

MEDICINAL PLANT RESOURCES OF MEGHALAYA: ENDEMISM, THREAT STATUS AND CONSUMPTION PATTERN

S.K. Barik, K. Haridasan and N.J. Lakadong*

Department of Botany, North Eastern Hill University, Shillong – 793 022

Introduction

The use of various plant parts to cure specific ailments by different ethnic groups around the world is in vogue since time immemorial. The world is endowed with a rich wealth of medicinal plants. Of the total 297,000–510,000 (Schippmann *et al.*, 2002) plant species in the world, 70,000 (10-18 per cent) are estimated to be employed in healthcare (Prajapati *et al.*, 2003). In India, of the total 17,500 native plant species, 6,000 (34.3 per cent) are known to have medicinal importance (Foundation for Revitalization of Local Health Traditions, 2007). The Himalayas including Northeast India harbour about 8,000 plant species of which 2,500 (21.3 per cent) have been reported to have important medicinal properties (Trivedi, 2002).

Meghalaya is inhabited by the Khasis, Jaintias and Garos, who have a tradition of practising indigenous medicine system. Of the total 3,331 plant species found in the state (Khan *et al.*, 1997), 834 (31.3 per cent) are estimated to be employed in healthcare (Lakadong and Barik, 2006). The sources of these medicinal plant species could be cultivated plants from homesteads, farm lands, cultivation fields or wild plants from forest lands. The plant parts used could be leaves, fruits, roots or stems and most of these are collected fresh and used. Sometimes the plant parts are collected and stored for future use, particularly when the plant in question is not available.

Meghalaya has a number of tribal village doctors addressing the health care issues in the state, particularly in remote villages. Usually they collect the medicinal plants from their known localities. A few of the folk healers have started cultivating them in their herbal gardens while, some medicinal plants are bought from the markets.

Over-exploitation by the local people has pushed many of the medicinal plants into threatened categories. Of the 17,500 plant species present

The attachment of these endemic species to such biodiversity rich areas may be due to habitat specificity, plant associations and well protected habitats. Thus, protection of areas with high endemism would also protect many other species growing in that area

*Foundation for Revitalisation of Local Health Traditions, Yelahanka, Bangalore

in India, about 5,725 are broadly considered as endemics, i.e. species that are restricted to a particular geographical region or ecological unit. These represent 32.7 per cent of the country's flora. Based on the distribution of endemics on the earth's surface, and threats to their habitats, hotspots have been identified globally. Of the total 34 hotspots in the world (Mittermeier *et al.*, 2004), India harbours three *viz.* Western Ghats, Himalayas and Indo-Burma. The Himalayas including Northeast India harbour 3,200 (40 per cent) endemic plant species (Dhar, 2002). Meghalaya is home to 239 (31.3 per cent) endemic plant species (Lakadong and Barik, 2006). Besides, endemism it is estimated that about 3,000 species of flowering plants fall in one or the other category of threatened plants, which also include several medicinal plants. The Red Data Books (Jain and Shastry, 1984; Nayar and Shastry, 1988, 1989, 1990) have listed 623 plant species, of which 550 are endemic that include some valuable medicinal plants.

Some of the studies on medicinal plants of Meghalaya are those by Upadhaya *et al.* (2005), Joseph and Kharkongor (1981), Kumar *et al.* (1980), Kumar *et al.* (1987), Prabhu (2004), Rao (1981a and b), Rao and Neogi (1980), Rao and Shanpru (1981), Tripathi and Goel (2001), etc. conducted during the last three decades mostly to document the ethnobotanical values and taxonomic aspects of the species. However, there is no comprehensive study so far available for medicinal plants of Meghalaya analyzing the endemism, species distribution pattern, threat status, availability and quantity consumed. The present study aims to bridge this information gap by providing vital data on medicinal plants of Meghalaya. Based on the empirical data collected, strategies for cultivation of medicinal plants in the state have been suggested.

Study Site

The study was conducted in the state of Meghalaya, which is characterized by wide variations in topography and elevation. The altitude ranges from 90 to 2,000 m

a.s.l. and the climate shows wide variation depending on the altitude. The total geographical area of the state is 22,549 km² and the state lies between 25°47' and 20°10' N latitude and 89°45' and 92°47' E longitude.

Methods

A list of medicinal plant species present in Meghalaya was prepared consulting published and unpublished literature as well as by collecting primary data. The primary data was collected from different parts of the state by conducting extensive field surveys in different seasons during the years 2003-07.

A list of endemic medicinal plants was prepared by reviewing the available literature (Nayar and Shastry, 1988, 1989, 1990, Haridasan and Rao, 1985-87; Balakrishnan, 1981-83; Joseph, 1980; Kanjilal *et al.*, 1934-40). The distribution of these endemic medicinal plant species was mapped based on the results of the field survey. Field visits were made during the active growth season of the species. Geographical positioning system (GPS) was used to record the exact location of occurrence of the species such as altitude, latitude and longitude.

Ethnomedicinal uses, availability and consumption of medicinal plants in the state were studied in 25 villages spreading over the Khasi, Jaintia and Garo hills of the state. The data so generated was extrapolated for the entire state by taking into consideration the number of villages in each region and the consumption pattern in the respective region.

Results

Habit

Of the total of 834 medicinal plant species, 266 (32 per cent) were herbs, 264 (32 per cent) trees, 177 (21 per cent) shrubs, 93 (11 per cent) lianas and climbers, and 34 (4 per cent) were undershrub (Fig. 1). These species were distributed under 548 genera and 166 families. The family with the highest number of medicinal plant species was Rubiaceae (27 genera and 40 species)

followed by Asteraceae (27 genera and 36 species) and Fabaceae (22 genera and 29 species; Fig. 2).

