug. - Oct.	Pbr
Quercus serrata	March - May	PexM	Nov. - Jan.	PD	April - May	PexA	Sept. - Nov.	PexL
Saprosma sp.	March - April July - Aug.	PexM	Dec. - Feb.	PE	March - May	PexA	Aug. - Sept.	Pbr
Schima wallichi	April - July	PexM	Feb. - April	PE	April - July	PexA	Dec. - Feb.	PexL
Terminalia citrina	March - June	PexM	Nov. - Feb.	PD	March - April	PexA	Oct. - Dec.	PexL
Vanguirea spinosa	March - May	PexM	Aug. - Oct.	PE	April - May	PexA	Nov. - Jan.	PexL
Wendlandia tinctoria	Jan. - March July - Aug.	PexM	Sept. - Jan.	PE	Dec. - April	PexA	Aug. - Sept.	PbL

P - Periodic; M - Multiple events per year; A - Asynchronous; D -Deciduous; E - Evergreen; S - Synchronous; L - Lengthy fruit maturation > 4 months; b - Brief periods < 2 weeks per episode; ex - Extended periods ≥ 2 weeks per episode; r - Rapid fruit maturation ≤ 4 months.

Flowering activity

Flowering activity in these tree species was initiated during the leaf flushing or after the event of leaf flushing. All the species were observed blooming once a year though period of flowering varied from species to species. Majority of the species flowered soon after the leaf flushing. Some species like *Marlea begoniaefolia*, *Oroxylum indicum*, *Saprosma* sp. and *Terminalia citrina* started flowering from the month of March. *Pasania polystachya* showed flowering late after the leaf flushing while *Wendlandia tinctoria* showed flowering during the leaf flushing and it was extended over a long period. *Quercus serrata* showed flowering soon after the leaf flushing. Asynchrony type of flowering was quite common among the selected species (Table VII. 3).

Fruiting activity

Duration of fruiting activity varied from species to species. Development of fruit started in April in the case of *Eugenia praecox*, *Marlea begoniaefolia*, *Oroxylum indicum*, *Saprosma* sp., *Terminalia citrina* and *Vanguirea spinosa*. Fruit development takes place after the initiation of flower dropping. Majority of the species showed discontinuous and extended period of time for fruiting. Half of the species recorded lengthy fruit development behaviour while the others showed brief period of fruiting activity (Table VII. 3). The period required for the maturation of the fruit varied from 2 to 5 months for the different species.

Survival of seedling

For all the species, seedling mortality was high during the month of February which experienced the cool and dry winter season. The survival was comparatively high in gaps than the understorey (Figure VII. 1). In the gap of Mahabali sacred grove, seedlings of *Eugenia praecox* and *Persea* sp. did not show any mortality during the study period.

Relative growth rate of seedlings in terms of height (RGRH) and total leaf area (RGRA)

Relative growth rate for height (RGRH) and for total leaf area (RGRA) of the seedlings of the selected species in the understorey of the Konthoujam Lairembi sacred grove (where gaps were not available) and in the understorey and gaps of Mahabali sacred grove, Langol Thongak Lairembi and Heingang Marjing sacred groves showed seasonal variation; the minimum being during October to February (Figure VII. 2). The cold and dry climatic conditions during these months may be responsible for poor growth of seedlings.

In the understorey of Konthoujam Lairembi sacred grove, the differences in RGRH and RGRA among the species were significant (RGRH, $F=18.34$, $P<0.0001$ and RGRA, $F= 21.35$, $P<0.0001$). Variation in relative growth rates for height differed significantly between $RGRH_1$ and $RGRH_2$ ($F=29.41$, $P<0.0001$), and $RGRH_2$ and $RGRH_3$ ($F=27.14$, $P<0.0001$). Significant differences in temporal changes of RGRAs were also recorded between $RGRA_1$ and $RGRA_2$ ($F=31.97$, $P<0.0001$), and $RGRA_2$ and $RGRA_3$

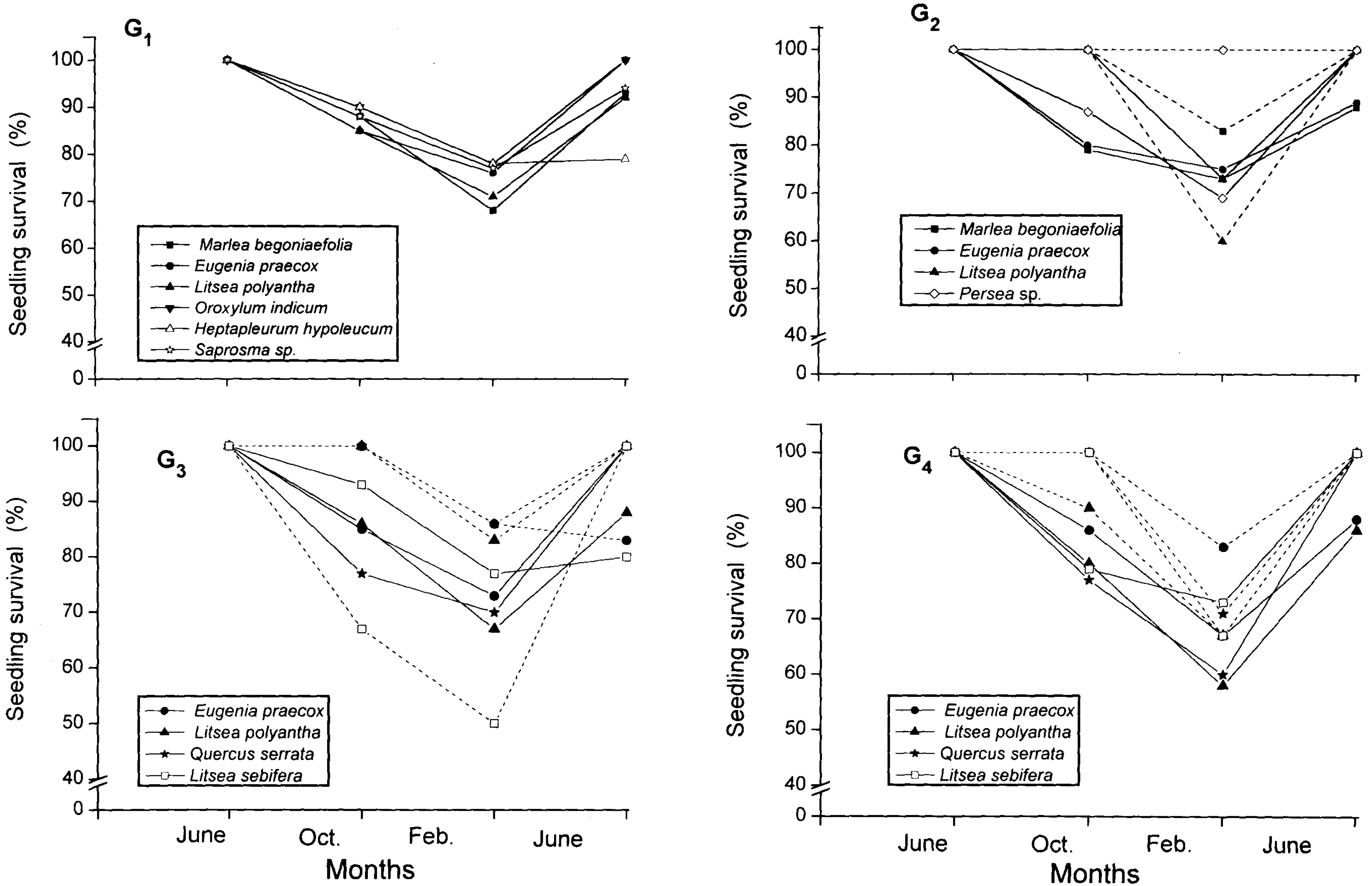

Figure VII. 1. Survival of seedlings of the selected tree species in the understorey and gaps of the four sacred groves. G_1- Konthoujam Lairembi sacred grove; G_2 - Mahabali sacred grove; G_3 - Langol Thongak Lairembi sacred grove; G_4 - Heingang Marjing sacred grove. Continuous lines represent understorey and broken lines represent the gaps.

