

Full Length Research Paper

Conservation and cultivation of threatened and high valued medicinal plants in North East India

Rama Shankar¹ and M. S. Rawat²

¹Ayurveda Regional Research Institute, Itanagar, 791111 India.

²National Medicinal Plants Board, Department of Ayush Ministry OF Health & FW, Government of India AYUSH Bhavan, Room No-309, 3rd Floor, B-Block, GPO Complex INA, NEW DELHI-110023.

Accepted 2 July, 2013

Medicinal plants exploration in North Eastern India has been carried out in the various forests including Crude drugs markets up to the range wherever medicinal plants produce are sold in the markets. Various attempts have also been made for the acclimatization through cultivation of medicinal plants from one zone to another in the Region. The crude drugs produce from the region are traded in the markets of Assam, West Bengal, Bihar and even in the Central market of Delhi. High valued medicinal plants from the states of North east are *Acorus calamus*, *Aconitum heterophyllum*, *Aquilaria malaccensis*, *Bacopa monnieri*, *Berberis aristata*, *Coptis teeta*, *Costus speciosus*, *Curcuma caesia*, *Elaeocarpus sphericus*, *Embelia ribes*, *Gmelina arborea*, *Gynocordia odorata*, *Hydnocarpus kurzii*, *Homalomena aromatica*, *Mesua ferrea*, *Nardostachys jatamansi*, *Paris polyphylla*, *Picrorhiza kurrooa*, *Rheum australe*, *Rubia cordifolia*, *Smilax china*, *Solanum anguivi*, *Swertia chirayita*, *Taxus wallichiana*, *Trichosanthis bracteata*, *Valeriana jatamansi*, *Zanthoxylum armatum*, etc. For the study of the potential and sustainable collection from forest areas, interaction with local people involved either in collection or having knowledge about the collection in and adjoining areas. Various conservational aspects for *in-situ* conservation and aspects on easy methods for cultivation which are easily acceptable by the inhabitants nearby forest areas have been worked out which is incorporated in the paper.

Key words: Conservation, threatened, *Oroxylum indicum*, *Paris polyphylla*, *Zanthoxylum armatum*.

INTRODUCTION

North Eastern India has a wide stretch over with a hilly forest areas as well as plains of Assam. It covers the states of Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. The states of Sikkim and Arunachal Pradesh fall under Himalayan hills whereas Manipur and Nagaland covers Naga hill and Meghalaya occupied by Garo, Jaintiya and Khasi hills; State of Mizoram comes under Lusai hills. According to the name of the hills, each one have variable range of altitudinal and topographic variations which governs the occurrence and distribution of biodiversity covering medicinal plants distribution. Topographical range of the region varies from tropical foot hills up to snow clad

alpine hills. According to variation of climatic zones, medicinal plants vary for their occurrence in different hills. Some of the medicinal plants are distributed in high potential whereas certain others go on depleting from their Natural habitat. This depletion is due to high pressure for their unsystemic exploitation through shifting cultivation expansion of urbanization, agricultural land and road development as well as some natural calamities like land sliding, etc. Comparison to other part of the Country population density in the region shows it to be less and most of the land was unutilized by the public sector in the region as a whole which needs to be protected to enrich the medicinal plant flora (Mudaiya et al.,

1987; Majumder, 1981; Rawat et al., 1997; Shankar et al., 1999; Website IUCN, 2009). Various attempts have been made for exploration of medicinal wealth in different forest land of the Region (Kharkonger and Joseph, 1981; Tiwari et al., 1993; Mahanti, 1994; Sharma and Sharma, 1994; Rai and Sharma, 1994; Sinha, 1996; Rawat et al., 1997; Sharma et al., 2001; Lalramnghinglova, 2003; Mudaiya and Majumder, 2004; Rai and Lalramnghinglova, 2010; Shankar and Rawat, 2008; Rawat and Shankar, 1997, 1998; Islam, 2009, Nair et al., 2009). Various exploitations of selected species of medicinal plants have also been made from the well known part of the Region. Cultivation of medicinal plants in the region have also been undertaken in large scale for acclimatization of plants growing in one part to other part accordingly. The present study was made for the selection of medicinal plants in different forests for conservation as well as undertaking cultivation by the local inhabitants in their own or community lands. For cultivation of different medicinal plants, seed germination till raising planting material was obtained for transplantation in field was adapted. Viability of seeds, survival of plant in field after transplantation was considered as tool for the study.