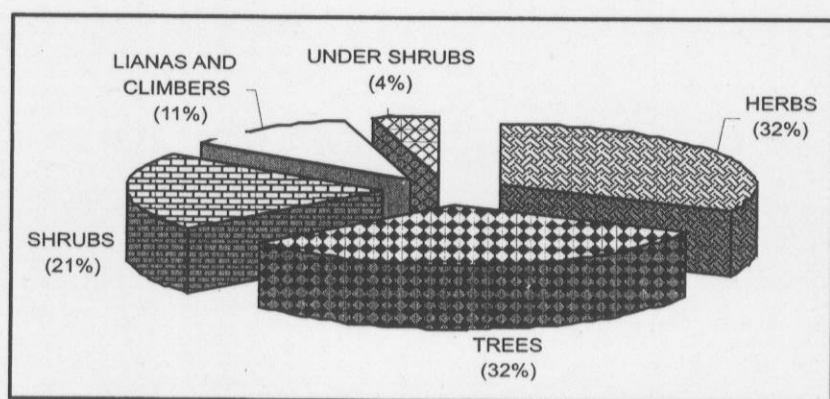


Fig. 1. Habit of medicinal plant species of Meghalaya

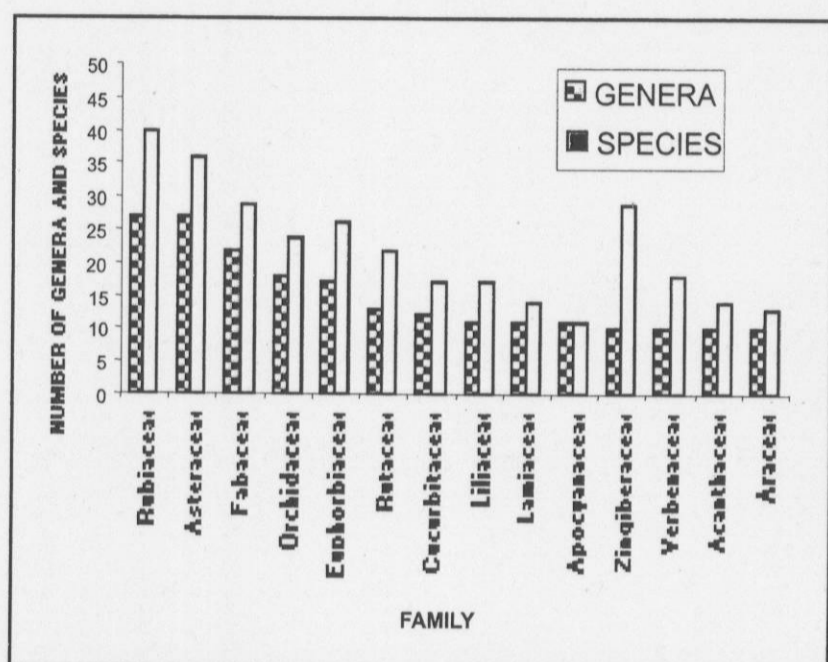


Fig. 2. Dominant medicinal plant families with number of genera and species in Meghalaya

Endemics

Thirty seven medicinal plant species (4.4 per cent of the total medicinal plant species) endemic either to Eastern Himalayas or Northeast India or Meghalaya were reported. These species belonged to 32 genera and 29 families. Sixteen (42 per cent) of them were trees, 10 (27 per cent) were herbs, five (14 per cent) were shrubs, five (14 per cent) were lianas and climbers and one (3 per cent) was undershrub (Table 1).

Medicinal Properties of Endemics

Seventeen (19 per cent) species are used for fever, bodyache, weakness and vomiting, 10 (27 per cent) for gastrointestinal problems and 10 (27 per cent) for gynaecological problems. Five endemic species are

used for fever, four species for stomachache and three species each for dysentery and diarrhoea. Three species are used as antidote for snake bite and three are used for diuresis.

Distribution of Endemics

The maximum number of endemics was found in low and mid-altitude zones ranging from 100 to 1,600m a.s.l. whereas, only a few of them were restricted to high altitudes i.e. above 1,600 m a.s.l. (Table 2). Twenty four species were restricted to altitudes ranging from 800 to 1,600 m a.s.l., 20 were found in altitudes ranging from 400 to 800 m a.s.l. and 15 were restricted to altitudes ranging from 100 to 400 m a.s.l. Only six species were restricted to an altitudinal range of 1,600 to 2,000 m a.s.l. Of the 37 species, 26 species were restricted to Northeast India while 11 were restricted only to Meghalaya.

Concentration of Endemic Medicinal Plant Species

High concentration of endemic medicinal plant species was found in Nokrek (37.8 per cent) followed by Jowai (35.1 per cent) and Raliang (32.4 per cent; Table 3).

Threat Status of Medicinal Plant Species

Of the 834 medicinal plant species, 116 were either threatened or endemic, or both constituting about 13.8 per cent of the total medicinal flora (Table 4). These belonged to 96 genera and 67 families, and 43 per cent of these were trees, 32 per cent were herbs, 16 per cent were shrubs, 8 per cent were lianas and climbers and 1 per cent was undershrubs.

Consumption Pattern of Medicinal Plants Used Under Traditional Healing Systems

Although the consumption data on medicinal plants provided in Table 5 has limitation due to small sample size, it does indicate the pattern of consumption of various medicinal plants in the state. *Oroxylum indicum* (21,931 kg/yr), *Centella asiatica* (25,685 kg/yr), *Embllica officinalis* (20,801 kg/yr),

Table 1. Ethnomedicinal information on 37 endemic medicinal plant species found in Meghalaya