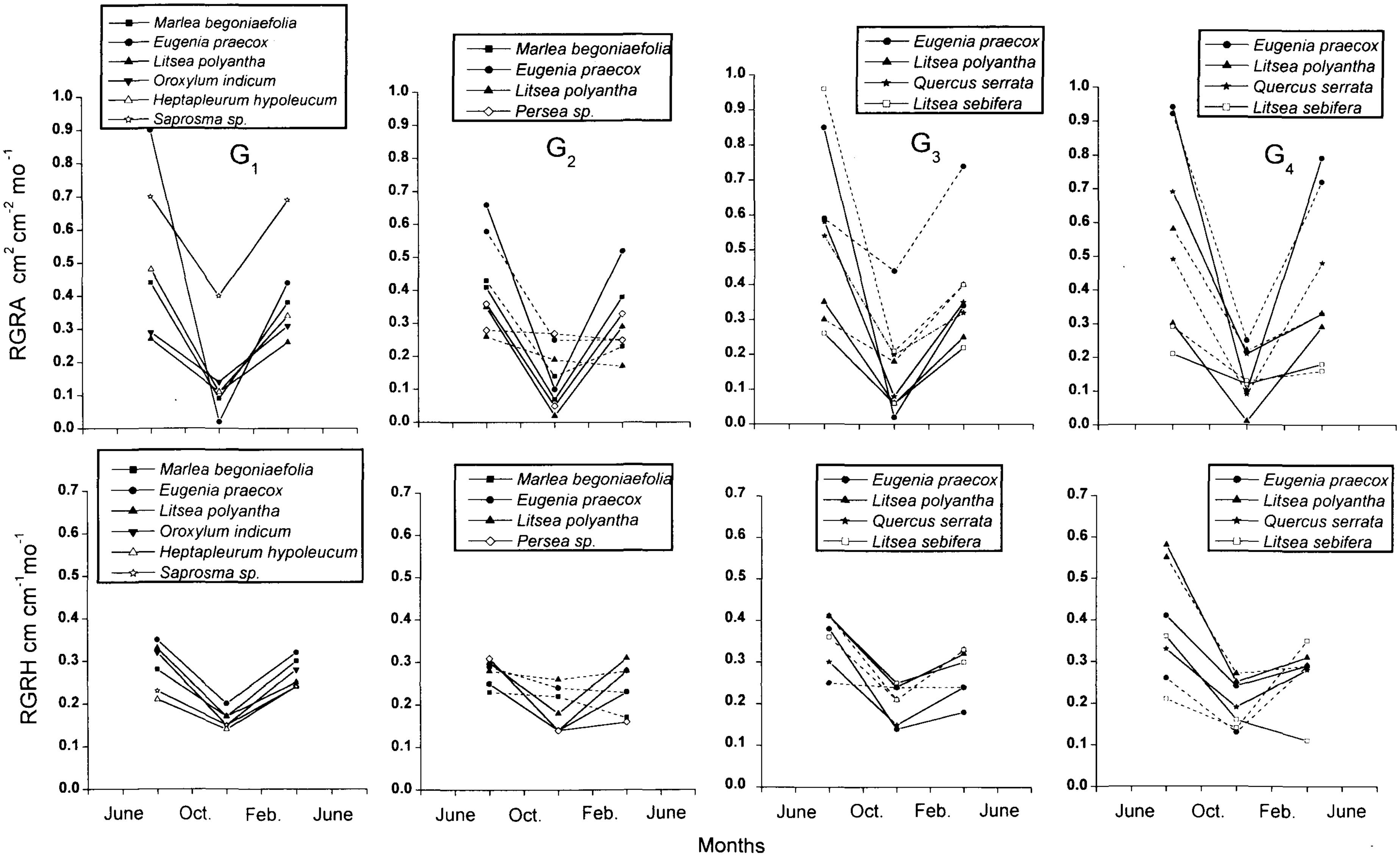

Figure VII. 2. Relative growth rate for height (RGRH) and for total leaf area (RGRA) of the seedlings of the selected tree species in the understorey and gaps of the four groves. G_1 - Konthoujam Lairembi sacred grove; G_2 - Mahabali sacred grove; G_3 - Langol Thongak Lairembi sacred grove; G_4 - Heingang Marjing sacred grove. Continuous lines represent understorey and broken lines represent the gap.

(F=15.7, P<0.0001). *Eugenia praecox* exhibited the highest RGRH and the value was lowest for *Heptapleurum hypoleucum*. *Saprosma* sp. showed the highest RGRA among the selected species (Figure VII. 2).

While analyzing the growth of two common species (*Eugenia praecox* and *Litsea polyantha*) between the understorey and gaps in the case of the three groves it was observed that the relative growth rates for stem height and total leaf area differed significantly throughout the study period (RGRH, F=33.1, P<0.0001; RGRA, F=215.18, P=0.0001). Both RGRHs and RGRAs showed significant differences between the gaps and understorey during the study period ($RGRH_1$ and $RGRH_2$, F= 13.86, P<0.0001; $RGRA_1$ and $RGRA_2$, F=16.8, P<0.0001; $RGRA_2$ and $RGRA_3$, F=12.11, P<0.001) except between $RGRH_2$ and $RGRH_3$ (F=3.03, P<0.08).

Increment of relative growth rate for stem height (F=35.83, P<0.0001) and for total leaf area (F=19.56, P<0.0001) was significant among the selected species between understorey and gaps of the three groves (Mahabali, Langol Thongak Lairembi and Heingang Marjing sacred groves) throughout the study period. However, RGRH and RGRA were not constant during the study period and showed substantial variation on each observation date. Temporal changes in relative growth rates for height differed significantly between $RGRH_1$ and $RGRH_2$ (F=60.65, P<0.0001) and, $RGRH_2$ and $RGRH_3$ (F=28.47, P<0.0001). Differences in RGRAs also varied significantly between $RGRA_1$ and $RGRA_2$ (F=26.67, P<0.0001) and $RGRA_2$ and $RGRA_3$ (F=50.64, P<0.0001). In general, growth of the selected seedlings in terms of RGRH and RGRA were characterized by seasonality showing marked decline during the period t_1 and t_2 which corresponds with the winter season (Figure VII. 2). However, all the selected seedlings recorded higher RGRH and RGRA in gaps than in the understorey particularly during the rainy season (t_1 and t_2). This clearly indicates that species differed in response to light environment and the growth of the seedlings was influenced by the canopy openness. Moreover, warm and wet period during summer season encouraged the growth of seedlings.

Absolute height and leaf area of the selected seedlings in the four sacred groves

At the end of one year study, significant differences ($F=14.06$, $P<0.0001$ for height and $F=15.02$, $P<0.0001$ for leaf area) were observed in absolute height and leaf area of the seedlings of different selected tree species in the understorey of Konthoujam Lairembi sacred grove. *Litsea polyantha* recorded the highest absolute growth followed by *Oroxylum indicum*, *Heptapleurum hypoleucum*, *Marlea begoniaefolia*, *Eugenia praecox* and *Saprosma* sp. (Figure VII. 3). Maximum leaf area was exhibited for *Litsea polyantha* followed by *Oroxylum indicum*, *Heptapleurum hypoleucum*, *Saprosma* sp. and *Marlea begoniaefolia*, while *Eugenia praecox* recorded the minimum leaf area (Figure VII. 3).