MATERIALS AND METHODS

Forest areas and distribution of high valued medicinal plants was made as the major tool of the study. Extensive exploration of medicinal plants was made with the aim to identify the potential and abundance in distribution for most of the high demand medicinal plants in Nature, and for the selection of conservation of the same by systemic utilization of required drug part. Sample specimens were collected for each of the medicinal plants available in the localities from time to time. Emphasis was also given to collect records of cultivated medicinal plants for the purpose of medicine or any other. Germplasm of the medicinal plants was also collected for various cultivation purposes in the Medicinal Plants Garden of the Institute. Development of seedlings growing under trees of several medicinal plants was also taken for the study. Trials on vegetative propagation by involving young and mature root and stem cuttings, rhizome proliferating as well as seed germination at various stages was undertaken for each high valued medicinal plants. Different developmental stages were kept under observation. To develop the *in-situ* conservation aspects for multiplication protection as well were taken up. Rhizomes and tubers were taken for cultivation of Zingibers and aroids like *Costus speciosus*, *Curcuma caesia*, *Hedychium spicatum*, *Homalomena aromatic*, etc. Seed germination of *Embelia ribes*, *Gynocordia odorata*, *Mesua ferrea*, *Oroxylum indicum*, *Picrorhiza kurrooa*, *Rubia manjith*, *Saraca asoca*, *Valeriana jatamansi*, *Zanthoxylum armatum*, etc. were studied within the Natural climate and beds. Germinated seedlings after 4-6 months (herbs) and one year (shrubs and tree species) were transplanted in the field. Further seed germination of the plants was observed in the vicinity of plant as tool for conservation within the field as well as transferring to similar field. Stem cuttings of *Hemidesmus indicus*, *R. manjith*, *Taxus wallichiana* and *Woodfordia fruticosa* were kept in sand mixed beds and were treated them with gibberic acid for root and shoot initiation which were transferred to the field after complete rooting and development of shoots in the polythene bags. Seed coats of *Elaeocarpus sphericus* were broken or treated with concentrated nitric acid before sowing in beds.

RESULTS

During field studies in north eastern India comprising of states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura (Figure 1). It was observed that the distributions of medicinal plants were categorized under tropical, subtropical, temperate and alpine zones according to species wise categorization. Plants such as *R. manjith* and *Z. armatum* were distributed in Temperate zone whereas *R. sikkimensis* and *Z. acanthopodium* were confined only to tropical and subtropical areas. The two plants species growing in temperate forests have great medicinal value for the purpose of commercial growth. Species of *Terminalia* like *T. arjuna*, *T. bellerica*, *T. chebula* and *T. citrina* were confined to Tropical areas and have high commercial medicinal value. Further, it was observed that plants of *Embelia ribes* growing in Tropical areas were different from *E. ribes* in Temperate forests however, retains similar medicinal value. Despite equivalent climatic condition in Sikkim and Arunachal Pradesh, plants of *N. jatamansi* that occurred in Alpine are largely used in Sikkim and have rare occurrence in Arunachal Pradesh.

