Most of the tropics and subtropics are the custodians of the traditional knowledge holders which are mainly the tribal communities inhabiting the hotspot regions of the world. The majority of the biodiversity is centered in tropical ecosystem which accounts for the 50% of the total biodiversity. The Northeast India is an important center for ethnobotanical studies because of its rich floristic and bio-cultural diversity. The Eastern Himalaya state of Arunachal Pradesh is regarded as one of the “Major Ethnobotanical Hotspots” because of the richness in both species and cultural diversity (Khan, 2005). The Dehang Debang Biosphere Reserve of Arunachal Pradesh is a unique ecosystem with rich biodiversity and inhabited by more than 10 major tribes who are fully dependent on forest resources for primary health care and fulfill their day to day requirement from forests due to remoteness of their locality and inaccessibility to modern medical facilities. The present research work was undertaken to understand and document the rich Traditional Knowledge System and taxonomic evaluation of medicinal plants of the BR particularly from the Siang part of the reserve. The overall result achieved in the study has been discussed in the following paragraphs.

### 6.1 TAXONOMIC DIVERSITY OF ETHNOMEDICINAL PLANTS

The DDBR exhibit a rich diversity of plants used ethnomedicinally where 209 species under 162 genera of 80 families have been found to be used by the tribes indicating the richness of medicinal plants in the BR. These species are used for curing all the types of health ailments. The treatment of 31 different ailments by using the plants indicates the dependency of the communities to the forest ecosystems. Among the species Dicotyledons (63 spp) are preceding over the Monocotyledons (19 spp). The report of higher number of dicotyledonous plants indicates the dominance of the groups in the BR. Among the 163 dicotyledons 53 species are herbs, 41 species are shrubs, 52 species are trees and 17 species are climbers. Among the monocots 28 species are herbs, 2 species are shrubs, 10 species are climbers (Fig 6.1.1). Besides, Pteridophytes are also found to be useful and are represented by 6 species. Therefore, it is inferred that majority of the plant species used in the treatment of various ailments are flowering plants as
compared to the non-flowering plants. Interestingly, although, a few Gymnosperms were
found in the area, have not been reported to be used.

The family Urticaceae (10 spp) is the most dominant one followed by
Euphorbiaceae and Zingiberaceae (9 spp each), Asteraceae, Solanaceae and Rubiaceae (7
spp each), Anacardiaceae and Poaceae (6 spp each) and Araceae, Moraceae,
Polygonaceae and Verbenaceae (5 spp each) (Fig 6.1.2). However, 16 families were
represented by 2 species and 33 families were represented by single species. Hence, it is
inferred that 81 (38.80%) species are found to be restricted to 12 dominant families on
the basis of utility of plants which could probably be due to species richness of flora in
their local vicinity (Haridasan et al., 2003; Kala, 2005, Chaudhary, 2008; Nimachow et
al., 2011). The report of Urticaceae and Euphorbiaceae as the dominant ethnomedicinal
plant families is interesting and unlikely to the previous reports from the region. Saklani
and Jain (1994) placed the Solanaceae and Lamiaceae as mostly used one for
ehnomedicines for Arunachal Pradesh while the Asteraceae for Northeast India.

Majority of the species (73.64%) are harvested from the wild indicating limited
practice of cultivation of medicinal plants in the field or in home gardens. Literature
recorded globally indicates the similar interpretation and shows that tropical forests are
the storehouse of medicinal plants (Lange and Chippmann, 1997; Srivastava et al., 1996;
Xiao Pen-Gen, 1991; Ramakrishnan, 1992; Ignacimuthu et al., 2006; Muthu et al., 2006;
Giday et al., 2007). About 11.96% medicinal plant species are harvested from both wild
and cultivated conditions which indicates the increasing trends of domestication practices
of wild plants among the tribes of the DDBR is undergoing. Among all the species only
1% species represent rare, endangered and threatened category highlighting the
availability of common flora in BR. Again 99% species are found to be growing in
tropical and subtropical forest which can be easily accessed by the communities (Fig
6.1.3).
Fig 6.1.1 Taxonomic diversity of ethnomedicinal plants