Species	Family	Habit	Part used	Ailment
<i>Aeschynanthus superba</i> Cl.	Gesneriaceae	Under shrub	Bark	Fracture, muscular sprain
<i>Boehmeria macrophylla</i> D. Don	Urticaceae	Tree	Root	Eczema, wounds
<i>Calamus erectus</i> Roxb.	Arecaceae	Shrub	Seed, Root	Indigestion, stomach ache, malaria, body ache
<i>Calamus floribundus</i> Griff.	Arecaceae	Climber	Root	Weakness
<i>Camellia caduca</i> Cl. ex Brandis	Theaceae	Tree	Root	Skin diseases
<i>Citrus aurantium</i> L.	Rutaceae	Tree	Leaf, Bark, Flower	Headache, sunstroke, laxative, urinary tract infections
<i>Citrus latipes</i> Tanaka	Rutaceae	Tree	Fruit, Leaf	Body ache, vomiting, cold, fever
<i>Citrus medica</i> L.	Rutaceae	Shrub	Root, Fruit	Laxative, colic, flatulence, renal and vesical calculi, tumours dysmenorrhagia
<i>Cocculus orbiculatus</i> DC.	Menispermaceae	Shrub	Root, Stem	Anodyne, antiphlogistic, carminative, diuretic, vermifuge, rh oedema, oliguria, antibacterial, anti-amoebic activity, asthma Jaundice, increases lactation, body swellings
<i>Curcuma montana</i> Roxb.	Zingiberaceae	Herb	Rhizome	Blood coagulant for large bleeding wounds
<i>Cymbidium aloifolium</i> Sw.	Orchidaceae	Epiphyte	Bulb	Boils
<i>Daphniphyllum himalense</i> Muell.-Arg.	Daphniphyllaceae	Tree	Stem	Sores, ulcers
<i>Eleaegnus conferta</i> Roxb.	Eleaegnaceae	Shrub	Flower, Fruit	Stimulant
<i>Erythroxylum kunthianum</i> Wall. ex Kurz.	Erythroxylaceae	Tree	Bark	Syphilis, indigestion, liver disorder
<i>Euonymus lawsonii</i> Cl. and Pr.	Celastraceae	Tree	Bark	Dysentery
<i>Garcinia cowa</i> Roxb. ex DC.	Clusiaceae	Tree	Fruit	Urinary troubles
<i>Garcinia pedunculata</i> G. Don	Clusiaceae	Tree	Fruit	Throat irritation
<i>Goniothalamus simonosii</i> Hk.f. and Th.	Anonaceae	Tree	Fruit	Diarrhoea, dysentery, wounds
<i>Grewia hirsuta</i> Vahl.	Tiliaceae	Shrub	Fruit, Root	Antiseptic
<i>Hedera nepalensis</i> K. Koch	Araliaceae	Climber	Whole plant	Astringent, febrifuge
<i>Hymenodictyon excelsum</i> Wall.	Rubiaceae	Tree	Bark	Cold, cough, tuberculosis
<i>Ilex embelooides</i> Hk.f.	Aquifoliaceae	Tree	Bark, Root	Haematic
<i>Impatiens tripetala</i> Roxb.	Balsaminaceae	Herb	Root	Eye diseases
<i>Mahonia pycnophylla</i> Takeda	Berberidaceae	Tree	Leaf, Bark	Stomachache, vomiting, loose motion
<i>Munronia pinnata</i> Harms.	Meliaceae	Under shrub	Root	Urinary troubles, stomach disorders, night blindness, skin di:
<i>Nepenthes khasiana</i> Hk.f.	Nepenthaceae	Shrub	Pitcher	Snake bite, menstrual complaints, asthma emollient
<i>Ochna squarrosa</i> Planet	Ochnaceae	Tree	Leaf, Root, Bark	Fever, sore throat, tonsils, facial blemishes
<i>Ophiorhiza subcapitata</i> Wall.	Rubiaceae	Climber	Root, Leaf	Snake bite, muscle swellings
<i>Osbeckia capitata</i> Benth.	Melastomataceae	Herb	Whole plant	Diuretic
<i>Paramignya micrantha</i> Kurth.	Rutaceae	Shrub	Root	Stomach troubles, diarrhoea, dysentery
<i>Piper griffithii</i> C. DC.	Piperaceae	Climber	Leaf, Stem, Fruit	Fever, paralysis
<i>Piper peepulooides</i> Roxb.	Piperaceae	Under shrub	Leaf, Bark	Diarrhoea, enteritis, bleeding hamorrhoids, gingivitis, febrif
<i>Polygonum bistorta</i> L.	Polygonaceae	Herb	Rhizome	Snake bite
<i>Raphidophora decursiva</i> Schott.	Araceae	Climber	Rhizome	Stomach ache, allergies
<i>Schima khasiana</i> Dyer.	Theaceae	Tree	Leaf, Bark	Pregnancy (purification of blood before and after delivery)
<i>Sophora acuminata</i> Baker	Fabaceae	Shrub	Bark	Stomach ache
<i>Xylosma longifolium</i> Clos.	Flacourtiaceae	Tree	Bark	

Table 2. Distribution of the 37 endemic medicinal plant species found in Meghalaya