In the matter of distribution of medicinal plants, Sikkim is a better source for *N.jatamansi*, *Panax* species, *P. kurrooa*, *S. chirayita* and *Z. armatu*; Arunachal Pradesh is a site of attraction for *A. melaccensis*, *C. caesia*, *M. ferrea*, *H. aromatica*, *L. citrata*, *O. indicum*, *P. longum*, *P. mullesua*, *T. arjuna*, *T. bellerica*, *T chebula*, *T. citrina* from tropical areas and *B. ciliata*, *I. griffithii*, *P. polyphylla*, *R. manjith*, *V. jatamansi*, *S. chirayita*, and *Z. armatum* from temperate and Alpine areas. From Nagaland and Manipur, *C. buchhanani*, *C. orchioides*, *S. glabra* and *T. wallichiana* are under high grade exploitation from their Natural habitat. State of Mizoram has undertaken cultivation of *G. arborea* in large scale. Assam is specific for *A. galangal*, *A. melaccensis*, *C. caesia*, *M. ferrea*, *O. indicum*, and *P. longum*. In the state of Tripura plants of *H. antidiysenterica* and *M. phillippinensis* and in the hills of West Garo Hill district of Meghalaya distribution of *H. antidiysenterica* was observed for *in situ* conservation.

During cultivation of tree species, it was experienced that flowering and fruiting occurs only in the exposed sides facing sun light. This is specifically for *E. sphericus*, *G. arborea*, *M. ferrea*, *T. bellerica* and *T. chebula*. As a result several tree species needs to be removed.

For the purpose of conservation within the area of occurrence of the plants, the best suitable species will be *A. heterophyllum*, *B. aristata*, *C. teeta*, *E. ribes*, *N. jatamansi*, *P. kurrooa*, *R. manjith* and *Z. armatum* as their seed germination takes place within one or two weeks after coming in contact with soil on the ground. Newly germinated seedlings can be transplanted within the same area. In case of *E. ribes* and *Z. armatum* during season after maturity of fruits, dense seedlings were germinated under same shade whereas if habitat is changed, development up to the level of flowering are