<table>
<thead>
<tr>
<th></th>
<th>Herbs</th>
<th>Shrubs</th>
<th>Tree</th>
<th>Climber</th>
<th>Family</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dicotyledones</strong></td>
<td>41</td>
<td>35</td>
<td>41</td>
<td>34</td>
<td>14</td>
<td>124</td>
</tr>
<tr>
<td><strong>Monocotyledones</strong></td>
<td>25</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td><strong>Pteridophytes</strong></td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>70</td>
<td>38</td>
<td>44</td>
<td>52</td>
<td>20</td>
<td>162</td>
</tr>
</tbody>
</table>

**Number of taxa:** 162

197
Fig 6.1.2 Top 12 dominant families represented by ≤5 species

Fig 6.1.3 Habitat, occurrence and cultivation status
6.2 CATEGORIZATION AND UTILIZATION PATTERN

Almost all the plant parts are used in the treatments and when categorized it is found that leaves were used predominantly (106 spp) followed by fruits (76 spp), stems (64 spp), roots (58 spp), and flowers (23 spp) tubers and rhizomes (10 spp) and latex (7 spp) in the treatment of 31 ailments by herbal practitioners (Fig 6.2.1). The preference for leaf in ethnomedicine had also been recorded amongst the communities elsewhere from India (Ayyanar and Ignacimuthu, 2005, Ragupathy et al., 2008, Bhattarai et al., 2010). Analysis based on plant species used in the treatment of various ailments revealed that maximum number of species (111 spp) were reported to be used in digestive system disorders which is followed by inflammation and wound healing (56 spp), reproductive system disorders (20 spp), pain (24 spp), fever (18 spp), respiratory system disorders (18 spp), circulatory system disorders (12 spp), nervous system disorders (11 spp), snake bite and scorpion sting (10 spp), dental problems (8 spp), general metabolism (16 spp), bone fracture (7 spp) while least in eye and ear ailments (4 spp) (Fig 5.1).

Among the crude drug types pounded powder and paste (124 spp) used for maximum cases followed by decoction (33 spp), juice and extract (18 spp) and infusion (8 spp). In case of plants being administered topically or orally the plant parts were collected fresh just before use and used in the form of pulverized and tie with poultice, shave and latex. The healers preferred fresh plant materials for herbal preparation to dry materials (Fig 6.2.2). For decoction quantification of herbal crude drugs was made by the researcher as 20-50 g plant material in 100-200 ml hot water. Remedies were mostly administered twice or thrice a day for 2-3 days after or before meal depending upon ailments treated or until cure. In special cases such as dog bite it was administered for 30 days. Crude drugs were usually prepared with the help of local make grinder. There was hardly any side effect reported by the patients treated. In some cases strict dietary regimens were imposed during the treatment of patients. In some cases spiritual functions are also observed before or during treatment.

When the grouping of ailments is made following predefined ethnobotanical or economic botany categories (Cook, 1995, Heinrich, 2000), the 31 ailments treated can be grouped into 13 categories. The digestive system disorders category that includes 9 ailments like dysentery and diarrhea, gastric, rectocele, piles etc. are found as major ailments type of the BR where 111 species used with 53.11% representation (Fig 5.1b (i)).
Dysentery and diarrhea is found the most common disease with uses of maximum species (33.33%) out of all the ailments treated. The decoction, pounded powder, slice...
infusion, extract and paste and juice are used in this category with decoction as major crude drug type (Fig 6.2.2). The species like Trichosanthes cordata, Garcinia pedunculata, Angiopteris evecta, Mikania micrantha, Curcuma caesia, Aristolochia tagala, Paederia foetida, Psidium guajava, Tacca integrifolia, Morus macroura was used as anthelmintic; Aristolochia sp., Dillenia indica etc. are the most utiliazed species. The uses of Eryngium foetidum as appetizer and Zanthoxylum armatum with Allium sativum for stomachache are very common. Another interesting species under this group is Campylandra aurantiaca (locally known as Kekong kelong) which has been used for curing dysentery, diarrhoea, stomachache, gastritis, malaria and common fever and also as tonic. Coptis teeta, an established medicinal plant in Indian Traditional medicinal system, used as anthelmintic, antimalarial, vulnery, anidysenteric, anti diarrhoeic, backache, anti-pyretic etc. and it is endemic to Arunachal Pradesh is a common medicinal plants for the tribe and used by other tribes of the state (Kala, 2005, Das & Hui, 2006, Nimasow, 2012). The observations made in the present study are partially in conformity with those made by Gajurel et al., (2006). Coptis teeta, Drymaria cordata, Houttuynia cordata, Paedaria foetida and Zanthoxylum armatum were some of the species reported for stomach disorders in both the studies. Species like Lagerstroemia macrocarpa, Melastoma malabothricum, Mikania micrantha and Trichosanthes cordata which were reported in this present study were also used by other tribes of India and elsewhere in the word (Bardwaj & Gakhar, 2003). Psidium guajava L. was reputed for its medicinal use in hyperactive gut disorders. The use of Mikania micrantha, Psidium guajava and Paederia foetida had also been reported from other countries for the treatment of digestive disorders though the formulation and parts used were different (Chawdhury et al., 1996). The ethanol extract of Paederia foetida (Afroz et al., 2006), and Psidium guajava (Shah et al., 2011) showed anti diarrhoeal activity in animal models by inhibiting gastrointestinal disorders which justify its use in traditional medicine. The study carried out by Mehrotra & Mehrotra (2005), Mahato & Chadhury (2005), Kumar & Chauhan (2005) also yielded similar results where most of the species were reported for stomach disorders. A large number report of bioactivities against gastrointestinal disorders have been made worldwide indicating the importance of medicinal plants for gastrointestinal problem in day to day healthcare (Yamahara et al., 1990; Matsuda et al., 2003; Gilani et al., 2005; Wu et al., 2000; Paul et al., 2011; Njume and Goduka, 2012).