Species	Altitude (m a.s.l.)	Worldwide	Distribution	
				Meghalaya
<i>Aeschynanthus superba</i> Cl.	800-1,500	NE India		Jowai, Raliang, Laskein, Mynso, Sohka, Nokrek, Jowai, Syndai-Muktapur
<i>Boehmeria macrophylla</i> D. Don	100-1,000	Sub-Tropical Himalayas		Lailad, Trongpleng, Syndai, Sohka-Daw
<i>Calamus erectus</i> Roxb.	100-1,000	Sikkim, NE India		Syndai, Rytang, Sohka-Dawki
<i>Clatamus floribundus</i> Griff.	100-1,000	NE India		Jowai, Mawsynram, Ialong, Mawsmi, M
<i>Camellia caduca</i> Brandis	1,000-1,600	Meghalaya		Nokrek
<i>Citrus aurantium</i> L.	100-500	Dehradun, Garhwal, Kumaon, Sikkim, Manipur, Montane forests of peninsular India		Nokrek, Umjaisaw-Mynsyngat, Ialong, R;
<i>Citrus latipes</i> Tanaka	500-1,500	Meghalaya		Nokrek, Umjaisaw-Mynsyngat
<i>Citrus medica</i> L.	500-1,200	Kumaon, Pachmarhi, Sikkim, Chittagong, Upper Yan Yanzalin Valley, Satpura hills, Western Ghats		Cherrapunjee, Jowai, Shillong, Jarain
<i>Cocculus mollis</i> Hk.f. and Th.	1,000-1,500	Nepal		Nartiang
<i>Curcuma montana</i> Roxb.	1,000-1,300	NE India, Konkan		Umsning, Nongpoh, Burnihat
<i>Cymbidium aloifolium</i> Sw.	100-700	Burma, Bhutan, Nepal, Thailand, Sri-Lanka, India		Ummulong, Thadlaskein, Jowai, Shillong
<i>Daphniphyllum himalense</i> Muell.	1,500-1,800	Temperate Himalayas-Burma		Nokrek, Tura, Balphakram, Shillong
<i>Eleagnus conferta</i> Roxb.	300-1,500	Indo-Malaya, Himalayas, South India		Ialong, Raliang, Swer, Nokrek, Mawphlar
<i>Erythroxylum kunthianum</i> Wall. ex Kurz.	1,000-2,000	Indo-Burma, NE India		Nokrek, Raliang, Shillong
<i>Euonymus lawsonii</i> Cl. and Prain.	1,200-1,600	Meghalaya		Nokrek, Bagmara
<i>Garcinia cowa</i> Roxb. ex DC.	100-1,500	Indo-Malaya, NE India		Sohka
<i>Garcinia pedunculata</i> G. Don	100-1,000	Indo-Burma, NE India		Nongkhylllem, Borlong, Mawsmi, Nokre
<i>Goniothalamus simonsii</i> Hk.f. and Th.	200-1,500	Meghalaya		Balphakram
<i>Grewia hirsuta</i> Vahl.	100-300	India, Sri-Lanka, Bangladesh, Burma		Ialong, Raliang, Swer, Nongkrem, Shillong
<i>Hedera nepalensis</i> K. Koch.	1,200-1,600	Himalayas		Nongpoh
<i>Hymenodictyon excelsum</i> Wall.	500-700	Indo-Malaya		Raliang, Dawki
<i>Ilex embelooides</i> Hk.f.	100-1,200	Meghalaya		Balphakram, Dawki
<i>Impatiens tripetala</i> DC.	100-800	NE India		Ialong, Jarain, Sohra-rim, Elephant falls
<i>Mahonia pycnophylla</i> Takeda	1,000-1,800	Indo-Burma, Eastern Himalayas, Nilgiris		Balphakram, Maheksola, Tura, Raliang
<i>Munronia pinnata</i> Harms.	100-1,700	Eastern Himalayas, NE India, Nilgiris		Lawbah, Pongtung, Pynursla, Mynkre, Nc
<i>Nepenthes khasiana</i> Hk.f.	1,200-1,500	Meghalaya		Longrein, Jarain, Sutnga, Maheksola, Tur; Rongrengiri
<i>Ochna squarrosa</i> L.	400-600	Burma, Andamans, Khasi hills		Jowai
<i>Ophiorhiza sub-capitata</i> Wall.	1,200-1,600	Meghalaya (Jaintia hills)		Jarain, Amlarem, Sutnga, Pynursla, Jowai
<i>Osbeckia capitata</i> Benth.	700-1,800	Meghalaya		Bapung, Sohra-rim, Khliehriat, Mawphlar
<i>Paramignya micrantha</i> Kurz.	1,000-1,500	Meghalaya		Umsaw, Nongstoin, Nongkrem, Mawsmi
<i>Piper griffithii</i> C. DC.	200-1,500	NE India		Nokrek, Raliang
<i>Piper peepulooides</i> Roxb.	200-1,500	Tropical Himalayas, NE India, Bangladesh, Nepal		Raliang, Ialong, Nokrek, Sohka, Mawsm
<i>Polygonum bistorta</i> L.	700-1,600	Meghalaya		Raliang, Nokrek, Nongkhylllem
<i>Raphidophora decursiva</i> Schott.	1,000-1,500	Sikkim Himalayas		Sutnga, Jarain, Bapung, Ummulong, Jowa
<i>Schima khasiana</i> Dyer.	1,200-1,800	Meghalaya		Mawphlang, Pongtung, Shillong, Amlar
<i>Sophora acuminata</i> Baker	800-1,300	Eastern Himalayas, Bangladesh, Burma		Ialong, Raliang, Nokrek, Jowai-Jarain
<i>Xylosma controversum</i> Clos.	1,000-1,500	Meghalaya		Shillong, Jowai, Sohra-rim, Pongtung, M; Mawsmi, Sutnga
				Jowai

Table 3. Concentration of endemics at different locations in Meghalaya

Site	Number of endemic medicinal plant species	Concentration (%)
Nokrek	14	37.8
Jowai	13	35.1
Raliang	12	32.4
Shillong	9	24.3
Ialong	7	18.9
Jarain	7	18.9
Balphakram	6	16.2
Mawsmai	6	16.2
Mawphlang	5	13.5
Pongtung	5	13.5
Sohra-rim	5	13.5
Sokha	5	13.5

Table 4. Threat status of medicinal plant species found in Meghalaya

Species	Habit	Status
<i>Acanthus leucostachys</i> Roxb.	Herb	Endemic and rare
<i>Acorus calamus</i> L.	Herb	Vulnerable
<i>Aeschynanthus superba</i> Cl.	Epiphyte	Endemic
<i>Aquilaria agallocha</i> Roxb.	Tree	Endangered
<i>Ardisia odontophylla</i> DC.	Shrub	Rare
<i>Aristolochia cathcartii</i> Hk.f.	Climber	Rare
<i>Aristolochia saccata</i> Wall.	Liana	Rare
<i>Artocarpus gomezianus</i> Wall. ex Trewl.	Tree	Rare
<i>Bergenia ciliata</i> Sternb.	Herb	Vulnerable
<i>Boehmeria macrophylla</i> D. Don	Tree	Endemic
<i>Brucea mollis</i> Wall. ex Kurz.	Shrub	Rare
<i>Butea monosperma</i> Taub.	Tree	Vulnerable
<i>Calamus erectus</i> Roxb.	Shrub	Endemic and rare
<i>Calamus floribundus</i> Griff.	Climber	Endemic
<i>Camellia caduca</i> Brandis	Tree	Endemic
<i>Cardamine impatiens</i> L.	Herb	Rare
<i>Caryota urens</i> L.	Tree	Rare
<i>Cephalotaxus mannii</i> Hk.f.	Tree	Vulnerable
<i>Cibotium barometz</i> Link.	Shrub	Vulnerable
<i>Cinnamomum tamala</i> Nees. and Eberm.	Tree	Vulnerable
<i>Citrus aurantium</i> L.	Tree	Endemic and rare
<i>Citrus latipes</i> Tanaka	Tree	Endemic and rare
<i>Citrus medica</i> L.	Shrub	Endemic
<i>Clerodendrum colebrookianum</i> Walp.	Shrub	Vulnerable
<i>Clerodendrum hastatum</i> Lindl.	Shrub	Endemic
<i>Clerodendrum serratum</i> Moon	Shrub	Vulnerable
<i>Cocculus mollis</i> Hk.f. and Th.	Shrub	Endemic
<i>Codonopsis javanica</i> Hk.f.	Climber	Data deficient
<i>Coldenia procumbens</i> L.	Herb	Rare
<i>Cordia dichotoma</i> Forst.f.	Tree	Very rare
<i>Cordia fragrantissima</i> Kurz.	Tree	Very rare