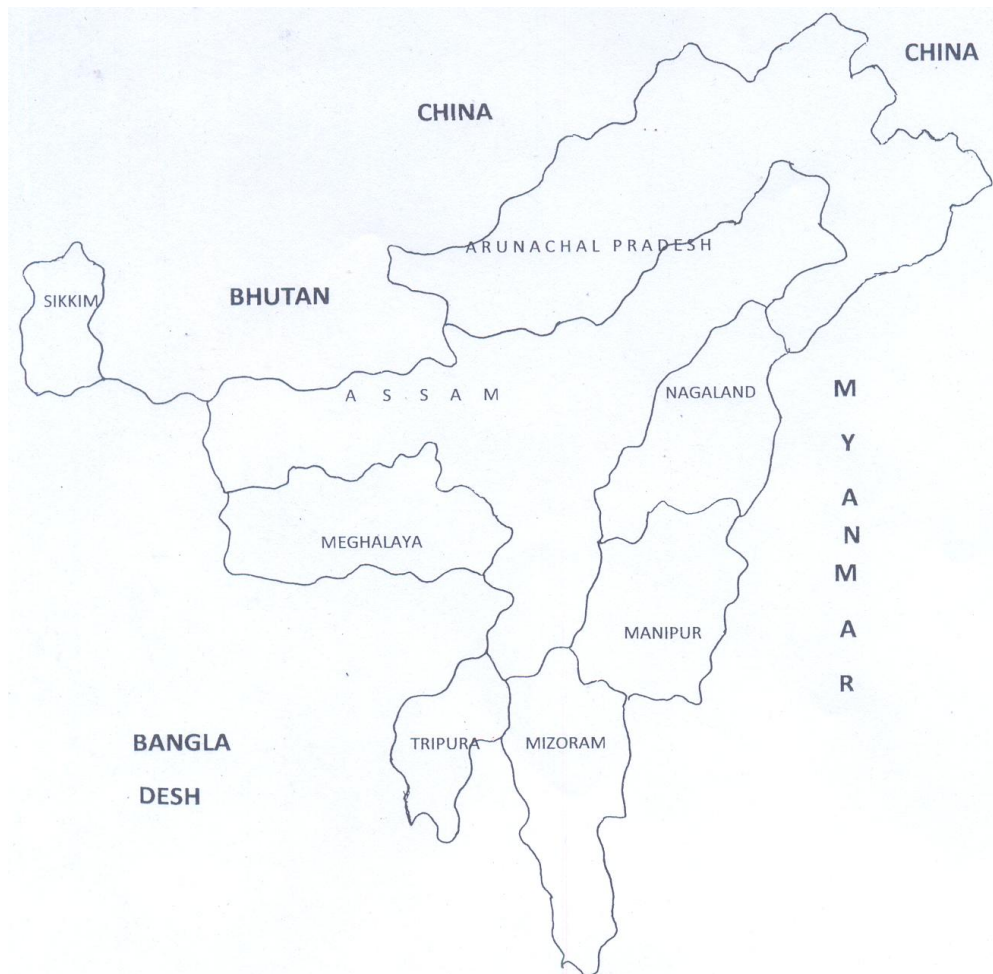


Figure 1. Map of North East India showing worked out areas

observed but fails for fruiting and fruits are major component for Pharmaceuticals. Cultivation of *A. malaccensis*, *G. arborea*, *M. ferrea* and *S. asoca* is highly adaptable in foothill areas of Arunachal Pradesh, Assam, Manipur, Mizoram, Nagaland and Tripura. *Acorus calamus* is highly acclimatizable in variable climatic conditions due to its polyploidy. *Costus speciosus* is another threat medicinal plant whose seed germination as well as rhizome replication provides newer plants. In this way various medicinal plants distributed in their Natural habitat of North East India are listed in Tables 1 and 2.

Conservation measures

North eastern Region of India is occupied by tropical, sub tropical, temperate and alpine climatic conditions under which diverse type of medicinal plants are naturally growing and acute pressure is exerted over these medicinal plants through unscientific collection of drugs from natural habitat only. Certain plants shed their fruits on ground on

maturity and just after getting favorable climatic conditions these seeds germinate and new seedlings are developed under the same vicinity. These seedlings are in need of protection from wild animals and unwanted forest practices like fire, and soil degradation. Secondly, these young seedlings need transplantation in and adjoining areas of their occurrence. This practice is feasible in the case of *B. aristata*, *E. ribes*, *N. jatamansi*, *P. kurrooa*, *S. chirayita*, *V. jatamansi* and *Z. armatum*, etc.

Cultivation

The second practice is through cultivation. Under this practice, authors have made various efforts for raising planting materials or seedlings of *A. racemosus*, *B. aristata*, *C. caesia*, *D. fimbriatum*, *E. sphericus*, *E. ribes*, *G. arborea*, *H. indicus*, *H. aromatica*, *H. kurzii*, *R. serpentina*, *R. manjith*, *S. asoca* and *T. wallichiana*. *Asparagus racemosus* seeds germinate within 25-30 days but seedling growth becomes very slow which takes

Table 1. List of medicinal plants for conservation in Tropical and Sub tropical Zone.