Next to the digestive system disorder the inflammation and wound healing is found import major category in the BR where 56 species comprising different habits and
parts are reported (Fig 5.1.2a). In this category 5 ailments have been treated such as inflammation, cuts and wound, dermatitis and eczema, abscesses and allergy. However, maximum species are used for only for cuts and wound (33 spp) indicating the ailments a common health problem (Fig 5.1.2b). Abroma augusta, Eupatorium odoratum, Ageratum conyzoides, Musaenda frondosa, Artemisia indica, Osbekia nepalensis, Lantana camara, Lycopodium clavatum, Plantago erosa, Melastoma nomale, Melastoma malabathricum, Mikania micrantha, Drymaria cordata, Rubia manjith are most commonly used one in the cuts and wounds. Seed oil of Gynocardia odorata was applied externally by the tribes of DDBR to treat leprosy. The use of Melastoma malabathricum in skin diseases had also been reported from Assam (Begum, & Nath, 2000) and Eupatorium odoratum, Ageratum conyzoides from Arunachal Pradesh (Namsa et al., 2009). In vivo experiment had established justification of claiming the use of Lantana camara in wound healing (Dash et al., 2001).

The category pain is also another important health problems in the region with uses of 24 (11.48%) species where leaves were used more frequently (12 spp) in the form of decoction (Fig 5.1.4 a). Campylandra aurantiaca, Capsicum annuum, Curcuma longa, Zanthoxylum armatum, and Zingiber officinale were most commonly used as pain reliever plants. Capsaicin from Capsicum annuum and other species of Capsicum was used in relieving pain (Altman and Barkin 2009), as was curcumin from Curcuma longa, which has analgesic and anti-inflammatory properties and was used as either a chemical or a phytotherapeutic agent (Anand et al., 2008, Namsa et al., 2009), use of Zanthoxylum armatum as pain reliever has also been reported elsewhere globally (Jain, 1991; Guo et al., 2011). Urinogenital system disorders although not so common category uses of 20 species have been reported with tuber and rhizome as a major part (Fig 5.1.3a). Plants mostly used in this category were Asparagus racemosus, Laportea crenulata, Campylandra aurantiaca, Hydrocotyle sibthorpioides, Litsea cubeba, Dendrocnide sinuata, Zingiber officinale, Nephrolepis tuberosa, Lycopodium clavatum, Zanthoxylum armatum, etc.

Ailments like pneumonia, cough, cold and asthma and sinusitis are very frequent in the area that can be grouped under respiratory ailments. For the treatments of these common problems 18 (8.61%) species were used mostly in the form decoction, fresh extract, pounded powder and paste and infusion (Fig 5.1.5 c). Piper attenuatum, Piper longum, Cinnamomum glanduliferum were used most commonly and these species are known for various curative properties (Anon., 1976-2009) and contain some essential
Besides *Adhatoda zeylenica* for cough, *Houttuynia cordata* and *Leucas aspera* for sinusitis, *Papaver somniferum* for tonsillitis; *Elettaria cardamomum*, *Artocarpus heterophyllus*, *Croton caudatus*, *Solanum torvum* for pneumonia are common practices. The use of *Leucas aspera* as an insecticide and in psoriasis, coughs and cold, anti-inflammatory and analgesic and larvicidal activity had also been reported from different parts of India (Chopra *et al.*, 1956; Kalyanasundaram & Das, 1985; Nadkarni, 1996, Nadkarni, 2001). The scientific investigation revealed the presence of alkaloids which showed maximum antibacterial activity and supports the claim of the usefulness of the herb in various disorders claimed in traditional medicine (Mangathayar* et al.*, 2005).