<i>Corylopsis himalayana</i> Griff.	Shrub	Vulnerable
<i>Cretaeva nurvala</i> Buch. - Ham.	Tree	Extremely rare
<i>Croton tiglium</i> L.	Tree	Rare
<i>Curcuma angustifolia</i> Roxb.	Herb	Near threatened
<i>Curcuma montana</i> Roxb.	Herb	Endemic and rare
<i>Cymbidium aloifolium</i> Sw.	Epiphyte	Endemic
<i>Cymbidium longifolium</i> D. Don	Epiphyte	Indeterminate
<i>Dalhousiea bracteata</i> Grah.	Shrub	Rare
<i>Daphniphyllum himalense</i> Muell. - Arg.	Tree	Endangered and endemic
<i>Dendrobium densiflorum</i> Wall.	Epiphyte	Rare
<i>Dendrobium macraei</i> Lindl.	Epiphyte	Vulnerable
<i>Dendrobium moschatum</i> Sw.	Epiphyte	Indeterminate
<i>Dendrobium nobile</i> Lindl.	Epiphyte	Endangered
<i>Diospyros pilosula</i> Hiren.	Tree	Extremely rare
<i>Drosera peltata</i> Sm.	Herb	Rare
<i>Elaeagnus conferta</i> Roxb. ssp. <i>dendroidea</i> Servettaz	Shrub	Endemic and endangered
<i>Erythroxylum kunthianum</i> Wall. ex Kurz.	Tree	Endemic
<i>Euonymus lawsonii</i> Cl. and Prain.	Tree	Endemic
<i>Ficus microcarpa</i> L.f.	Tree	Very rare
<i>Ficus sub-incisa</i> Buch.-Ham. ex J.E. Sm.	Shrub	Rare
<i>Fraxinus floribunda</i> Wall.	Tree	Very rare
<i>Garcinia cowa</i> Roxb. ex DC.	Tree	Endemic
<i>Garcinia pedunculata</i> G. Don	Tree	Endemic
<i>Gardenia campanulata</i> Roxb.	Tree	Very rare
<i>Gloriosa superba</i> L.	Herb	Endangered
<i>Goniothalamus simonsii</i> Hk.f. and Th.	Tree	Indeterminate
<i>Grewia hirsuta</i> Vahl.	Under shrub	Endemic
<i>Hedera nepalensis</i> K. Koch	Climber	Vulnerable and endemic
<i>Hedychium coronarium</i> Koenig	Herb	Endangered
<i>Hedychium spicatum</i> Ham. ex Sm.	Herb	Vulnerable
<i>Hedyotis scandens</i> D. Don	Shrub	Data deficient
<i>Helicia excelsa</i> Bl.	Tree	Rare
<i>Heptapleurum hypoleucum</i> Kurz	Tree	Data deficient
<i>Holoptelea integrifolia</i> Planch	Tree	Very rare
<i>Hydnocarpus kurzii</i> Ward.	Tree	Vulnerable
<i>Hymenodictyon excelsum</i> Wall.	Tree	Endemic and rare
<i>Ichnocarpus frutescens</i> R. Br.	Herb	Rare
<i>Ilex embeloides</i> Hk.f.	Tree	Endemic and indeterminate
<i>Ilex khasiana</i> Purk.	Tree	Endangered and endemic
<i>Illicium griffithii</i> Hk.f. and Th.	Tree	Critically endangered
<i>Impatiens tripetala</i> DC.	Herb	Endemic
<i>Juglans regia</i> L.	Tree	Indeterminate

Contd. on next page

<i>Luvunga scandens</i> Ham.	Shrub	Extremely rare
<i>Mahonia pycnophylla</i> Takeda	Tree	Endemic and vulnerable
<i>Mimusops elengi</i> L.	Tree	Rare
<i>Mitrephora tomentosa</i> Hk.f. and Th.	Tree	Rare
<i>Monotropa uniflora</i> L.	Herb	Rare
<i>Morinda umbellata</i> L.	Shrub	Very Rare
<i>Munronia pinnata</i> Harms.	Herb	Endemic and rare
<i>Nepenthes khasiana</i> Hk.f.	Herb	Endemic and endangered
<i>Ochna squarrosa</i> Planet.	Tree	Endemic and vulnerable
<i>Ophiorrhiza sub-capitata</i> Wall. ex Hk.f.	Herb	Endemic and endangered
<i>Oroxylum indicum</i> Vent.	Tree	Vulnerable
<i>Osbeckia capitata</i> Benth.	Herb	Endemic
<i>Panax pseudo-ginseng</i> Wall.	Herb	Rare
<i>Paphiopedilum insigne</i> Pfitz.	Terrestrial	Vulnerable
<i>Paramignya micrantha</i> Kurz	Liana	Rare and endemic
<i>Parkia roxburghii</i> A. DC.	Tree	Rare
<i>Picrasma javanica</i> Bl.	Tree	Very rare
<i>Piper boehmeriaefolium</i> Wall. ex C. DC.	Shrub	Near threatened
<i>Piper griffithii</i> C. DC.	Climber	Endemic
<i>Piper peepuloides</i> Roxb.	Climber	Vulnerable and endemic
<i>Polygonum bistorta</i> L.	Herb	Endemic
<i>Pterygota alata</i> R. Br.	Tree	Very rare
<i>Raphidophora decursiva</i> Schott.	Epiphyte	Endemic
<i>Rauvolfia serpentina</i> Benth. ex Kurz	Herb	Endangered
<i>Rhynchosyilis retusa</i> Bl.	Epiphyte	Indeterminate
<i>Salix tetrasperma</i> Roxb.	Tree	Vulnerable
<i>Saraca asoca</i> Willd.	Tree	Rare
<i>Schima khasiana</i> Dyer.	Tree	Rare and endemic
<i>Schleichera trijuga</i> Willd.	Tree	Data deficient
<i>Smilacina fusca</i> Hk.f.	Herb	Indeterminate
<i>Sophora accuminata</i> Baker	Shrub	Rare and endemic
<i>Stemona tuberosa</i> Lour.	Herb	Extremely rare
<i>Sterculia roxburghii</i> Wall.	Tree	Rare
<i>Streblus asper</i> Lour.	Tree	Rare
<i>Swertia chirayita</i> Karst.	Herb	Vulnerable
<i>Taxus wallichiana</i> Zucc.	Tree	Critically endangered
<i>Thalictrum foliolosum</i> DC.	Herb	Vulnerable
<i>Thunbergia coccinea</i> Wall.	Climber	Rare
<i>Valeriana hardwickii</i> Wall.	Herb	Vulnerable
<i>Valeriana jatamansii</i> Jones	Herb	Vulnerable
<i>Wallichia densiflora</i> Mart.	Tree	Data deficient
<i>Xylia xylocarpa</i> Taub.	Tree	Rare
<i>Xylosma longifolium</i> Clos.	Tree	Rare