Differences in absolute height of the two common species, *Eugenia praecox* and *Litsea polyantha* in the understorey and gaps of the three

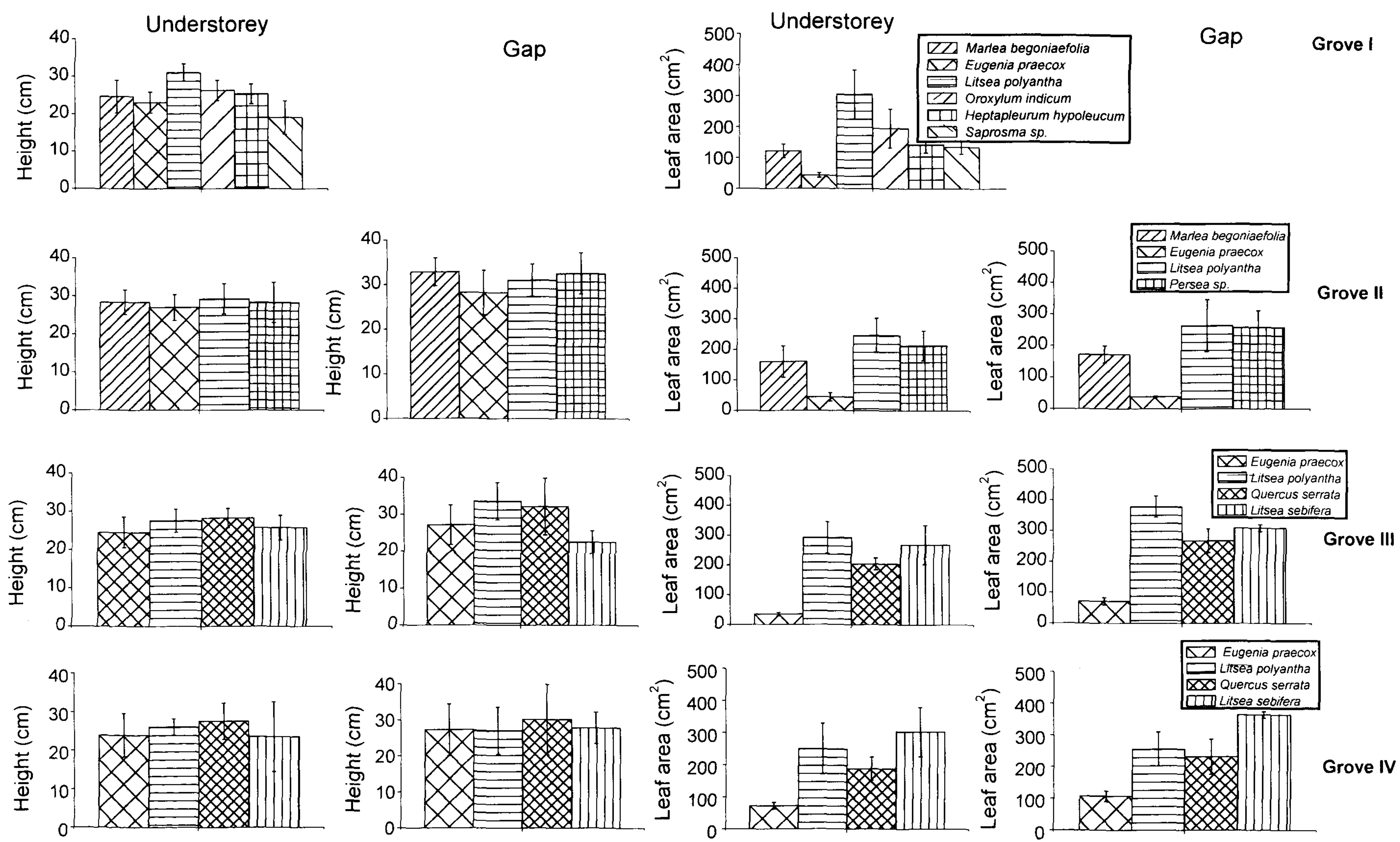

Figure VII. 3. Growth of the tree seedlings in terms of height and leaf area after one year in the understorey and gaps of the selected sacred groves. Grove I - Konthoujam Lairembi sacred grove; Grove II - Mahabali sacred grove; Grove III - Langol Thongak Lairembi sacred grove; Grove IV - Heingang Marjing sacred grove. Line bar indicates ± SD.

groves, were significant (F=12.52, P<0.0001), whereas the differences were insignificant in the case of leaf area.

Absolute growth for height and leaf area varied significantly (height, F=3.61, P<0.0001; leaf area, F=19.46, P<0.0001) in the understorey and gaps of the three groves. Height and leaf area of the seedlings of different species were slightly greater in gaps than in the understorey (Figure VII. 3), however differences were not significant.

Discussion

The overall vegetation type of the four groves was evergreen. The occurrence of maximum number of evergreen species in the groves maintains the greenness of these sacred forests throughout the year. The annual cycle of the environmental factors prevailing in the groves regulates the phenological characteristics of individual species. Leaf fall, leaf flushing, flowering and fruiting as recorded in the present study varied from season to season. The cool and dry winter period is responsible for maximum leaf drop whereas the increase in temperature during warm and wet periods induces the leaf flushing and flowering in most of the species. The different timings of the leaf fall may be due to micro-environmental differences (Boojh and Ramakrishnan 1981a), such as insolation and water retention by the tree species. Most of the species shed their leaves during the cool and dry period of the year. Similar observations have been reported by Boojh and Ramakrishnan (1981a) for sub-tropical forests of Meghalaya. Maximum leaf fall was reported recurrently during the driest part of the year in forest communities (Bhat 1992, Bullock and Solis-Magallenus 1990, Frankie *et al.* 1974, Hopkins 1966, Murali and Sukumar 1993, Prasad and Hegde 1986, Shukla and Ramakrishnan 1982a, Singh and Singh 1992, Taylor 1960). The leaf fall was followed by the bursting of buds during March-April. The bud bursting minimizes the stress of leaf fall during such periods and maximizes the photosynthetic activity during the wet warm summer season of the year. Reich and Borchert (1982) observed that the rate of leaf fall during the dry months of the year was strongly correlated with the reduced soil moisture content and increasing water stress of the tree.

Leaf flushing in most of the tree species selected for study was observed during March to April, which may be attributed to warm climate of the year before the onset of rains. A few species continued leaf flushing during mid-wet season. This may be ascribed to intrinsic factors. Flushing of leaf towards the end of the dry season before rains is well reported (Bhat 1992, Frankie *et al.* 1974, Shukla and Ramakrishnan 1982a, Singh and Singh 1992, Singh *et al.* 2000, Whitmore 1984). This can be attributed to the triggering effect of the rising temperature (Walter 1968) in the wet season (Bullock and Solis-Magallenus 1990, Procter *et al.* 1983).

Most of the species flowered during the late dry and early wet seasons (before rainy season). Some other workers have also reported the peak flowering before rainy season (Boojh and Ramakrishnan 1981a, Kikim and Yadava 2001, Singh and Singh 1992), and it has been argued that moisture, temperature and photoperiod during this period are responsible for peak flowering (Frankie *et al.* 1974, Lawton and Akpan 1968, Murali and Sukumar 1993, Njoku 1963, Pandey *et al.* 2002, Wright and van Schaik 1994).

Fruit development starts when flower begins dropping. The peak fruiting period varied from species to species. Period of fruit maturation was extended and lengthy in several species, while *Eugenia praecox*, *Marlea begoniaefolia*, *Saprosma* sp. and *Persea* sp. showed brief activity and rapid fruit maturation. The peak production of mature fruit has during October which represents transitional period between the wet season and dry season. Therefore, most of the species have seeds with winter dormancy which germinate when warm rainy season starts (Boojh and Ramakrishnan 1981a, Bullock and Solis-Magallenus 1990, Kikim and Yadava 2001, Ralhan *et al.* 1982). It is clear that the phenological characteristics in these tree species are regulated by environmental factors like temperature, moisture, solar radiation and humidity, as well as the intrinsic factors of the species.

