The rich biodiversity of the Eastern Himalayan state of Arunachal Pradesh is due to its diverse eco-climatic condition. Each of the forest and vegetation types has its uniqueness with representation of different floristic composition. The records of more than 5000 species of flowering plants have been made from the state (Haridasan et al., 2003). Many forest areas are still unexplored and the species diversity and compositions are not known exactly. It is still very difficult to figure out and enumerate the actual diversity and taxonomic status of all the species of different families. Taxonomic studies selecting a specific group or family have been always found significant in understanding the diversity, distribution, ecology and inter and intraspecific variation of the different species of the group. Particularly such studies are found quite significant for the group with higher species diversity. Moraceae is one such family with rich species diversity mostly distributed in the tropical and subtropical climates. Considering the richness of species diversity, taxonomic difficulties, economic uses and ecological significance the present study of the family Moraceae has been taken up with an aim to document the diversity, distribution, taxonomy and socioeconomic importance. The study has been undertaken in 2009-2012 with extensive field survey and collections of species in different parts of the state. A large number of species were collected which were subjected to complete morphological characterization and comparison. The main findings and observation of the study which have been presented in the preceding chapters are discussed here in the following headings:

5.1: Taxonomic diversity:

The family Moraceae Gaudich often called as Mulberry or fig family under the order Rosales comprises about 37 genera and 1100 species worldwide (Berg et al., 2011). Moraceous plants are characterized by mostly trees, shrubs, woody
climbers and rarely herbs, terrestrial, hemi-epiphytic, with milky latex in all parenchymatous tissues. Leaves are alternate and spirally arranged or distichous, opposite or sub-opposite; stipules fully amplexicaul or semi amplexicaul lateral or interpetiolar free, persistent, sub-persistent and caducous, lamina elliptic, ovate, lanceolate, symmetric and asymmetric, margin entire or serrate. Both dioecious and monoecious plants occur in the family. Inflorescences typically in pairs, unisexual or bisexual, racemose, spicate or capitate with a discoid to cup-shaped receptacle or with an urocelate receptacle, uniflorus to multiflorus.

As recorded earlier in some floristic works (Hooker, 1888; Kanjilal et al., 1940; Giri et al., 2008) the state Arunachal Pradesh exhibits a rich species diversity of Moraceae. The present study on taxonomic diversity of the family also reveals the the rich diversity of the family with occurrence of more then 70 species some of which are yet to be identified. Among the identified species, 64 distinct taxa (60 species, 2 subspecies and 2 varieties) are recorded under 6 genera namely Artocarpus (4 spp.), Broussonetia (2 spp.), Ficus (51 spp.), Maclura (2 spp.), Morus (3 spp.) and Streblus (1 sp.). The genus Streblus have been added for the first time from the state. The genus Ficus shows highest diversity of species with 51 identified species and 7 unidentified species. Following the recent taxonomic work of Wu et al., (2003), Berg et al., (2006 & 2011), the largest genus Ficus have been divided into 6 subgenera and further into sections in the present work. Among the subgenera the subgenus Urostigma represents the highest number of species (14 spp), followed by Sycomorus (11 spp) and Ficus (11 spp). While the subgenus Pharmacosycea is represented by one species only. The detail segregation of the Ficus in subgeneric and sectional level with number of species and key characters are represented in the table 5.1.

Earlier the genus Ficus was subdivided directly into 7 sections without the subgeneric segregation namely Palaemomorphae, Urostigma, Sycidium, Covellia, Eusycea, Neomorphe and Synoecia (King, 1887). The same division has been followed later by Kanjilal et al. (1940) in the Flora of Assam.
Table: 5.1. Sub-division of the genus *Ficus* with number of species reported.