Terminalia chebula (18,298 kg/yr), *Passiflora nepalensis* (16,691 kg/yr), *Rauvolfia serpentina* (14,638 kg/yr), *Paederia scandens* (14,038 kg/yr) and *Swertia chirayita* (12,892 kg/yr) are highly consumed medicinal plants at folk healers' level. *Rubia cordifolia* and *Taxus wallichiana* are being exported outside the state (Table 6).

Discussion

The uses of the medicinal plant species varied among different ethnic groups in Meghalaya. According to the nature and acuteness of the ailment, a given species is being used in more than one disease or for curing a particular disease more than one species is being used. For instance, *Cocculus orbiculatus* is used for curing as many as 15 ailments and *Citrus medica* for seven ailments.

The endemic species were mostly restricted to low (100 to 400 m a.s.l.) and mid (400 to 1,600 m a.s.l.) elevation zones of the state. Field observations indicate that these species are mostly restricted to undisturbed habitats and protected areas such as Nokrek Biosphere Reserve, Jowai sacred forests and Raliang sacred forests. However, overuse of such plants in traditional as well as modern medicine system has posed a major threat to these species. Due to high level of exploitation and faulty harvesting techniques, many of the endemic species such as *Acanthus leucostachys*, *Calamus erectus*, *C. aurantium*, *C. latipes*, *Curcuma montana*, *Daphniphyllum himalense*, *Elaeagnus conferta*, *Goniothalamus simonsii*, *Hedera nepalensis*, *Hymenodictyon excelsum*, *Ilex embeloides*, *Mahonia pycnophylla*, *Munronia pinnata*, *Nepenthes khasiana*, *Ochna squarrosa*, *Ophiorrhiza sub-capitata*, *Paramignya micrantha*, *Piper peepuloides*, *Schima khasiana* and *Sophora accuminata* have been rendered rare (Haridasan *et al.*, 1995). Therefore, effective conservation measures for these species needs to be adopted to prevent them from extinction.

Table 5. Estimated annual raw drug (medicinal plant parts) consumed through Folk Healers in Meghalaya