**Bone fracture** is again found as one of common problem in the area and is due to accident occurred in various farm activities and day to day activities in the hilly terrains. Treatment was usually practiced through preparation of paste from plant origin and application of poultice upon them as per the prescription of traditional healer. A total of 7 (2.87%) plants have been recorded to be used in the treatment of bone fracture. For the treatment of bone fracture, roots are used predominantly (6 species), followed by stems (3 species) mainly in the form of pounded paste or powder (6 species) (Fig 5.1.6a). The most common plant used externally in the treatment of bone fracture was *Pothos scandens* (leaf and stem), *Cryptolepis dubia* (stem), *Litsea monopetala* (leaves), *Ricinus communis* (leaf) etc. The use of *Ricinus communis*, *Litsea monopetala* and *Pothos scandens* and use of *Ficus recemos* was similar for the treatment of bone fracture by the tribes of DDBR and elsewhere in India (Srivastava, 2009, Srivastava, 2010, Nath *et al.*, 2011, Nimasow *et al.*, 2012, Shankar *et al.*, 2012). *Ricinus communis* is also used in the treatment of bone fracture of chick and fowls which is a new report from the state. Findings of researchers provide evidence that besides use in the treatment of bone fracture, *Pothos scandens* is also potential as anti-allergic anti-asthmatic agent (Gupta *et al.*, 2013). People who have no modern medical accessibility and therefore, the poor tribal people directly depend upon traditional methods of curing various ailments. In case of bone fracture traditional medicine is still considered by the tribes of the DDBR as one of the best treatment. Instead of replacing the bones through modern medical techniques they prefer natural way to reset fractured bones by applying herbal medicines.

During investigation 12 (6.74 %) species were found to be used in the treatment of **circulatory system disorders** in which leaves were used more frequently (7 species), and flowers least (2 species) in the form of pounded paste or powder (9 species) and extract (1 species) (Fig 5.7a) as anti-hypertensive, blood purifier and hair shampoo.
*Allium sativum* and *Clerodendrum colebrookianum* were used as antihypertensive. The bulb of *Allium sativum* had been used for both culinary and many medicinal purposes (Block, 1992). In vitro studies have shown that garlic possesses antibacterial, antiviral, and antifungal and other pharmacological activities. It yields allicin, an antibiotic when crushed and various sulfur-containing compounds including alliin, ajoene, diallyl polysulphides in the fresh state (Block, 1992). Ethanol extract of *Allium sativum* has been shown effective in producing dose-dependent and reversible hypotensive effects on arterial blood pressure and heart rate of rats after an intravenous administration (Brankovic et al., 2011). *Clerodendrum colebrookianum*, an ethnomedinal plant is used as antihypertensive in almost all northeastern state (Das et al., 2008; Khongsai et al., 2011, Namsa et al., 2011, Namasow et al., 2011; Devi et al., 2011).

A total of 18 (8.61%) plant species were reported to be used in the treatment of malaria and mild fever of which leaves were used most frequently (13 species) and latex least (1 species) in the form of pounded paste (6 species) and decoction (6 species), infusion (4 species), extract (5 species), boil (1 species) (Fig 5.1.8a & b). Beads made from rhizome of *Acorus calamus* is tied in the neck of children to prevent cold, cough, asthmatic trouble and fever etc. To manage malarial fever decoction of *Campylandra aurantiaca*, infusion of dry rhizome of *Coptis teeta*, decoction of *Liparis nervosa*, tuber extract of *Stemona tuberosa*, root decoction of *Carica papaya* are administered to patients. In the treatment of general fever infusion of *Andrographis paniculata* fresh extract of *Centela asiatica*, decoction of stem of *Tinospora cordifollia*, *Clerodendrum serratum* (leaf paste), *Portulaca oleracea* (leaf paste) and *Cardiospermum halicacabum* (crushed seeds) are applied on fore head topically during severe fever to reduce body temperature and in burns.