<table>
<thead>
<tr>
<th>Genus</th>
<th>Sub-genera</th>
<th>Section</th>
<th>No of taxa</th>
<th>Major characters</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ficus</em></td>
<td><em>Ficus</em></td>
<td></td>
<td>6</td>
<td>Shrub and trees; lamina entire</td>
</tr>
<tr>
<td></td>
<td><em>Eriosycea</em></td>
<td></td>
<td>5</td>
<td>Trees or shrub; lamina often palmately lobed.</td>
</tr>
<tr>
<td><em>Pharmacosycea</em></td>
<td><em>Glandulosae</em></td>
<td></td>
<td>1</td>
<td>Waxy glands in the axils of basal lateral veins.</td>
</tr>
<tr>
<td><em>Sycidium</em></td>
<td><em>Sycidium</em></td>
<td></td>
<td>4</td>
<td>Procumbent and erect shrub or treelet</td>
</tr>
<tr>
<td><em>Sycomorus</em></td>
<td><em>Sycidium</em></td>
<td><em>Palaeomorphae</em></td>
<td>4</td>
<td>Mostly hemi-epiphytes</td>
</tr>
<tr>
<td><em>Ficus</em></td>
<td><em>Hemicardia</em></td>
<td></td>
<td>3</td>
<td>Symmetrical leaves</td>
</tr>
<tr>
<td></td>
<td><em>Sycocarpus</em></td>
<td></td>
<td>5</td>
<td>Asymmetrical leaves; figs born on stolons</td>
</tr>
<tr>
<td></td>
<td><em>Synoeoica</em></td>
<td><em>Kissosycea</em></td>
<td>1</td>
<td>Tasselate lamina</td>
</tr>
<tr>
<td></td>
<td><em>Rhizocladus</em></td>
<td></td>
<td>5</td>
<td>Non-tasselate lamina</td>
</tr>
<tr>
<td><em>Urostigma</em></td>
<td><em>Urostigma</em></td>
<td></td>
<td>14</td>
<td>This is characterized by circular ostioles, mostly persistent bract and distributed mainly in Asia</td>
</tr>
</tbody>
</table>

Total 51

Although the occurrence of more than 60 species had been made by Giri *et al.*, (2008) in the state flora (Arunachal Pradesh), it has been found that some names which have already been confirmed as synonym are treated as distinct species. Moreover the various available taxonomic publications that enumerated the species although useful for the basic information, are not found so suitable to understand the complete characters, their variations and hence accurate identification. Out of the 60 species recorded in the present study seven species namely *Broussonetia papyrifera*, *Ficus gaspariniana*, *F. gaspariniana* var. *lacertifolia*, *F. abelii*, *F. fulva*, *F. pubigera* var. *maliformis* and *F. subulata* are purely based on herbarium records found in different herbaria (CAL, ASSAM, APFH, and ARUN). On the otherhand the 5 species (namely *Artocarpus gomezianus*, *Broussonetia fruticosa*, *Ficus sinuta*, *Maclura fruticosa* and *Morus acida*) recorded and described here is purely based on previous records from the state as they could not be recorded both from the field and herbarium in the present work. Further extensive and critical studies may confirm their actual status of occurrence in the state. It is pertinent to
mention here that the present collection and record of 64 taxa and about 7 unidentified species are only based on the field survey of 11 districts in the selected forests. It may be assumed that the exploration of the survey areas covering more areas may increase the number of species far beyond 70. Thus it can be said that the Himalayan state of Arunachal Pradesh is one of the important centres of species diversity of the family Moraceae.

When compared with the earlier works on the family from the state included in important floras like Flora of British India, Flora of Assam, Material for the flora of Arunachal Pradesh and Flora of Namdapha it has been found that the present work has added a number of interesting aspects of the family. The comparative analysis of the flora is presented below (Table. 5.2.). Although the total figure for recorded species under the family in the previous state flora found almost similar with the present work, the record of 60 species in the earlier work is due to treatment of many synonyms as independent species. Seven synonyms of *Ficus* and one species of *Cudrania* which is synonym of *Maclura* were treated as distinct species. Moreover the *Aboriella myriantha* which is under Urticaceae have been included under Moraceae.

**Table: 5.2.** Comparative analysis of major flora for Moraceous species reported from Arunachal Pradesh

<table>
<thead>
<tr>
<th>Name of the Genus</th>
<th>Present investigation</th>
<th>Flora of British India</th>
<th>Flora of Assam</th>
<th>Flora of Namdapha</th>
<th>Material for the flora of Arunachal Pradesh</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aboriella</em> (Under Urticaceae)</td>
<td>Not included</td>
<td>Not found</td>
<td>Not found</td>
<td>Not found</td>
<td>1 species (as Moraceae)</td>
</tr>
<tr>
<td><em>Broussonetia</em></td>
<td>2</td>
<td>1 species</td>
<td>1</td>
<td>Not found</td>
<td>2</td>
</tr>
<tr>
<td><em>Cudrania</em> (Synonym of <em>Maclura</em>)</td>
<td>Nil</td>
<td>1</td>
<td>Nil</td>
<td>Nil</td>
<td>1</td>
</tr>
<tr>
<td><em>Artocarpus</em></td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><em>Ficus</em></td>
<td>51*</td>
<td>28**</td>
<td>16</td>
<td>19</td>
<td>51***</td>
</tr>
<tr>
<td><em>Maclura</em></td>
<td>2</td>
<td>Nil</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><em>Morus</em></td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>Nil</td>
<td>3</td>
</tr>
<tr>
<td><em>Streblus</em></td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Not reported</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>33</td>
<td>23</td>
<td>22</td>
<td>64 (7 eroneous)</td>
</tr>
</tbody>
</table>
* out of the 51, 6 species are new record to the state.
** including the species indicated as Tropical Himalaya, Eastern Himalaya etc.
*** out of the 51 species 5 species are found erroneous as synonyms are treated independent.