Medicinal plant species	Annual raw drug consumption in Meghalaya (kg)			
	Garro Hills	Khasi Hills	Jaintia Hills	Total
<i>Acorus calamus</i> (kynbat ksuid)	-	9,306	-	9,306
<i>Adhatoda zeylanica</i> (diengkhlou)	-	-	1,388.3	1,388
<i>Aegle marmelos</i> (selpri/belethi)	3,136.8	-	-	3,137
<i>Ageratum conyzoides</i> (saphlang ke)	-	-	163.3	163
<i>Allium sativum</i> (rynsun syntiew ner)	-	2,831.4	-	2,831
<i>Alpinia galanga</i> (lakud)	-	2,262.8	-	2,263
<i>Artemisia vulgaris</i> (jaiaw)	-	1,386.0	-	1,386
<i>Asparagus racemosus</i> (memang tamatchi)	5,228.0	-	-	4,356
<i>Averrhoa carambola</i> (amlenga)	1,568.4	-	163.33	1,732
<i>Azadirachta indica</i> (neem)	-	-	1,225.0	1,225
<i>Begonia roxburghii</i> (jagaw)	-	574.2	245.0	819
<i>Bergenia ciliata</i> (kynbat parnon)	-	2,262.8	-	2,263
<i>Canna indica</i> (kynshiang)	-	1,980.0	-	1,980
<i>Cannabis sativa</i> (bhang)	-	-	163.3	163
<i>Cassia fistula</i> (snaru)	6,979.4	-	-	6,979
<i>Centella asiatica</i> (mana muni)	4,705.2	12,731.4	8,248.3	25,685
<i>Chenopodium ambrosioides</i> (jada)	-	-	408.3	408
<i>Cissus quadrangularis</i> (samritchu)	4,211.1	-	-	4,211
<i>Clematis gonriana</i> (bat bteng doh)	-	5,088.6	-	5,088
<i>Clerodendrum colebrookianum</i>	-	1,702.8	-	1,703
<i>Commelina benghalensis</i> (jataid)	-	1,386.0	-	1,386
<i>Curcuma amada</i> (dike tegatchu)	2,038.9	-	-	2,038
<i>Curcuma zedoaria</i> (holdiasok)	6,979.4	-	2,041.7	9,021
<i>Cyperus rotundus</i> (satruin ke)	-	-	245.0	245
<i>Datura stramonium</i> (tiew shulim)	-	2,831.4	-	2,831
<i>Dillenia pentagyna</i> (agatchi)	1,568.4	-	-	1,568
<i>Dioscorea bulbifera</i> (bat bteng)	-	851.4	-	851
<i>Drymeria cordata</i> (nai ke)	-	-	490.0	490
<i>Embllica officinalis</i> (ambare)	18,820.8	1,980.0	-	20,801
<i>Eupatorium adenophorum</i> (latnaiong)	-	3,385.8	2,041.7	5,427
<i>Fagopyrum cymosum</i> (jarain)	-	3,108.6	-	3,108
<i>Ficus bengalensis</i> (dienggri)	-	-	163.3	163
<i>Flacourtia jangomas</i> (darechik budu)	1,307.0	-	-	1,307
<i>Flickingeria fugax</i>	-	1,702.8	-	1,703
<i>Gerbera maxima</i>	-	851.4	-	851
<i>Gynocardia odorata</i> (bolribu)	1,568.4	-	-	1,568
<i>Hedychium coronarium</i> (gong)	5,228.0	-	-	5,228
<i>Hedyotis scandens</i>	-	2,262.8	-	2,263
<i>Holarrhena antidysenterica</i> (bolmatra)	3,136.8	-	-	3,136
<i>Houttuynia cordata</i> (jamyrdoh)	-	-	4,491.7	4,491
<i>Justicia gendarusa</i> (dojagipe)	4,914.3	-	-	4,914
<i>Kaemferia galanga</i> (wakprata)	1,150.2	-	-	1,150
<i>Knema linifolia</i> (bolanchi)	4,940.5	-	-	4,940
<i>Litsea monopetala</i> (boldokakki / lahambol)	3,136.8	-	-	3,136
<i>Morinda angustifolia</i> (chenong)	6,979.4	-	-	6,979
<i>Mussaenda frondosa</i> (syntu slalieh)	-	-	571.7	571
<i>Myrica esculenta</i> (sophie)	-	2,554.2	-	2,554
<i>Nepenthes khasiana</i> (tiew rakot)	-	1,386.0	491.8	1,878
<i>Nicotiana tabaccum</i> (duma)	-	-	245.0	245
<i>Oroxylum indicum</i> (kiring)	2,1931.4	-	-	21,931
<i>Oxalis corniculata</i> (ladaw ke)	-	-	980.0	980
<i>Paederia scandens</i> (pasim)	1,307.0	12,731.4	-	14,038
<i>Passiflora nepalensis</i> (soh brap)	-	16,691.4	-	16,691
<i>Phlogacanthus tubiflorus</i> (alot)	2,091.2	-	-	2,091
<i>Pinus kesiya</i> (dieng kseh)	-	1,128.6	-	1,128
<i>Piper longum</i> (bat sohmarit)	-	1,386.0	-	1,386
<i>Piper peepuloides</i> (sohmrit khlaw)	-	9,900.0	-	9,900
<i>Pithecellobium heterophyllum</i> (mongnal)	2,091.2	-	-	2,091
<i>Potentilla fulgens</i> (laniang kynthei)	-	9,900.0	-	9,900
<i>Pouzolzia hirta</i>	-	851.4	-	851
<i>Psidium guajava</i> (saprian)	-	-	1,796.7	1,796
<i>Rauvolfia serpentina</i> (dogrikme)	14,638.4	-	-	14,638
<i>Rhus acuminata</i> (bolmicheng)	1,568.4	-	-	1,568
<i>Rhus javanica</i> (sama)	-	-	1,715.0	1,715
<i>Ricinus communis</i> (dieng kastor)	-	-	571.7	571
<i>Rubus rugosus</i> (soh nep bah)	-	1,386.0	-	1,386
<i>Schefflera venulosa</i> (jengjil)	1,150.2	-	-	1,150
<i>Schima wallichii</i> (dieng phuh lieh)	-	-	408.3	408
<i>Senecio cappa</i> (sla jalieh)	-	1,128.6	-	1,128
<i>Setaria palmifolia</i> (syntiew lakot)	-	1,702.8	-	1,703
<i>Stephanua hermardifolia</i> (samkusim)	575.1	-	-	575
<i>Swertia chirayana</i> (chirota)	11,763.0	1,128.6	-	12,892
<i>Tamarindus indica</i> (cheeng)	862.6	-	-	862
<i>Terminalia bellurica</i> (chirore)	5,803.1	-	-	5,803
<i>Terminalia chebula</i> (satak)	18,298.0	-	-	18,298
<i>Tinospora cordifolia</i> (gyrmi khlaw)	-	2,262.8	-	2,263
<i>Viburnum colebrookianum</i> (syntuiap bru)	-	-	81.7	81
<i>Zingiber officinalis</i> (syung)	-	-	408.3	408

Table 6. Estimated annual export of raw drugs (medicinal plant parts) from Meghalaya to outside the state

Market centre from where exported	Medicinal plant species	Quantity per annum (kg)
Damalgre	<i>Terminalia chebula</i>	1,500 (till 2001)
	<i>Terminalia bellirica</i>	
	<i>Emblica officinalis</i>	
Nongstoin	<i>Acorus calamus</i>	1,000
	<i>Taxus wallichiana</i>	1,500
	<i>Centella asiatica</i>	1,000
	<i>Rubia cordifolia</i>	2,500
Diskiangpungsior, Nonngstoin	<i>Rubia cordifolia</i>	2,000
	<i>Centella asiatica</i>	40
	<i>Rauwolfia serpentina</i>	30

For effective conservation of these species, identification of the causes of threats is a prerequisite for regulation of threat factors. The endemic-rich areas identified in the present study may be considered as priority areas for conservation and thus be protected, and special conservation measures may be introduced. The endemics are generally related to biodiversity rich areas of the state such as Nokrek, Jowai, Raliang, and Shillong. The attachment of these endemic species to such biodiversity rich areas may be due to habitat specificity, plant associations and well protected habitats. Thus, protection of areas with high endemism would also protect many other species growing in that area.