S/N	Botanical name	Vernacular name	State and habitat condition / mode of conservation	Use
1	<i>Acorus calamus</i> L.	Vacha	All eight states in marshy places through rhizome cuttings.	Rhizome in respiratory diseases, nerve tonic.
2	<i>Angiopteris evecta</i> (Forst.) Hoff.	Ghora Bom	Top/ Arunachal Pradesh, Manipur Meghalaya, Nagaland, Sikkim and Tripura in Natural habitat of occurrence through rhizome.	Rhizome in dysentery
3	<i>Aquilaria malaccensis</i> Lam.	Agaru	Arunachal Pradesh and Assam in plains through seed germination.	Heart wood stimulant, tonic.
4	<i>Cissampelos pareira</i> L.	Ambashtha/ Patha	Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura on slopes of upper reaches having climbing support through seeds	Root in fever, purgative, cough urinary troubles.
5	<i>Curcuma caesia</i> Roxb.	Narkachura	Arunachal Pradesh, Assam, Meghalaya under shades and away from water logging places through rhizome cuttings.	Rhizome stimulant, carminative, sprain.
6	<i>Desmotrichum fimbriatum</i> Bl.	Jivanti	Arunachal Pradesh, Meghalaya, Sikkim as epiphyte through rootlet cuttings.	Whole plant stimulant, tonic.
7	<i>Dioscorea bulbifera</i> L.	Varahi kand	Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Tripura through bulbils.	Tuber in piles, dysentery.
8	<i>D. pentaphylla</i> L.	Varahi kand	All states preferably through bulbils	Tuber in dispersing swelling tonic.
9	<i>Elaeocarpus sphericus</i> (Gaertn) Schum	Rudraksha	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura up to 500 a.m.s.l. elevation through seeds.	Seeds in epileptic fits.
10	<i>Embelia ribes</i> Burm. f.	Vai bidang	Arunachal Pradesh, Meghalaya on slopes having climbing support of trees through seeds.	Fruits antihelmintic, tonic.
11	<i>Gmelina arborea</i> Roxb.	Gambhari	All 8 states in foot hills up to 500 elevation through seeds.	Root bark in gonorrhoea, cough as one of the constituent of Dasmula Quath.
12	<i>Gynocordia odorata</i> R.Br.	Chalmoogra	Arunachal Pradesh, Assam, Mizoram, Nagaland and Tripura up to 500 msl elevation on slopes and waste land through seeds.	Seed oil in leprosy and other skin disease.
13	<i>Hemidesmus indicus</i> L.	Ananta	Arunachal Pradesh, Meghalaya under shades and moist places having climbing support through stem cuttings and seeds.	Stem Diaphoretic, diuretic, tonic.

Table 1 Contd.

14	<i>Homalomena aromatica</i> (Spreng.) Schott.	Sugandhamantri	Arunachal Pradesh, Assam, Meghalaya in foot hills under shades through rhizome cuttings.	Aromatic, stimulant.
15	<i>Hydnocarpus kurzii</i> (King.) Warb.	Tubaraka	Arunachal Pradesh Manipur, Mizoram, Tripura through seeds.	Seed oil in leprosy and other skin diseases.
16	<i>Kaempferia galanga</i> L.	Chandramulika	Arunachal Pradesh, Assam in foot hills and plain under shades through rhizome cuttings.	Rhizome stimulant, cough.
17	<i>Mesua ferrea</i> L.	Nagakeshara	Arunachal Pradesh, Assam, Manipur, Nagaland, Mizoram, Tripura as avenue plant through seeds.	Flower astringent used in cough.
18	<i>Oroxylum indicum</i> Vent.	Shyonaka	Arunachal Pradesh, Assam, Meghalaya in foot hills on slopes through seeds.	Bark bitter tonic, in rheumatism.
19	<i>Rauvolfia serpentina</i> Benth.	Sarpagandha	Arunachal Pradesh, Assam in sandy loam soil	Root insomnia, hypertension.
20	<i>Saraca asoca</i> (Roxb.) de Wilde	Ashoka	Arunachal Pradesh, Assam, Mizoram, Tripura in foot hills through seeds.	Stem bark uterine tonic.
21	<i>Smilax glabra</i> Roxb.	Chobchini	Manipur, Meghalaya and Nagaland under shades having climbing support through seeds and roots.	Aphrodisiac, tonic.
22	<i>Solanum anguivi</i> Lam.	Brahati	Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Tripura near by houses and waste land through seeds.	Root carminative, expectorant.
23	<i>Stephania japonica</i> (Thunb.) Miers	Rajpatha	Arunachal Pradesh, Assam, Manipur, Meghalaya Mizoram, and Tripura in foot hills preferably waste land having climbing support through seeds.	Tuber bitter used in fever, urinary diseases.
24	<i>Tylophora indica</i> (Burm. f.) Merr.	Dama Buti	Arunachal Pradesh, Meghalaya on upper reaches having climbing support through seeds.	Leaf in Asthma