Ear complaints include all ailments of ear, discharge from ear and impairment of hearing and eye diseases includes cataract, sore eye, night blindness, conjunctivitis, stye etc. For the treatment of ear and eye ailments a total of 4 (1.91%) plant species have been reported to be used and plant parts used are leaves (2 species), stem (1 species), roots (1 species) and fruit (1 species) in the forms juice (2 species), pounded paste and fresh extract (1 species each) (Table 5.1.9a). Present investigation showed that least number (4 species) of plants has been recorded to be used in this category during entire ethnomedicobotanical investigation. A common trouble of ear is the earache which may be caused by inflammation of middle ear and due to some external injuries. Fruit juice of *Caesaria vareca*, is dropped into ears when attacked by ticks. The use report of *Caesaria*
vareca in earache has also been recorded from various parts of India (Kharkongor and Joseph, 1981; Rao et al., 1981). To treat conjunctivitis root extract of Clerodendrum serratum is used traditionally by the Adi tribes of Jido village. To treat soreness of eyes juice exudates from hollow pith of Uncaria lavigata were applied externally to reduce eye irritation.

Snakebite, dog bite and scorpion sting is a common incident in the locality of DDBR since almost all village roads were forest tracks only. Even though all snakes are not poisonous, immediate action is taken to deal with snake bite. A total of 10 species have been recorded in this category mostly used in the form decoction and extract and powder (Fig 5.1.11a). To combat snake bite the juice of Amaranthus spinosus (whole plant); fresh extract of Hydrocotyle himalaica (15-30 ml) of whole plant was taken twice / thrice a day which was administered orally along with some spiritual practices. Dry roots of Aconitum ferox are applied topically on the site to cure snake bite. The juice of Alocasia macrorrhiza, paste prepared from stem bark of Erythrina stricta was applied locally during scorpion sting. To manage scorpion sting, if possible, tribal people catch the scorpion and grind it to paste and applied topically on the spot to counteract poison. To manage dog bite root decoction of Carica papaya (2-3 roots in 20 ml water) was administered once a day for 3 days. Seed paste of Caesalpinia bonduc, one seed of Datura stramoniumis mixed with fruits of Musa paradisiaca was administered to the patient in one month interval for 3 months to cure dog bite traditionally. Interestingly, maximum tribal people of the present study site preferred traditional healing practices to modern medical treatment in the case of scorpion sting, snake bite and dog bite.

The use of “general metabolism” category is included here as recommended by other ethnobotanical researchers (Cook, 1995, Heinrich, 2000) and it is an integral part of the health concept of DDBR communities in which healers insist on having plants as part of their diet to maintain sound health. An ancient tradition of the Adi community is to consume certain plants on a regular basis available in certain seasons in order to prevent certain diseases. It is common practice for the Adi tribes to consume various fresh plant parts that they come across while they go out for hunting, fishing, gathering fire woods, farm activities or any other day to day work. They believe it will aid their general health and provide treatment for chronic disorders. The present investigation revealed that 8 (3.82%) species were used as tonic and in general metabolism in the form of infusion (2 species) and decoction and paste (1 species each) (Fig 5.1.12a). Plants used as tonic and in general metabolism were Andrographis paniculata, Asparagus racemosus, Bacopa
monnieri, Campylandra aurantiaca, Centella asiatica, Christella parasitica, Coptis teeta and Costus speciosus. Nervous system disorders and toothache are other ailment categories and negligible in comparison to the major one. In the treatment of nervous system disorder and in toothache 11 species and 8 species respectively have been reported.

The traditional uses recorded for Erynium foetidum were numerous and mainly medicinal. The Apantani of Arunachal Pradesh and tribes Mexico, the Caribs of the Caribbean, the Ramamidwives of Nicaragua used various preparations for stomachache (Kala, 2005, Heinrich et al., 1992, Zamora-Martinez et al., 1992; Leonti et al., 2003; Coe and Anderson, 2005; Coe, 2008). Literature survey showed that the plant was useful for female reproductive problems such as infertility, childbirth complications, menstrual pains, ease of delivery, postpartum, abdominal pains, vaginal infections and as an emmenagogue (Coe, 2008, Lans, 2007; Kala, 2005; Rodrigues, 2007; Weniger, 1982), in hypertension (Noumi, 1999), rheumatism (Leonti et al., 2003), asthma (Zamora-Martinez et al., 1992), eye disease (Zheng & Xing 2009), poisoning (Ndip et al., 2007), as a vermifuge (Lans, 2007; Rodrigues, 2007; Simon & Singh, 1986), pain (Rajith & Ramachandran, 2010), malaria (Roumy et al., 2007) and snake bites (Coe & Anderson, 2005; Houghton & Osibogun, 1993).