The medicinal plants in Meghalaya are mostly found in wild and there is not much effort for their cultivation. Thus, it is natural that much of the collection in the state has a wild origin. Perhaps *Cinnamomum tamala* is the only medicinal crop that is available from cultivated source. The stakeholders of medicinal plants sector are different, so is the method of collection and processing. As in the rest of the country, the current practices of harvesting of medicinal plants in Meghalaya are unsustainable. Many pharmaceutical companies are also responsible for inefficient, imperfect, informal and opportunistic marketing of medicinal plants. There is a vast, secretive and largely unregulated trade in medicinal plants, mainly from the wild. Such unfair trade continues to grow in the absence of a medicinal plant policy and absence of any regulatory mechanism for extraction of wild medicinal plants, particularly from the community and privately owned forests. Confusion also exists in

the identification of plant materials where the origin of a particular drug is assigned to more than one plant (*Piper longum* and *P. mullesua*). This leads to adulteration of raw materials. All these affect the market both directly and indirectly. Marketability of products is a crucial factor in determining the failure or success of medicinal plant sector. The market outlets in Meghalaya are mostly for local use, although only a few are meant for export. Besides conservation aspects, a clear understanding of the supply related issues and the factors driving the demand and size of the medicinal plants market is a vital step towards medicinal plant development planning.

Acknowledgements

The authors would like to thank Dona M. Sangma and V. Manners for assisting in data collection. The financial supports received from the State Medicinal Plant Board, Shillong for conducting the study and UGC-CSIR NET Fellowship to the third author are gratefully acknowledged.

References

- Balakrishnan, N.P. 1983. Flora of Jowai. Meghalaya. 2 vols. Howrah, BSI.
- Dhar, U. 2002. Conservation implications of plant endemism in high-altitude Himalaya. *Current Science*, 82(2): 141-154.
- Foundation for Revitalization of Local Health Traditions. 2007. A report. Bangalore, FRLHT.
- Haridasan, K. and Rao, R.R. 1985-87. Forest flora of Meghalaya. Vol. 1 and II. Dehradun, Bishen Singh Mahendrapal Singh.
- Haridasan, K.; Shukla, G.P. and Beniwal, B.S. 1995. Medicinal plants of Arunachal Pradesh. Itanagar, State Forest Research Institute.
- Jain, S.K. and Sastry, A.R.K. 1984. The Indian plant red data book - I. Howrah, Botanical Survey of India.

- Joseph, J. 1980. Flora of Nongpoh and its vicinity. Howrah, Botanical Survey of India.
- Joseph, J. and Kharkongor, P. 1981. A preliminary ethnobotanical survey in the Khasi and Jaintia hills, Meghalaya. In: Jain, S.K. Ed. Glimpses of Indian ethnobotany. New Delhi, Oxford and IBH. pp. 115-123.
- Kanjilal, U.N.; Kanjilal, P.C.; Das, A.; De, R.N. and Bor, N.L. 1934-40. Flora of Assam. 5 Vols. Shillong, Govt. Press.
- Khan, M.L.; Shaily, M. and Kamaljit, S.B. 1997. Effectiveness of the protected area network in biodiversity conservation: A case study of Meghalaya state. *Biodiversity and Conservation*, 6: 853-868.
- Kumar, Y.; Haridasan, K. and Rao, R.R. 1980. Ethnobotanical note on certain medicinal plants among some Garo people around Balphakram Sanctuary in Meghalaya. *Bulletin of the Botanical Survey of India*, 22(1-4): 161-165.
- Kumar, Y.; Scarlet, F. and Rao, R.R. 1987. Further contribution to the ethnobotany of Meghalaya: Plants used by War Jaintia in Jaintia hills district. *Journal of Economic and Taxonomic Botany*, 11(1): 65-70.
- Lakadong, N.J. and Barik, S.K. 2006. Diversity and distribution of endemic plants in Meghalaya. In: Pandey, H.N. and Barik, S.K. Eds. Ecology, diversity and conservation of plants and ecosystems in India. New Delhi, Regency Publications. pp. 274-311.
- Mittermeier, R.A.; Robies, Gil P.; Hoffmann, M.; Pilgrim, J.; Brooks, T.; Mittermeier, C.G.; Lamoreux, J.; and da Fonseca, G.A.B. 2004. Hotspots revisited. Mexico, CEMEX.
- Nayar, M.P. and Sastry, A.R.K. 1988. Red data book of Indian plants. Vol. I. Howrah, Botanical Survey of India.
- Nayar, M.P. and Sastry, A.R.K. 1989. Red data book of Indian plants. Vol. II. Howrah, Botanical Survey of India.
- Nayar, M.P. and Sastry, A.R.K. 1990. Red data book of Indian plants. Vol. III. Howrah, Botanical Survey of India.
- Prabhu, S.D. 2004. Impact of human activities on plant biodiversity of Nokrek Biosphere Reserve of Meghalaya. Ph.D. thesis. North Eastern Hill University, Shillong.
- Prajapati, N. D.; Purohit, S.S.; Sharma, A.K. and Kumar, T. 2003. A handbook of medicinal plants: A complete source book. Jodhpur, Agrobios.
- Rao, M.K.V and Shanpru R. 1981. Some plants in the life of Garos of Meghalaya. In: Jain, S.K. Ed. Glimpses of Indian Ethnobotany. New Delhi, Oxford and IBH. pp.153-160.
- Rao, R.R. 1981a. Ethnobotanical studies of the flora of Meghalaya. I: Some interesting report of herbal medicines. In: Jain, S.K. Ed. Glimpses of Indian ethnobotany. New Delhi, Oxford and IBH. pp. 124-136.
- Rao, R.R. 1981b. Ethnobotany of Meghalaya: Medicinal plants used by Khasi and Garo tribes in Meghalaya. *Economic Botany*, 35 (1): 4-9.
- Rao, R.R. and Neogi, B. 1980. Observation on the ethnobotany of the Khasi and Garo tribes in Meghalaya (India). *Journal of Economic and Taxonomic Botany*, 1: 157-162.
- Schippmann, U.; Leaman, D.J. and Cunningham, A.B. 2002. Impact of cultivation and gathering of medicinal plants on biodiversity: Global trends and issues. Rome, F.A.O.
- Tripathi, S. and Goel, A.K. 2001. Ethnobotanical diversity of Zingiberaceae in Northeast India. *Ethnobotany*, 13: 67-79.
- Trivedi, P.C. Ed. 2002. Ethnobotany. Aavishkar Publishers. 455 p.
- Upadhaya K.; Pandey, H.N.; Law, P.S and Tripathi, R.S. 2005. Plants of ethnobotanical importance in the sacred groves of Jaintia hills of Meghalaya. *Indian Forester*, 131(6): 819-828. ●