Seedling survival was greater in the gaps then in the understorey of the groves. Nagamatsu *et al.* (2002) discussed that the survival rate of seedlings of different species was affected by canopy openness. The seedling mortality was greater in the month of February and lower during June which is a wet month in Manipur. Lieberman and Li (1992) and Swaine *et al.* (1990) also reported that survival rate of the seedlings of tree species increased progressively during wet season. The seedlings are generally vulnerable to cool and dry climatic conditions prevailing during the winter season and a large number of seedlings died in both understorey and gaps. The detrimental effect of soil moisture stress on the survival of tree seedlings has been reported by several workers (Khan *et al.* 1986, Khan and Tripathi 1991, Kikim 1999, Kumar *et al.* 1994, McLead and Murphy 1977, Mueller-Dombois *et al.* 1980, Perira and Kozlowski 1977, Rao and Singh 1985, Rao *et al.* 1997, Schulte and Marshall 1983). The microenvironmental conditions created due to the formation of natural gaps in the groves might be potentially favourable for the survival of tree seedlings as also observed by Brokaw (1984). This signifies the role of light during the seedling establishment and survival. The importance of light (Augspurger 1984b, Burton and Muller-Dombois 1984, Connell *et al.* 1984), temperature (Sorensen and Ferrel 1973) and litter depth (Collins and Good 1987) in regulating tree seedling survival in tropical forests has been emphasized. A large number of species show better survival in gaps than in the understorey (Brokaw 1985b, Welden *et al.* 1991).

The overall RGRHs and RGRAs for the seedlings of different species varied seasonally. Seasonal variability in growth response to light environment is an important parameter to determine the growth of subtropical tree species. There were increases in RGRHs and RGRAs during the wet season attaining a peak during June. Differences in relative growth rates among the species are caused by morphological parameters, while temporal changes are caused by physiological parameters (Isabel *et al.* 2001). Seedlings of all the species showed low RGRHs and RGRAs during the months of October and February which may be due to cold and dry winter season with high soil moisture stress due to low rainfall. The role of soil moisture in influencing growth of seedlings has been studied by many workers (McLead and Murphy 1977, Mueller-Dombois *et al.* 1980). The peak seedling growth during rainy season could be attributed to the increased availability of nutrients due to rapid decomposition of litter on the forest floor and also to the higher moisture content of the soil. Relative growth rate for height and total leaf area were higher in the gaps than in the understorey. Brokaw (1985b) also found higher growth rates in gaps for pioneer species than the primary species. Augspurger (1984b) and Pompa and Bongers (1988) reported enhanced growth for all species in gaps. Spatial variation in light among gaps and understorey and its effect on growth have been extensively studied by many workers (Brokaw 1985a, Canham and Marks 1985, Denslow 1980b, Juliette 2003, Whitmore 1982, Zuleika *et al.* 2003).

The absolute seedling height and leaf area were also greater in the gaps than the understorey for all species in the four groves. Variation in height growth and leaf area of the seedlings of different species may be partly responsible for the difference in growth behaviour under a given set of environmental conditions. Physiological ability of the plant influenced by the species-specific attribute for the efficient utilization of resources under various microenvironmental conditions also account for the differential growth response of seedlings of different tree species.

The results of the present study indicate that different species differed in their growth responses in the understorey and gaps, which may be due to their specific attributes to influence the physiological ability to utilize the environmental resources efficiently.

GENERAL DISCUSSION

Sacred groves of Manipur are conserved by "*Meitei*" community for worshipping the sacred deities called *Umanglais*. These groves being closely associated with the culture and religion of the indigenous people, have been protected by them over the years. Meiteis worship Umanglais with the celebrations called "Lai-Harouba" (the pleasing of God) in their dwelling groves that are performed once in a year. It is believed that these celebrations please the deities who protect the local people, from sickness, harm, natural disasters and invasion by enemies.

In total, 166 sacred groves were inventoried in the valley districts of Manipur where Meitei community dominates the population. The size of the individual sacred grove varies from a clump of a few trees having an area 0.001ha to 40 ha at the elevations ranging from 691 to 860 m asl. Area of majority of the groves ranged from 0.09 ha to 1.5 ha and the total area of all the inventoried sacred groves was 175.62 hectares. Some plant species found in these sacred groves are believed to be the incarnation of the deity and some species are associated with rituals. These species are regarded as sacred. Some of the examples of such species are: *Ficus religiosa* (Sana-khonang) and *Mangifera* sp. in Langol Thongak Lairembi sacred grove, *Terminalia arjuna* (Mayokpha) in Mayokpha sacred grove, *Syzygium jambos* in Konthoujam Lairembi sacred grove.

The sacred groves found in different locations of the state help in the conservation of rare and endemic plants and animals and various ethnobotanically used plants. However, the sacred groves are being ~~distributed~~ and degraded due to the impact of developmental activities, urbanization, increase in population and other anthropogenic pressures. Moreover, the people's traditional beliefs are also being eroded, and indigenous and cultural practices associated with the sacred groves are considered as superstitions by a large section of people, particularly by the younger generation. All this has led to the degradation of sacred groves. Only a few of the groves (11%) are well preserved and are really helpful in maintaining the ecological balance and conservation of biodiversity, while most of them are either partly threatened (58%) or ~~and~~ seriously threatened (31%). This clearly shows that presently, the sacred groves of Manipur are not immune to human interference as the traditional beliefs have been considerably eroded.

The floristic survey of the four sacred groves revealed the occurrence of 173 plant species belonging to 145 genera under 70 families which is floristically significant not only in terms of plant diversity but also in terms of diversity of families. Maximum number of species belonged to family Asteraceae and Rubiaceae (11 each) followed by Mimosaceae and Verbenaceae (8). Out of the total 173 species, 80 species were trees representing 59 genera under 33 families including 1 species of liana and 2 species were unidentified, 24 were shrubs belonging to 23 genera under 14 families, 62 species were herbs representing 34 families in 58 genera, and 6 species were pteridophytes representing 3 genera under 3 families, which is higher than the reported number of species from the sacred groves in the

Western Ghats (Sundarapandian and Swamy 1997). This may be due to high rainfall and moderate climatic conditions prevailing in Manipur. Number of shrubs was low in comparison to trees and herbs. The ethnobotanical survey showed that out of the 173 species, 125 species (72%) representing 109 genera and 59 families have the ethnobotanical importance. Among the 125 ethnobotanically important species, 120 species (96%) representing 106 genera under 57 families have medicinal value and are used for curing various ailments through indigenous practices. While examining the conservation status of the enumerated species based on the record of Manipur Biodiversity Strategy and Action Plan under National Biodiversity Strategy and Action Plan 2002, it was found that 5 species fall under the rare and vulnerable categories, 1 under vulnerable, 1 under endemic and vulnerable, 3 under the threatened and 1 under endangered category.

The vegetation of the groves showed distinct stratification having tree, shrub and herb layers. The relationship between topography and the distribution of individuals of different species have been depicted by vegetation profile diagrams. The emergent layer of the canopy increased the extent of topstorey layer in Konthoujam Lairembi sacred grove, which creates heterogeneous microenvironment in the grove, thus allowing the maintenance of a diversified species composition (Cao and Zhang 1997). Emergent vertical strata of upper layer in Mahabali sacred grove permits the easy penetration of sunlight. The canopy is more or less closed in Langol Thongak Lairembi and Heingang Marjing sacred groves. The shrub layer and herb layer were formed by a variety of shrubs and annual and perennial herbs. Thus, these groves with multi-layered stratification are characterised by the presence of a large number of heterogeneous microsites and are more effective in the protection and conservation of soil and water resources. The quantitative analysis shows that *Saprosma* sp. was the dominant species in Konthoujam Lairembi sacred grove with the IVI value of 29.7 and showed the maximum density (54 stems ha^{-1}). The dominant tree species in Mahabali sacred grove was *Persea* sp. with the highest IVI value (52.4) and stand density (85 ha^{-1}). *Pinus kesiya* was the dominant species in the two groves located in the hills and had the highest IVI value (176.3) in Langol Thongak Lairembi sacred grove and ~~and~~ (153.7) in Heingang Marjing sacred grove. It also had high density of 690 stems ha^{-1} in Langol Thongak Lairembi sacred grove and 705 stems ha^{-1} in Heingang Marjing sacred grove. A liana *Entada scandens* was found only in Konthoujam Lairembi sacred grove.