The utility of Dryamria cordata in various ailments like wound healing, scabies, toothache, gastrointestinal trouble, asthma and sinusitis, dysentery, skin diseases, burns, snake bite, mouth diseases and to repel caterpillar hair from the body have been reported by various workers (Saklani and Jain 1994; Majumder et al., 1978, Bosissya and Majumder, 1980; Sinha, 1986, 1996; Kannapa et al., 1986, Kharkongor and Joseph, 1981; Rao, 1981; Rao et al. 1981; Kumar et al., 1987; Rao and Jamir, 1982a, 1982b and Asholkar et al.,1992). Hence, the species can be used as an important medicinal plant.

Present investigation reveals that a total of 198 species are used by Adi community and 128 species by Memba community. Most of the recorded species were identical in the two communities. While both the communities use about one half of the total recorded species (116 species) for the treatment of various ailments prevailed in the locality (Table 6.2.3). The degree of overlapping uses of medicinal plants in both the tribes is illustrated in Fig. 6.2.3. However, a total of 82 species has been recorded to be used exclusively by Adi community and only 11 species by Memba community. Interestingly, only a few Memba phytonyms were quoted by the Adi informants and most of the Adi phytonyms were quoted by the Memba informants. Plants like Senecio
scandens, Edgeworthia gardneri, Phlogacanthus thyrsiflorus, Mangifera sylvatica etc. are used exclusively by Memba tribe.

Table: 6.2.3 Use records of medicinal plants by Adi and Memba communities of DDBR

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Total use record of medicinal plants by communities</th>
<th>Numbers plant taxa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adi community</td>
<td>198</td>
</tr>
<tr>
<td>2</td>
<td>Memba community</td>
<td>127</td>
</tr>
<tr>
<td>3</td>
<td>Both the communities</td>
<td>116</td>
</tr>
<tr>
<td>4</td>
<td>Exclusively within Adi community</td>
<td>82</td>
</tr>
<tr>
<td>5</td>
<td>Exclusively within Memba community</td>
<td>11</td>
</tr>
</tbody>
</table>

Fig. 6.2.3 Venn diagram shows overlaps between the medicinal plant uses recorded among the Adi and Memba communities

This comparative study showed that medicinal plant uses within the same biophysical environment can be heavily influence by cultural and religious components. In contrast to other previous ethnobotanical studies conducted among ethnic groups in India and world (Ceutericka et al., 2008) this study shows how diasporic communities may cope with cultural change, within a given natural-cultural space, in an unique way, which differentiates them from the autochthonous populations in the traditional knowledge of plants related to primary health care system. Although it may conclude that cultural resilience of the communities plays an important role in the distinction of their Traditional Knowledge from one another, we cannot discount the possibility that this paradigm is due instead to acculturation of the Memba communities to the customs of the Adis. The present observation reveals that despite living in close proximity to each other with continuous contact, both the communities have either maintained or developed quite
distinct phyotherapeutic practices. Moreover, it is likely that this continuous contact and inter-community dynamics may lead to the erosion of the original phytonomenclature. Therefore, further cross cultural study on the Traditional Knowledge on medicinal plants among the tribes of DDBR is necessary.