at least 6 months for developing seedlings worth transplantation. *B. aristata* plants are cultivated by raising planting materials through stem cuttings and seed germination. *E. ribes* seeds mature in different interval of time and both immature and mature seeds appear red being difficult to identify the mature fruits. Only full mature fruits with less moisture content in fruits germinate and young seedlings develop worth transplantation within 3-4 months. *E. sphericus* seeds germinate by breaking stony coat. To break stony coat, seeds are treated with nitric acid or broken through hammer. Young seedlings are transplanted in plantation pits. Cultivation of *H. indicum* takes place through stem cuttings having nodes. Root

initiation takes place easily after treating stem cuttings with dilute solution of gibberellic acid. For cultivation of *H. kurzii*, fresh seeds taken off from fruits are sown in sandy soil mixed with clay and compost filled polythene bags. Seed germination initiates within 25-30 days. Seedlings develop for transplantation within 5-6 months.

For cultivation of Zingiber and aroids *Curcuma caesia*, *Homalomena aromatica* and Merantiaceae and Liliaceous members *Paris Polyphylla* and *Polygonatum cirrifolium*, rhizome, tuber and bulbs are used for plantation and regeneration. The important medicinal plants with high value and which are threatened are shown in Figures 2 and 3.

Table 2. List of medicinal plants for conservation in Temperate and Alpine zone.

S/N	Botanical Name	Vern. Name	State Habitat condition/ mode of conservation	Use
1	<i>Aconitum heterophyllum</i> Wall. Ex Royle	Atish	Arunachal Pradesh, Sikkim through seeds.	Root aphrodisiac, tonic.
2	<i>Berberis aristata</i> DC.	Daruharidra	Arunachal Pradesh through seeds.	Root in jaundice, malaria, eye affection.
3	<i>Bergenia ciliata</i> (Haw.) Sternb.	Pashan Bheda	Arunachal Pradesh, Meghalaya, Sikkim through transplantation and seeds.	Root tonic in fever, diarrhea and pulmonary diseases.
4	<i>Coptis teeta</i> Wall.	Mamira	Arunachal Pradesh through roots within the place of occurrence through seeds.	Root tonic in jaundice and diabetes.
5	<i>Illicium griffithii</i> Hook. f.	Lisi	Arunachal Pradesh through stem cuttings through stem cuttings.	Fruits stimulant, carminative.
6	<i>Nardostachys jatamansi</i> DC.	Jatamansi	Sikkim through seed within occurrence place through seeds and root cuttings.	Root, aromatic bitter tonic.
7	<i>Paris polyphylla</i> Smith	Mithi Vacha	Arunachal Pradesh, Manipur, Sikkim through root.	Root stimulant, tonic.
8	<i>Picrorhiza kurrooa</i> Royal ex Benth.	Katuki	Arunachal Pradesh, Sikkim through in-situ protection through stolon and seeds.	Root bitter purgative in jaundice and malaria.
9	<i>Rheum australe</i> D.Don	Revandchini	Arunachal Pradesh through root cutting and seeds.	Rhizome and root purgative, astringent, tonic.
10	<i>Rubia manjith</i> Roxb. ex Flem.	Manjishtha	Arunachal Pradesh through stem cutting and seeds.	Root tonic, astringent.
11	<i>Sinopodophyllum hexandrum</i> (Royle) T.S.Ying	Papra, Himalayan Mayapple	Arunachal Pradesh, Sikkim through In situ protection through seeds.	Root hepatic stimulant, purgative.
12	<i>Swertia chirayita</i> (Wall.) L.	Chiraita	Arunachal Pradesh, Sikkim through seeds.	Whole plant bitter tonic, laxative in fever, malaria, jaundice.
13	<i>Taxus wallichiana</i> Zucc.	Talisa	Arunachal Pradesh, Manipur, Meghalaya, Nagaland through stem cuttings.	Leaf in cough, cancer.
14	<i>Valeriana jatamansi</i> Jones	Tagara	Arunachal Pradesh, Nagaland through root cutting and seeds.	Root stimulant, carminative, tonic.
15	<i>Zanthoxylum armatum</i> Roxb.	Timbru	Arunachal Pradesh, Manipur, Nagaland, Sikkim through seeds.	Seeds and bark aromatic tonic, dental disorders and also in rheumatism.