The biological spectra of the four sacred groves of Manipur prepared on the basis of Raunkiaer's life form system are more or less similar with the normal spectrum of phanerogamic flora of the world, which indicates that the vegetation is a relic of the tropical evergreen forests. The differences in climate and other environmental conditions in the groves, located at different elevations (plains and hills) seem to favour the development of different life forms, however, biotic disturbance may also change the proportion of life forms. Pandeya (1954) and Tiwari (1955) concluded that biological spectrum of a region reflects the most operative feature of the environment and the climate of the region.

One of the major considerations in recognizing the importance of an area for conservation perspectives is species richness of different life forms. The quantitative inventory of vegetation in the four sacred groves of Manipur showed high level of plant species diversity. The tree species richness recorded from the four sacred groves of Manipur falls within the range of 20-233 species ha^{-1} which is more or less similar to the range reported by Procter *et al.* (1983) and Whitmore (1984) in tropical forests. Overall species richness recorded in the four sacred groves of Manipur was within the range of 35 - 90 species per hectare (*c.f.* Murphy and Logo 1986) and followed the similar trend (trees > herbs > shrubs) as reported by Singh *et al.* (1995). Saxena and Singh (1982a) also suggested that different species come up according to their preferences of light and shady environment to favour seedling establishment of tree, shrub and herb species. Species diversity and density varied with the habitat, different gradients of elevations, environmental factors and edaphic characteristics. Moreover, species diversity is often correlated with rainfall and nutrient status (Hartshorn 1980).

The recorded stand density of trees (359 to 1218 stems ha^{-1}) in the four groves is much higher than the reported stand density in sacred groves of southern India (Kumar and Swamy 2003, Ramanujam and Kumar 2003, Visalakshi 1995). Stand density of the two groves located in the plains viz., Konthoujam Lairembi and Mahabali sacred groves, falls within the range of 245-859 stems (>30 cm gbh) per hectare which is comparable with the figures reported by Ashton (1964), Bhuyan *et al.* (2003), Campbell *et al.* (1992) and Richards (1952) for tropical forests, while the stand density (995 and 1218 stems ha^{-1}) of the other two groves located in the hills was higher than the oak forest of Manipur which ranged from 181 to 219 stems ha^{-1} (Srinivas 1992). The overall comparison shows that the sacred groves of Manipur exhibited comparatively higher density than the Western Ghats. The density of shrubs recorded in the groves was also within the range (1800 to 7000 per ha) of old growth tropical plantations (Pande *et al.* 1988).

The values of basal area (35.51 to 85.54 m^2 ha^{-1}) of the groves are much higher than that of the reported range of 11 to 68 m^2 ha^{-1} for tropical forests (Parthasarathy *et al.* 1992, Visalakshi 1995), and in the vegetation of dry tropics 17-40 m^2 ha^{-1} (Murphy and Logo 1986). The strikingly high basal area (85.54 m^2 ha^{-1}) obtained in the Mahabali sacred grove is comparable with the basal area (73.6 m^2 ha^{-1}) at Gum Gum, Sabah (Burgess 1961) which had matured and good sized native or primary forest species having larger girth. The lowest basal area recorded in Langol Thongak Lairembi sacred grove may be due to the dominance of *Pinus kesiya* having narrow range of girth class.

Difference in species diversity between communities generally resulted from variations in site quality (Denslow 1980a). Shannon-Weiner diversity indices are generally high for tropical forests of Indian subcontinent which ranged from 0.81 to 4.1 (Bhuyan *et al.* 2003, Parthasarathy *et al.* 1992, Singh *et al.* 1984, Visalakshi 1995). The values obtained in the present study (1.79 to 3.17) fall within the reported range for tropical forests, and are markedly lower than those reported by Knight (1975) for young (5.06) and old (5.4) stands.

The calculated values of concentration of dominance in the groves are higher than the values reported for tropical forests elsewhere (Bisht 1989, Parthasarathy *et al.* 1992, Visalakshi 1995). The values for species diversity indices showed the trend as herbs>trees>shrubs while the concentration of dominance values showed the opposite trend (shrubs>trees>herbs). In general, species diversity and concentration of dominance showed inverse relationship (Joshi and Behera 1991, Murthy and Panthak 1972, Singh and Mishra 1969). The high diversity and low concentration of dominance may be due to the different levels of biotic influences in the four groves.

All the four groves of the present study showed a remarkable degree of dissimilarity in their species composition at the level of habit (tree, shrub, herb species) of the plant species. The least similarity in occurrence of common species among the groves may be due to the narrow ecological amplitude of the species and differences in the prevailing habitat conditions. Murphy and Logo (1986) suggested that the differences in the species composition and physiognomy of vegetation might be due to the soil characteristics. Moreover, the variation in habitat may also alter the species composition. Maximum β diversity value recorded between Mahabali and Langol Thongak Lairembi sacred grove may be attributed to the variation in topography, habitat conditions and soil characteristics. There was altitudinal variation of *ca.* 100 m above mean sea level between the sacred groves in the plains and in the hills, and soil moisture content was slightly higher in Mahabali sacred grove than the Langol Thongak Lairembi sacred grove. It may be mentioned that

Mahabali sacred grove is located near the catchment area while Langol Thongak Lairembi sacred grove is in the hill ranges.

Least value of β diversity between Langol Thongak Lairembi and Heingang Marjing sacred grove in terms of tree, shrub and herb species, may be due to similar microenvironmental conditions, altitude and biotic stresses. Pande *et al.* (1988) argued that the impact of altitude and other factors significantly influence turnover of species among the sites. The higher values of β diversity and low similarity index as observed in the present study revealed that there is a marked variation between the groves in terms of their species content.

There was a gradual decrease of species diversity and plant density with increase in girth class which is in conformity with the studies in the Western Ghats, India (Parthasarathy and Karthikeyan 1997a, Pascal and Pelissier 1996), Malaysia (Manokaran and LaFamkie 1990, Newbery *et al.* 1992), Coata Rica (Lieberman *et al.* 1985, Nadkarni *et al.* 1995), New Guinea (Paijmans 1970) and New Caledonia (Jeffre and Veillon 1990).

Microsite characteristics of the forest floor and microenvironmental conditions under the forest canopy also influence the regeneration of tree through seeds (Tripathi and Khan 1990). In general, regeneration of species is affected by anthropogenic factors (Khan and Tripathi 1989b, Sukumar *et al.* 1994) and natural phenomena (Welden *et al.* 1991). The overall status of regeneration in the four groves was good as majority of the tree species in these groves recorded high seedling density as compared to the density of saplings and adult trees. This may be due to favourable microenvironmental factors such as sufficient light for photosynthesis, soil moisture and litter layer on the soil surface. The occurrence of high proportion of plant species which were new to the grove and were represented by seedlings and saplings only, may be attributed to the invasion of new species through dispersal/migration from other areas. It may also be possible that the microenvironmental conditions in the grove are favourable for the survival and growth of these new colonizers.