6.3 INFORMANTS’ CONSENSUS ANALYSIS

Informants’ consensus analysis of ethnomedicinal plant usage with the tribes of DDBR resulted in Informant Consensus Factor ($F_{ic}$) values between 0.10 and 0.92 in individual disease category (Table: 5.3.1). The category that has the highest $F_{ic}$ value is bone fracture (0.92) followed by ear and eye diseases (0.84). The lowest is digestive system disorders (0.10). The average $F_{ic}$ value for all disease categories is calculated as 0.62 indicating a significant level of informant consensus i.e. homogeneity of information provided by different informants is high compared to similar studies from other countries (Trotter and Logan, 1986, Johns et al., 1990, Phillips & Gentry, 1993, Heinrich, 2000, Amiguet et al., 2005, Ghorbani, 2005, Muthu et al., 2006, Estomba et al., 2006, Owuor and Kisangau, 2006, Teklehaymanot & Giday, 2007). This analysis indicates a high level of consensus among the DDBR communities. A high consensus factor may indicate that there is certain key phytochemical constituent(s) in those plants. The investigation revealed that the category bone fracture comprised only 7 species, resulting in a high $F_{ic}$ factor of 0.92, indicating higher homogeneity among informants. The low consensus factor ($F_{ic}$ 0.10) for the gastrointestinal category indicate the higher number of plant species used in this category but lesser homogeneity among informants. Studies of other cultures have shown high incidents of gastrointestinal occurrences (Muthu et al., 2006, Ghorbani, 2005, Estomba et al., 2006) and among the tribes of DDBR it is also frequent due to lack of hygienic condition. The consensus factor ($F_{ic}$ 0.83) for the fever illness category shows the significant level. An explanation for a consensus factor may be that there are a variety of plants being used for a variety of fever causations, such as sore throat, cold and flu by many traditional healers. This consensus analysis provided a new perception for several other categories of medicinal utility by the tribes of DDBR from which we learned that they routinely consume plants for their vital wellbeing and good health. The general metabolism category included a number of taxa, reports of utility and a relatively high level of consensus ($F_{ic}$=0.79). It was observed in the present ethnobotanical survey that some of the plants used in the General metabolism category were used also as edibles by the tribes of DDBR (8 species). An ancient tradition of the Adi community is to consume certain plants on a regular basis available
in certain seasons in order to prevent certain diseases. It is common practice for the Adi tribes to collect freshly and consume plants that they come across while they go out for hunting, fishing, gathering fire woods, farm activities or any other day to day work. Consensus analysis is a crucial tool in establishing a reasonable assessment of the level of informants’ consensus on the use of medicinal plant remedies (Owuor and Kisangau, 2006, Johns et al., 1990). More recently, a number of botanists used the consensus analysis to identify the important Traditional Knowledge in the treatment of different ailments in various parts of the world (Leaman et al., 1995, Kisangau et al., 2007, Schlage et al., 2000). Although consensus analysis is a valuable tool, we agree with other researchers (Almeida et al., 2006, Balasubramaniam and Murugesan, 2004, Amiguet et al., 2005, Etten (2006), Bourbonnais-Spear, 2005, Gazzaneo et al., 2005, Heinrich, 2000, Kisangau et al., 2007, Schlage et al., 2000, Teklehaymanot and Giday, 2007, Mutheeswaran et al., 2011) that there are some factors like (i) lesser numbers of knowledgeable informants within a local culture, (ii) heterogeneous uses, and (iii) lesser numbers of surveys that limit the reliability of a consensus analysis.

During this investigation it was observed that illiterate informants reported higher number of medicinal plants than literate ones which could probably be due to higher influence of modernization among the later. Similar observation has also been drawn in studies elsewhere in the world (Ojewole et al., 2008 and Rahim et al., 2010). Many ailments have been diagnosed and treated at household or family level. The fact that most treatments were given at household level was also highlighted in the observations made by other researchers (Shetty et al., 2006; Upadhyay et al., 2007; Ojewole et al., 2008; Rahim et al., 2010; Gutierrez et al., 2008). There was average agreement among informants that transfer of knowledge to people outside the family circle took place on substantial payment. Most informants reported that knowledge was formally transferred along the family line and mainly through sons (Panghal et al., 2010; Teklehaymanot, 2009; Giday et al., 2003, 2007; Collins et al., 2006; Deribe et al., 2006; Ignacimuthu, 2006). Example has been drawn by Gedif et al., (2003) from Ethiopia where parents prefer to transfer their traditional medicinal knowledge secretly to sons or daughters. Most of the informants reported that vertical transfer of medicinal plant knowledge was not taking place effectively due to lack of interest among the younger generation to learn and practice it mainly due to acculturation and modernization. It was also revealed that some informants ceased to practice traditional medicine specially in urban areas due to the increasing availability of allopathic medicines.
6.4 SUSTAINABLE HARVESTING AND CONSERVATION