DISCUSSION

Exploration of medicinal plants in the states of North east India is a matter of attraction to the Scientists, traders as well as pharmaceuticals, and is being regularly carried out. Kharkonger and Joseph (1981) and Tiwari et al. (1993) had emphasized the aspect of medicinal plants used by local traditional healers in Meghalaya. Rai and Sharma (1994) and Pandey et al. (1991) has given the extensive exploration of medicinal plants and folklore medicines in Sikkim whereas Rai and Lalram Linghiglova (2010) and Mahanti (1994) described the medicinal plants and folklores of Mizoram. Sinha (1996) gave detailed accounts of medicinal plants of Manipur and Nair et al. (2009) listed the medicinal plants of Tripura and the

medicinal plants of Assam was described by Basumatari (1981); Sharma and Sharma (1994). Status of threatened medicinal plants of Sikkim, Northeast and Arunachal Pradesh were described by Mudaiya et al. (1987), Majumder (1981), Rawat et al. (1997) and Shankar and Rawat (2008) and Website IUCN (2009) whereas the aspect of conservation and cultivation in different states was yet to be described and the present attempt was to fulfill the aspect of conservation and cultivation of threatened as well as high demand medicinal plants in different states of North east India. Conservation and cultivation of *E. ribes* and *W. fruticososa* has been described in detail by Shankar et al., 2012 and Shankar and Rawat (2012). The present attempt was to explore as well the possibilities for conservation and acclimatization



Figure 2. Photographs of threatened and high value medicinal plants of North East India



Figure 3. Photographs of threatened and high value medicinal plants of North East India

behavior of high valued threatened plants in different climatic conditions in North eastern states. Details of various experiences are emphasized in this communication. While selecting plants for a specific climatic condition of one and other states, all necessary attempts were made by involving local farmers through providing planting materials and regular observation. During course of the study for longer duration till the procurement of the produce, it was necessary to plant tree species whose flowers and fruits are used as drug with more spacing gap or plantation in scattered form. For the plants where leaf, root and bark is used as drug, spacing with 5 m is sufficient for procurement of drugs like *G. arborea*, *O. indicum*, *S. asoca*, *T. arjuna* etc. Besides the medicinal plants mentioned in the list of rare, endangered and threatened plants, there are certain others which are having acute pressure of exploitation that can undergo threat; *Berginia ciliata*, *Hemidesmus indicus*, *Rubia manjith*, *Tylophora indica*, etc. Their protection through cultivation is required. Various method of cultivation of threatened medicinal plants has been discussed in detail.

Conclusion

The study reveals that there is acute pressure on natural habitat of medicinal plants due to unsystematic collection and habitat destruction of medicinal plants. Important medicinal plants used in the formulation are being threatened in North-East India. Therefore, there should be conservation measures like establishment of Medicinal Plants Conservation Areas (MPCAs) in potential habitat and species specific of such important and endemic medicinal plants of the region. Further, local inhabitants need to be aware of conservation and cultivation activities for their socio-economic upliftment.

ACKNOWLEDGEMENTS

The authors are grateful to the Director General, CCRAS, for providing necessary facilities. Financial assistance rendered by the National Medicinal Plants Board is also thankfully acknowledged.