Proportion of seedlings, saplings and young trees in any forest community can provide satisfactory information on the regeneration behaviour of the forests (Saxena and Singh 1984). The observed variations in the population structure of the selected tree species may be attributed to the differences in their habitat and prevailing microenvironmental factors. Density-diameter distribution of the selected species (Figure VI. 2a to b) in the four groves indicates the greater population of seedlings than the saplings and trees except for *Marlea begoniaefolia* and *Litsea polyantha* in Konthoujam Lairembi sacred grove, *Eugenia praecox* in Mahabali sacred grove and, *Wendlandia tinctoria* in Langol Thongak Lairembi and Heingang Marjing sacred groves. The seedling population was greater during May (rainy season) as compared with other seasons but sapling population did not show marked seasonal differences. Reduction in seedling population during dry winter season may be due to adverse effect of soil moisture stress and unfavourable temperatures on survival of tree seedlings. Similar results have also been reported by several workers (Kumar *et al.* 1994, Perira and Kozlowski 1977, Rao and Singh 1985, Schulte and Marshall 1983). The greater sapling population of *Marlea begoniaefolia*, *Litsea polyantha* in Konthoujam Lairembi sacred grove and *Wendlandia tinctoria* in Langol Thongak Lairembi and Heingang Marjing sacred grove than the seedlings and trees clearly indicates that these species will persist and may determine the composition of future vegetation of the groves (Jayasingham and Vivekanantharaja 1994, Swaine and Hall 1988). Swaine and Hall (1988) stated that greater number of saplings alone may not depict the future composition of forest community because over a period of time any drastic environmental changes could nullify the effect. However, in the absence of catastrophic events the saplings will gradually form future crowns.

The overall pattern of population structure of the selected tree species reveals that seedling population dominates the population structure and the fluctuation in population density in various seasons is dependent on the variations in the environmental factors. Recruitment of all the species increased during the major wet season attaining a peak during June, which may be due to the favourable moisture conditions during the rainy season. Similar observations have been reported in tropical dry forest at Pinkwae, Ghana (Lieberman and Li 1992, Swaine *et al.* 1990).

Studies on phenological events are important for the better understanding of ecological adaptations of individual species as well as community level interactions (Reich and Borchert 1982, Reich *et al.* 1991, Wright 1991). Majority of the woody species found in these groves showed the emergence of atleast small amount of new leaves throughout the year on account of which the greenness of the forest is maintained. Hence, the overall nature of the four groves was evergreen. The annual cycle of the environmental factors prevailing in the groves regulates the phenological characteristics of individual species. Most of the selected species shed their leaves during the cool-dry period of the year and flushing starts with the bursting of buds during March-April when warm period of the year begins, before the onset of rains. Stress of leaf fall was minimized during the wet warm summer season of the year maximizing the photosynthetic activity. Reich and Borchert (1982) observed that the rate of leaf fall during the dry months of the year was strongly correlated with the reduced soil moisture content and increasing water stress of the tree. The maximum leaf fall during the driest part of the year and greater leaf flushing during the wet season are in agreement with the observations of several workers (Bullock and Solis Magallenus 1990, Frankie *et al.* 1974, Procter *et al.* 1983, Shukla and Ramakrishnan 1982a, Singh and Singh 1992). Most of the species flowered during the later period of dry and early period of wet seasons (before rainy season) and fruit development starts when flower begins drooping, however, peak fruiting timing varied from species to species. Some other workers also reported the peak flowering before rainy season (Boojh and Ramakrishnan 1981a, Kikim and Yadava 2001, Singh and Singh 1992), and it has been argued that moisture, temperature and photoperiod prevailing during this period of the year are favourable for flowering (Frankie *et al.* 1974, Lawton and Akpan 1968, Murali and Sukumar 1993, Njoku 1963, Pandey *et al.* 2002, Wright *et al.* 1994). The peak production of mature fruit of the selected tree species occurred during the transitional period (after October), between the rainy season and cool-dry winter season. Therefore most of the species have seeds with winter dormancy and they germinate when warm rainy season starts (Boojh and Ramakrishnan 1981a, b, Bullock and Solis-Magallenus 1990, Kikim and Yadava 2001).

A good regeneration of tree species in the forests is an indicator of the well being of the forest. Natural regeneration of species depends upon the production and germination of seeds, and successful establishment of seedlings and saplings in the forests (Rao 1988). Natural regeneration provides a better possibility for conserving forest biodiversity. Besides, it also causes dense forest growth with a wider variation in vegetation structure. However, natural regeneration and establishment of primary forest species are the crucial phases because their requirements are more species-specific (Gomez-Pompa *et al.* 1972, Primack 1990, Whitmore 1984). Most of the studies relating to the regeneration of either specific species or the forest stand as a whole have focused on the impact of anthropogenic factors and natural disturbances. The regeneration of species is particularly affected by natural phenomenon such as light gaps (Welden *et al.* 1991). It has been reported that regeneration of the species is greatly affected by fire (Khan and Tripathi 1989c, Kikim and Yadava 1998, Stocker 1981, Sukumar *et al.* 1994, Toky and Ramakrishnan 1983) and logging (Guariguata and Dupuy 1997). Degradation has been reported to reduce species number, stem density and regeneration potential of the forests (Murali *et al.* 1996). Although moderate levels of disturbance may enhance the level of forest diversity (Connell 1978) and regeneration (Barik *et al.*1996a, Khan and Tripathi 1987a). Successful regeneration of any type of species can only occur if the right amount of growing space becomes available for the establishment and growth of seedlings (Klinka *et al.* 1990). Degree of stability of tropical forests may have important implications for maintaining biodiversity (Phillips and Gentry 1994).

Canopy gaps created by treefalls provide favourable conditions for the growth of tree seedlings and in most close canopied forests tree regeneration is dependent upon the occurrence of gaps in the community (Miles 1974, Milthrope 1961). Gaps may play an important role in the maintenance of high species diversity (Connell 1978, Denslow 1980b) mediated by a high environmental heterogeneity (Brokaw and Busing 2000, Hubbell *et al.* 1999). Gap size is said to be the most important characteristic of gaps because it often correlates with biologically functional parameters (Denslow 1980a, Denslow and Hartshorn 1994, Rao *et al.* 1997, Turner 1990). Seedling growth is directly related to the way in which species can adjust their morphological and physiological characters to the environment. Seedling survival and relative growth rate of nine selected tree species were greater in the gaps compared to the understorey. Seedling survival was lower in winter and greater during wet season. Relative growth rates for height (RGRH) and total leaf area (RGRA) of seedlings of the selected species were low during the months of October to February which signifies the impact of winter season which was characterized by the low temperature conditions and high soil moisture stress due to very low rainfall. The detrimental effect of soil moisture stress on the survival and growth of tree seedlings has been reported by several workers (Khan *et al.* 1986, Khan and Tripathi 1991, Kikim 1999, Kumar *et al.* 1994, McLead and Murphy 1977, Mueller-Dombois *et al.* 1980, Perira and Kozlowski 1977, Rao and Singh 1985, Schulte and Marshall 1983). The greater RGRHs and RGRAs of seedlings during the wet season ascribed a peak during the month of June may be accredited to the favourable temperature and edaphic conditions including availability of nutrients as a result of rapid decomposition of litter on the forest floor and also to the higher moisture content of the soil. Lieberman and Li (1992) and Swaine *et al.* (1990) also reported that survival rate of the seedlings of tree species increased progressively during wet season.

Seedling survival and the overall RGRH and RGRA of the selected tree species were higher in the gaps than the understorey. The microenvironmental conditions created due to the formation of natural gaps in the groves might be potentially favourable for the survival of tree seedlings (Brokaw 1984). It signifies the role of light (Augspurger 1984a, Burton and Muller-Dombois 1984, Connell *et al.* 1984), temperature (Sorensen and Ferrel 1973) and litter depth (Collins and Good 1987) in regulating tree seedling survival in tropical forests. Brokaw (1985b) also found higher growth rates in gaps for pioneer species than the primary species. However, Augspurger (1984b) and Pompa and Bongers (1988) reported enhanced growth for all species in gaps. Spatial variation in light among gaps and understorey and its effect on growth has been extensively studied by many workers (Brokaw 1985b, Canham and Marks 1985, Denslow 1980b, Juliette 2003, Whitmore 1982, Zuleika *et al.* 2003). Differences in relative growth rates among the species are caused by morphological parameters, while temporal changes are caused by physiological parameters (Isabel *et al.* 2001). This clearly indicates that species differed in their response to light environment, and the growth of seedlings was influenced by the canopy openness.