The species recorded from the state in the present study include 6 new records for the state, 1 new record to India and 3 commonly cultivated species of which *Ficus conglobata* and *F. hookeriana* is found as a least reported and rarely known species. One rare variety of *Morus* species i.e. *M. macroura*. var. *laxiflora* Upadhyay et. Ansari (2010) is also reported in the present study. The two species *Ficus variegata*, *F. racemosa* and *Streblus asper* which are found to be widely distributed, were not reported from the state. The record of *Streblus asper* is also a new addition of the genus to the state flora. *Ficus pumila* originally an exotic species is now found a very common and naturalized one particularly in urban areas. Similarly *Ficus religiosa* and *F. rumphii* are although recognized as cultivated species are also found in wild. *Ficus geocarpa* a Malayan species is reported here for the first time and is a new record for India. Some of the interesting records of the state made during the studies are as follows.

<table>
<thead>
<tr>
<th>New records for the State</th>
<th>New record for India</th>
<th>Cultivated but naturalized</th>
<th>Rare species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ficus conglobata</em></td>
<td><em>Ficus geocarpa</em></td>
<td><em>Ficus religiosa</em></td>
<td><em>Morus macroura</em>. var. <em>laxiflora</em>.</td>
</tr>
<tr>
<td><em>Ficus pumila</em></td>
<td></td>
<td><em>Ficus pumila</em></td>
<td><em>F. conglobata</em></td>
</tr>
<tr>
<td><em>Ficus racemosa</em></td>
<td></td>
<td><em>Ficus rumphii</em></td>
<td><em>F. hookeriana</em></td>
</tr>
<tr>
<td><em>Ficus variegata</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Streblus asper</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The major part of the present thesis is the taxonomic enumeration and description of species. All the species are enumerated as per recent classification (Wu *et al.*, 2003, Berg, 2005 and Berg *et al.*, 2011). In the enumeration, key is provided for genera, subgenera and for the species. These keys are of indented type, designated using some suitable characters that may be easy for field identification. The construction of key in the present work is mostly based on the work of King (1888), Corner (1962), Kanjilal *et al.*, (1940) and Berg *et al.*, (2011.) with modification and additions of suitable characters. Full citation for each species has
been provided following various taxonomic publications. Following citation full description of each species has been made with details of characters of leaves, stipules, inflorescence, microscopic flowers and phenophases. The description is followed by notes on distribution, ecology, specimen examined during the present work and additional specimen examined which was collected previously from different parts of the country especially from the northeastern region and housed in APFH, ARUN, ASSAM, CAL and LWG. The complete distributional feature specifying the major centres of distribution in the region and around the world are also included which is an additional feature of the present work.

One of the significant aspects of the present study is the evaluation of microscopic floral characters which were neglected in most of the earlier works. Most of the earlier works on the family especially for the genus *Ficus* from the country are silent on the floral characters particularly on staminate and pistillate flowers. The nature of the male and female flower with the hairy parianths have been characterized and illustrated for most of the species. The morphology of inflorescence is found to be very useful to differentiate the species and can be used as key characters. However the floral characters are not found so suitable for field identification because of microscopic nature and limited variation. Collection of large number of species with complete distributional records, detailed taxonomic enumeration and characterization supported through suitable key have not been found in any of the taxonomic work from the region. Hence the present work assume greater significance in understanding the diversity and taxonomy of the family in the region.