The local people of the DDBR have been harvesting medicinal plants for household purposes since long time and still the remains seemingly undisturbed. However, it is to be noted that the intensity of subsistence harvesting of medicinal plants as traditionally practiced by dwellers of fringe villages is quite lower than that of commercial exploitation. The present investigation reveals that most of the medicinal plant (63.64%) species are harvested from the natural habitat and relatively less number of plant species (24.40%) are cultivated which indicates that there is very little practice of keeping medicinal plants in cultivated areas or in home gardens. Plants like *Coptis teeta*, *Aconitum ferox*, and *Campylandra aruntiaca* are collected directly from the wild habitat. The roots of *Coptis teeta*, *Aconitum ferox* are uprooted in large scale to sell to the middle men. Moreover, these two species are categorized under IUCN’s RET plant list. In spite of that, illegal collection is still going on.

The most important component required to achieve a truly sustainable form of resource use is information (Peters, 1994). Database should be established to store periodic data on the medicinal plant species of DDBR. It should include the inventory of medicinal plants, the prioritized species for conservation purpose, data on regeneration and abundance and socio-economic conditions like species in trade, volume and value of trade, and contribution of medicinal plants to livelihoods of the target species. The collected data on medicinal plants can be used in providing data on various subjects such as maximum harvest allocations and habitats of collection. In addition, the stored data should be updated regularly and circulated to decision-makers, scientists, researchers and stakeholders to contribute to build up a national strategy for the sustainable use of medicinal plants and to strengthen the institutional and policy frameworks for these species (Cetinkaya, 2009). The BR should prepare a policy on the conservation and utilization of medicinal plants in BBBR.

Gradual increase in global demand on medicinal plants, the poverty and lacking of knowledge on sustainable harvesting of collectors lead to unsustainable harvesting practices. The growing global demand for medicinal plants can be met only through domesticating commercially important medicinal plants (Saigal *et al.*, 1997). Lack of the proper marketing mechanism for the medicinal plant species in trade has led to a market failure. Inadequate information about market prices at collector level results in the market failure due to which middlemen monopolize the trade in medicinal plants. The right to collect medicinal plants from the forests of buffer zone of the BR is conferred on the
dwellers of the fringe villages. Still outsiders collect the commercially important medicinal plants from the BR illegally. The authorities are not keen to check illegal collection of medicinal plants from the BR. Limited employment opportunities and access to settled farmland have pushed the forest dwellers of DDBR to poor livelihods. For this reason, design and implementation of a sustainable rural livelihood strategy, putting tribal people at the Centre of development, is needed to bring a positive synergy to diversify medicinal plant-based livelihoods; to control the possible impacts of harvesting on the wild populations of medicinal plants and their habitats and to reduce heavy dependency upon the wild-collection of medicinal plants through strengthening community income which are vital for a sustainable livelihood. Earlier, the sustainable use of medicinal plants was having inadvertent controls and some intentional conservation practices (Cunningham, 1993). Sustainable harvesting of medicinal plants from the wild is not easy to achieve; therefore, certification standards can play a significant role to assure that a product meets certain standards of sustainability (Schippmann et al., 2006).

6.5 New ethnomedicobotanical reports

The present ethnomedicobotanical investigation and review literature revealed that the use of Senecio scandens, Liparis nervosa and Uncaria lavigata are new record for ethnomedicinal use from the state of Aruchal Pradesh and India. The flower extract of Senecio scandens was used in the treatment of pimples by the Memba tribe. The root of Liparis nervosa is used in the treatment of malaria and fever by Memba tribe of Geling area and Mishmi tribe of Dibang Valley disitrict. The stem exudates from the pith of Uncaria lavigata are applied externally in the treatment of earache. The ethnobotanical use of Tectaria zeylanica is also a new report to Arunachal Pradesh. About 2-3 teaspoonful of decoction of rhizome is drunk 2-3 times a day for 5-7 to cure impotency. Leaf juice is used to relieve from blisters on the tongue. Powdered rhizome (5 g) along with milk is used for vitality and brain tonic. Its rhizome and about 5 g of rhizome of Chlorophytum arundineaeum and root of Bombax ceiba are made into paste which is given for one month for waist pain as tonic. Milang communities of Mlinang village of Mariyang area believe that the presence of Tectaria zeylanica indicates the availability of nutrients for cultivation wet rice. This plant can be used as bioindicator of the availability of water availability in near future. Moreover, this species is monospecific genera and its distribution is scanty in the DDBR area.