Absolute seedling height and leaf area were also greater in the gaps than in the understorey for all species in the four sacred groves. This may be due to the species-specific attributes which influence the physiological ability of plant for efficient utilization of environmental resources. Moreover, variation in height growth and leaf area of the seedlings of different species may be only partly responsible for the difference in their growth behaviour under a given set of environmental conditions.

It may be concluded that the vegetation composition and regeneration of the selected tree species depend on the interactive influence of biotic and abiotic factors of the environment. The prevailing microenvironmental conditions of the groves provide the ecological niches that can nurture the rich plant biodiversity of ecological and economic importance. The observed better survival and growth of the tree seedlings in the gaps than the understorey depicts that the available microenvironmental factors in the gaps such as light, water, nutrients etc. are more conducive for the survival and growth of tree seedlings. Seasonal changes in the prevailing environmental conditions also affect the survival and growth of the species.

The present study encompasses the floristic, phytosociological and ethnobotanical aspects of the four selected sacred groves of Manipur, besides the investigations covering the regeneration, phenology, and survival and growth of seedlings of a few important tree species found in these groves.

The study has generated a wealth of useful scientific information on the representative sacred groves of Manipur, however in order to gain a deeper insight into the ecosystem process, and phenology, germination of seeds, survival and growth of seedlings of the successional and primary forest tree species of these sacred groves, the following studies need to be carried out:

1. Detailed studies on the impact of the prevailing environmental conditions on the phenological events and tree seed bank dynamics in the sacred forest ecosystem.

2. Detailed studies on seasonal variation on microenvironmental variables such as photon flux intensity, relative humidity and soil moisture in gaps and understorey that influence the survivorship and growth of tree seedlings.

3. Studies on significance of dynamics of nutrient cycling (litter fall and decomposition and nutrient mineralization pattern) in the regeneration of species.

4. Detailed studies on regeneration of keystone tree species in relation to different treatments at different microsites.

Findings of the present study may be helpful in understanding and appreciating the rich plant diversity in the sacred groves of Manipur, comprising rare, threatened, endemic and ethnobotanically important species, and regeneration status of important tree species composing these groves.

Based on the findings of the present study, the strategies and action plans may also be formulated for the better management of these sacred groves and for the conservation of the valuable plant taxa some of which are confined only to these groves.

SUMMARY

Sacred groves are the only forest patches that are saved from destruction caused by several anthropogenic stresses such as increase in human population, over-exploitation of forest resources, degradation due to urbanization and various developmental activities, forest fire, logging etc., that take place in other categories of forests. However, the religious beliefs, taboos and socio-cultural practices of the indigenous people associated with the sacred forests have contributed a great deal to the protection of these forests and conservation of biodiversity. The inventorization of their biodiversity, vegetation analysis, phenological observations and regeneration status of important tree species occurring in these sacred groves provide the background information for taking appropriate measures for conserving these groves which are now being degraded. There is a rich tradition of protecting and conserving forest patches in the north-eastern region by declaring them sacred and treating them as the dwelling places of gods and goddesses. A good number of ecological studies have been carried out on several sacred groves of Meghalaya, but the large number of such groves occurring in the state of Manipur have not been studied so far in detail. Therefore, the sacred groves of Manipur were inventoried and four sacred groves located in Imphal east and Imphal west districts of Manipur were selected for detailed study. Out of these, two groves viz. Konthoujam Lairembi and Mahabali are located in the plain/valley and two groves namely Langol Thongak Lairembi and

Heingang Marjing are located in the hills. The study focuses on the following aspects:

i) Inventory of the sacred groves in Manipur.

ii) Species richness, population structure and regeneration status of tree species in relation to their natural habitat.

iii) Ethnobotanical value of the plant species occurring in the four sacred groves with emphasis on medicinal plants.

iv) Population structure and regeneration status of a few selected tree species in the four sacred groves.

v) Phenology of a few selected tree species in the four sacred groves, and survival and relative growth rate of their seedlings in the understorey and gaps.

Inventory of the sacred groves

An inventory of sacred groves distributed in varied locations in the four districts of Manipur viz. Imphal East, Imphal West, Bishnupur and Thoubal, was prepared based on an extensive field survey of these districts. In total, 166 sacred groves were recorded from these districts. The area of the groves ranged from 0.001 to 40 ha and majority of them were threatened due to human interference. The groves located in the urban area are more degraded as compared with those located in the village areas.

Plant biodiversity, species richness and population structure of the four groves

A total of 173 species belonging to 145 genera under 70 families were recorded from the four sacred groves that were selected for detailed study. Out of 173 species, 80 species were trees representing 59 genera under 33 families including 1 species of liana, 24 were shrubs belonging to 23 genera under 14 families, 62 species were herbs representing 34 families in 58 genera, and 6 species were pteridophytes representing 3 genera under 3 families. Maximum number of species belonged to the family Asteraceae and Rubiaceae.

The overall species richness in the four sacred groves was recorded highest in Konthoujam Lairembi sacred grove which had 81 species in 70 genera belonging to 42 families and lowest in Langol Thongak Lairembi sacred grove which comprised 53 species representing 46 genera under 32 families. In the case of woody species, the highest number of species was recorded highest in Konthoujam Lairembi sacred grove which had 44 species in 36 genera under 22 families along with 1 unidentified species. The number of woody species was lowest in Mahabali sacred grove (20 species of 17 genera in 11 families). The highest stand density of woody species (1218 stems ha^{-1}) was recorded in Heingang Marjing sacred grove and lowest in Konthoujam Lairembi sacred grove (359 stems ha^{-1}), whereas the basal area was recorded highest in Mahabali sacred grove (85.54 m^2 ha^{-1}) and minimum in Langol Thongak Lairembi sacred grove (35.51 m^2 ha^{-1}). Species composition and distribution pattern varied among the groves, however, the two groves located in hills were more or less similar.

The groves had multi-layered vegetation formed by trees, shrubs and herbs. Among the tree layer *Saprosma* sp. was the dominant species in Konthoujam Lairembi sacred grove with the IVI value of 29.7 and it also contributed the maximum density (54 stems ha^{-1}). The dominant tree species, in Mahabali sacred grove was *Persea* sp. with the highest IVI value (52.4) and stand density (85 ha $^{-1}$). *Pinus kesiya* in Langol Thongak Lairembi and Heingang Marjing sacred groves exhibited the maximum IVI value (176.3 in Langol Thongak Lairembi and 153.7 in Heingang Marjing sacred grove) and stand density (690 stems ha^{-1} in Langol Thongak Lairembi and 705 stems ha^{-1} in Heingang Marjing sacred grove.

The highest stand density and species richness were observed in the lowest girth class (30-60cm) decreasing consistently with increasing girth class.

Konthoujam Lairembi sacred grove recorded the highest number of tree species (55 species) out of which 32 species (62% of the total) were regenerating. 9 species were not regenerating and 14 (25 %) were the new colonizers represented only by the seedlings or saplings. In Mahabali sacred grove, out of 39 species, 18 (46%) were regenerating, 2 (5%) were not regenerating and 19 (49 %) were the new colonizers. Out of the 38 species recorded in Langol Thongak Lairembi sacred grove, 23 (60%) were regenerating, 1 (3%) was not regenerating and 14 (37%) were the new colonizers. Heingang Marjing sacred grove recorded the lowest number of species (42 species), out of which 30 species (72%) were regenerating, 1 (2%) was not regenerating and 11 (26%) were the new colonizers. The proportion of species showing good regeneration was maximum (18% of the total species) in Mahabali and Langol Thongak Lairembi sacred groves and lowest proportion (15%) of such species was recorded in Konthoujam Lairembi sacred grove.