REFERENCES

- Basumatari (1981). Ethnobotanical notes on the Miris. (Mishings) of Assam plains. In Glimpses of India Ethnobotany: Ed. S.K. Jain; I.B.H. Publisher, pp.161-169.
- Islam M (2009). Medicinal Plants of North East Pointer Publisher, Daryaganj, New Delhi. pp. 4-78.
- Kharkonger P, Joseph J (1981). Folklore medico botany of Rural Khasi and Jayantia tribes in Meghalaya In Glimpses of Indian Ethnobotany, Ed. SK Jain. Oxford & IBH, New Delhi p.137.
- Lalramnghinglova H (2003). Ethno medicinal plants of Mizoram. Bishensingh Mahendrapal Singh, Dehradun. pp. 3- 95.
- Mahanti N (1994). Tribal Ethnobotany of Mizoram. Inter- India Publications, New Delhi. pp. 5-94.
- Majumder R (1991). Some threatened medicinal plants from the Northeast region. Bull. Medico Ethno Bot. Res. 12(1-2):12-16
- Mudaiya RK, Majumder R (2004). Medicinal wealth of North East Region. Their exploration. Bull. Medico- Ethno Bot. Res. 25(1-4):42-46.
- Mudaiya RK, Sharma BN, Singh DN (1987). Threatened and rare medicinal plants from Sikkim. Bull. Medico Ethno Bot. Res. 8(3-4):155-159.
- Nair DD, Gupta AK, Das HB, Chakraborti A (2009). Medicinal Plants of Tripura. Ridhi International Jodhpur. pp.3-106.
- Pandey VN (1991). Ethnobotanical exploration in Sikkim Himalaya. CCRAS, New Delhi. pp. 1-198
- Rai LK, Sharma E (1994). Medicinal Plants of Sikkim Himalaya, Status use and Potential. Bishen Singh Mahendra pal Dehradun GB PIHED, Sikkim.
- Rai PK, Lalramnghinglova H (2010). Lesser known ethno medicinal plants of Mizoram, Northeast India an Indoburman hotspot region. J. Med. Plants Res. 4(13):1301-1307.
- Rawat MS, Shankar R, Singh VK (1998). Conservation and cultivation of some rare and threatened medicinal plants in Arunachal Pradesh. Bull. Medico- Ethno Bot. Res. 19(3-4):151-159.
- Rawat MS, Shankar R, Singh VK (1997). Cultivation of medicinal plants in social forestry programme in Arunachal Pradesh. Bull. Medico Ethno Bot. Res., 18(3-4):169-174.
- Shankar R, Lavekar GS, Rawat MS, Deb S, Sharma BK (2012). Distribution, conservation and folk use of Vai Bidang- (*Embelia ribes* Burm. f.). Inter. J. Biodiver. Conserv. 4(13):525-529.
- Shankar R, Rawat MS (2008). Medico Ethnobotany of Arunachal Pradesh (Papumpare, Lower Subansiri and Upper Subansiri districts). Himalayan Publisher, New Delhi & Itanagar. pp. 89-91
- Shankar R, Rawat MS (2013). Exploration, conservation and cultivation of *Woodfordia fruticosa* Kurz. Internat. J. Med. Plants (Photon) 105:213-217.
- Shankar R, Singh VK, Rawat MS (1995). Some important Ayurvedic medicinal plants of Arunachal Pradesh. Bull. Medico -Ethno Bot. Res. 15(1-2):27-32.
- Shankar R, Singh VK, Rawat MS (1999). Some rare medicinal plants in Arunachal Pradesh: Need for their conservation. Bull. Medico Ethno bot. Res. 20(1-4):128-131.
- Sharma HK, Changta L, Dolui AK (2001). Traditional medicinal plants in Mizoram, India Fitoterapia, 72:146-161.
- Sharma TK, Sharma S (1994). Medicinal Plants of Sikkim, Gangtok. Sharma and Sharma Publication; pp. 103-110.
- Sinha SC (1996). Medicinal Plants of Manipur. Imphal. pp.1-202
- Tiwari KC, Sharma BN, Majumder R, Pandey G (1993). Studies in medicinal plants of Khasi and Jayantiya hills in North East region of India. J. Econ. Bot. Res. 17:275-281.
- Website: IUCN (2009). IUCN IUCN Red list of threatened Species www. iucnredlist.org.