Ethnobotanical values and conservation status of the plant species occurring in the four sacred groves

Out of 173 species recorded from the four groves, 125 species were found having ethnobotanical values. Among the 125 ethnobotanically important species, 120 species (96%) representing 106 genera and 57 families were found to be of medicinal value being used for the treatment of various ailments through indigenous practices. So far as the conservation status is concerned, 5 species were under the rare and vulnerable categories, 1 under the endemic and vulnerable, 1 under vulnerable, 3 under the threatened and 1 in the endangered category.

Population structure of a few selected tree species

Population structure of the selected tree species viz. *Marlea begoniaefolia*, *Eugenia praecox*, *Litsea polyantha*, *Persea* sp., *Heptapleurum hypoleucum*, *Oroxylum indicum*, *Saprosma* sp, *Wendlandia tinctoria*, *Quercus serrata* and *Litsea sebifera* was studied during 2001-2002. Proportion of seedlings and saplings varied among the species and in different seasons. In all the species, density of seedlings was found higher than the saplings and adult trees. The seedling density was greater during rainy season attaining a peak in the month of June but sapling and adult tree populations did not show marked variation and had more or less similar density in different seasons. Seedlings constituted about 79% of the total density (3640 ha^{-1}) in Konthoujam Lairembi sacred grove, followed by 68% each in Mahabali sacred grove and Langol Thongak Lairembi sacred grove having the total density of 1784 ha $^{-1}$ and 1303 ha $^{-1}$, respectively, and in Heingang Marjing sacred grove 56% of the total density (1586 ha^{-1}) was constituted by the seedlings. Total sapling density per hectare in the four groves was recorded in the order of 645 (Konthoujam Lairembi)>499 (Heingang Marjing)>422 (Mahabali)>331 (Langol Thongak Lairembi).

Phenology of a few selected tree species in the four sacred groves

Based on the pattern of leafiness, all the woody species (81 species) recorded in the four sacred groves were categorised into two major classes, viz. evergreen and deciduous. Majority of the species in these groves were evergreen species, showing the presence of atleast small amount of new leaves throughout the year. The highest proportion of evergreen species (80%) was recorded in Mahabali sacred grove followed by Konthoujam Lairembi sacred grove (78%), Langol Thongak Lairembi sacred grove (71%) and Heingang Marjing sacred grove (70%). Thus, all the four groves had the composition of evergreen forest.

Phenological observations were made seasonally on 11 selected tree species (*Oroxylum indicum*, *Saprosma* sp., *Marlea begoniaefolia*, *Vanguirea spinosa*, *Persea* sp., *Quercus serrata*, *Terminalia citrina*, *Pasania polystachya*, *Eugenia praecox*, *Wendlandia tinctoria* and *Schima wallichii*) of the four sacred groves. Most of the selected species shed their leaves during the cool and dry period of the year and leaf flushing starts with the bursting of buds during March-April with the onset of warm climate before the rainy season. Majority of the species flowered soon after the leaf flushing. Development of fruit usually takes place in the month of April after the initiation of flower dropping.

Survival and relative growth rate of a selected tree seedlings in the understorey and gaps.

The survival and growth of seedlings of nine tree species viz., *Eugenia praecox*, *Litsea polyantha*, *Marlea begoniaefolia*, *Heptapleurum hypoleucum*, *Oroxylum indicum*, *Saprosma* sp., *Persea* sp., *Quercus serrata* and *Litsea sebifera* were monitored in the understorey and gaps from June 2002 to June 2003. Seedling mortality for all the species was high during the month of February, which was characterized by the cool and dry condition. The survival was comparatively higher in the gaps than the understorey. In Mahabali sacred grove, *Eugenia praecox*, and *Persea* sp. registered no mortality in the gaps throughout the study period.

Relative growth rates for height (RGRH) and total leaf area (RGRA) were higher in the gaps than the understorey and varied seasonally showing a marked decline during the winter season. The low rainfall and high soil moisture stress during the cold and dry climate of winter season may be responsible for the poor growth of seedlings. In the understorey of Konthoujam Lairembi sacred grove *Eugenia praecox* exhibited the highest RGRH and the growth rate was lowest for *Heptapleurum hypoleucum*. *Saprosma* sp. showed the highest RGRA among the selected species. The tree seedlings recorded higher RGRH and RGRA in the gaps than in the understorey particularly during the rainy season. This clearly indicates that tree species differed in their response to light environment and the growth of seedlings was influenced by the canopy openness. The peak seedling growth during the rainy season in all the species could be attributed to the favourable temperature and soil moisture conditions.

The absolute growth in height and leaf area differed among the seedlings of selected species in the understorey of Konthoujam Lairembi sacred grove. *Litsea polyantha* recorded the highest absolute height and leaf area, while *Saprosma* sp. recorded the lowest absolute height and *Eugenia praecox* showed the lowest absolute leaf area.

In all the three groves, the absolute growth for height and leaf were greater in the gaps than in the understorey, however, no remarkable differences were observed.

The data generated from the present study on various aspects of plant diversity, and phenology, population structure and regeneration status of the selected tree species may be helpful in the sustainable management and conservation of biodiversity of the sacred groves. The documentation of ethnobotanical values and conservation status of species may be useful for the formulation of the strategies and action plans for the conservation of sacred groves of Manipur by the government and the non-government organizations.

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APPENDIX (i)

Publication arising from the thesis

Paper Accepted:

1. Ashalata Devi Khumbongmayum, M. L. Khan and R. S. Tripathi. Sacred groves of Manipur, northeast India: Biodiversity value, status and strategies for their conservation. *Biodiversity and Conservation.*

Paper communicated:

1. Ashalata Devi Khumbongmayum, M. L. Khan and R. S. Tripathi. Sacred groves of Manipur: ideal centres for biodiversity conservation. *Current Science.*

APPENDIX (ii)

BIO – DATA

Name in full	:	KHUMBONGMAYUM ASHALATA DEVI (Surname) (Name)
Father's name	:	SHRI KH. IBOHAL SINGH
Nationality	:	INDIAN
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EDUCATIONAL QUALIFICATION

Exam. Passed	Year of Passing	Board/University/ Institute	Division	% Marks	Subjects : Main & Ancillary
HSLC	1991	Board of Sec. Edn., Manipur	II	47.36	Science, Arts, English, Maths.
HSSLC	1993	Council of Hr. Sec. School, Manipur.	II	54.80	Physics, Chemistry, Life Science.
B. Sc.	1997	Manipur University, Manipur.	I (Ist Position)	75.58	Environmental Science, Chemistry, Botany. (Core in Environmental Sc.)
M. Sc.	1999	H.N.B. Garhwal University, Uttar Pradesh.	I	73.55	Environmental Science.
M. Phil.	2000	Gauhati University, Assam	I (2nd Position)	69	Environmental Science.

* Qualified UGC-NET Lectureship (LS) in Environmental Science in 2000.

Research experience: -

Junior Research Fellow: - Worked as 'JRF' from 3rd October 2000 to 31st July 2002 in a research project entitled *"Inventory, biodiversity value, status and strategies for conservation of sacred groves of Manipur"* funded by GBPHIED, Amlora, Uttaranchal.

Senior Research Fellow: - Working as 'SRF' from 1st August 2002 at Department of Forestry, NERIST, Nirjuli, (Itanagar) Arunachal Pradesh awarded by CSIR, New Delhi (Award No. 9/725(7)2002 EMR-I, dated 11.09.02).

Published papers:-

1. M. L. Khan, Upadhaya K., L. Bihari & **Ashalata Devi**. 2002. A plea for conservation of threatened tree fern (*Cyathea gigantia*). *Current Science* 82(4) 375-376.

Paper accepted for publication :-

1. **Ashalata Devi Khumbongmayum**, M. L. Khan and R. S. Tripathi. Sacred groves of Manipur, northeast India: Biodiversity value, status and strategies for their conservation. *Biodiversity and Conservation.*

Communicated papers:-

1. **Ashalata Devi Khumbongmayum**, M. L. Khan and R. S. Tripathi. Sacred groves of Manipur: ideal centres for biodiversity conservation. *Current Science.*

Miss Kh. Ashalata Devi