Besides the key and characterization of species, another important aspect of the present study is the examination of nomenclatural anomalies for inclusion of correct name of all the species through consultation of some of the recent publications. The name appeared in recent taxonomic work of Wu *et al.*, (2003), Berg *et al.*, (2011) and Chaudhery *et al.*, (2012) are followed here with verification and confirmation through International Plant Name Index (IPNI) available at website
The examination of nomenclature reveals that number of synonyms were treated as distinct taxa in the earlier works. The name *Cudrania cochinchinensis* which is a synonym of *Maclura cochinchinensis* was treated as a distinct species. In the same way, the name *Ficus roxburghii* Wall. ex King, is a synonym of *F. auriculata*, *Ficus laevis* var. *assamica* (Miq.)Miq., is synonym of *F. laevis*, *Ficus xiphas* C.E.C. Fischer. is synonym of *F. filicauda* and *F. neriifolia* J. E. Sm. var. *nemoralis* (Wall. ex Miq.) Corner and *F. neriifolia* J. E. Sm. var. *fieldingii* (Miq.) Corner the synonym of *F. neriifolia* are treated as distinct species leading to large taxonomic confusion. This has erroneously increased the number of species in earlier works. In many earlier publications (Haridasan and Rao, 1987; Kanjilal et al., 1940) *Morus alba* L. and *M. australis* Poir are differentiated and treated separately based upon the length of the style. However recently *M. australis* Poir is merged as a synonym of *M. alba* as the weak difference of the style between the two species can not be used to treat the two taxa separately (Berg et al., 2011). The species *Aboriella myriantha* (Dunn) Bennet included earlier under Moraceae family is now placed under Urticaceae (Wu et al., 2003 and Berg et al., 2006). The names that are verified and confirmed as synonyms based on the literature in the present work are listed in the Table 5.3.

**Table: 5.3.** List of synonyms used as correct names in various floristic works of the region with their present accepted names.

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Correct name (Author)</th>
<th>Synonyms</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td><em>Ficus assamica</em> Miq.</td>
<td><em>Ficus heterophylla</em> var. <em>assamica</em> (Miq.) Corner</td>
</tr>
<tr>
<td>3</td>
<td><em>Ficus auriculata</em> Lour</td>
<td><em>Ficus roxburghii</em> Wall. ex King</td>
</tr>
<tr>
<td>5</td>
<td><em>Ficus gasparrintana</em> Miq. var. <em>laceratifolia</em> (Levl. &amp; Vant.) Corner</td>
<td><em>Ficus bhotanica</em> King</td>
</tr>
<tr>
<td>6</td>
<td><em>Ficus hirta</em> Vahl subsp. <em>triloba</em> (Buch.-Ham. ex Voigt) Chaudhary</td>
<td><em>Ficus hirta var. roxburghii</em> (Miq.) King.</td>
</tr>
<tr>
<td>7</td>
<td><em>Ficus laevis</em> Blume</td>
<td><em>Ficus laevis var. assamica</em> (Miq.) Miq.</td>
</tr>
<tr>
<td>8</td>
<td><em>Ficus lamponga</em> Miq.</td>
<td><em>Ficus lepidosa</em> Wall.</td>
</tr>
</tbody>
</table>
Variation of morphological characters and its taxonomic Use:

Comparative accounts of characters within and between the species are very useful in understanding the range of inter and intraspecific variation that exist in nature. Study of such variation can be employed in solving taxonomic problems and in demarcation of species. The comparative studies of morphological variation including various characters reveal the distinct range of interspecific and intraspecific variation. As the genus *Ficus* has largest numbers of species the comparative morphological variation in the genus has been worked out. As the other genera are represented by one or two species and do not have taxonomic confusion as in the *Ficus* they are not subjected for variation studies. The species of *Ficus* exhibits diversification particularly in relation to habit, leaves, stipules and receptacles.

The variation pattern of the leaves among the species has been found to be most suitable character for the specific determination and grouping of the species, which is used in developing the key of the present study. The shape of the leaves and apex, base, margin, surfaces and lateral veins of the lamina can be successfully employed for taxonomic purposes. King (1887), Corner (1965) and Berg *et al.*, (2011) have also given importance to the leaf characters in their taxonomic treatment. The shape of the leaves variously formed as elliptic oblong, ovate, subobovate and cordate with distinction and variation within the known shape. For example the cordate leaves are represented as deeply cordate as in *F. laevis*, minutely cordate in *F. drupacea* and subcordate in *F. semicordata*. The size of the leaves shows a maximum degree of variations and ranges from 4 cm to 40 cm in length and

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Variants</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td><em>Ficus nerifolia</em> J. E. Sm</td>
<td><em>Ficus nerifolia</em> J. E. Sm. var. nemoralis (Wall. ex Miq.) Corner</td>
</tr>
<tr>
<td>10</td>
<td><em>Ficus sagittata</em> Vahl.</td>
<td><em>F. sagittata</em> Vahl var. oligosperma (Miq.) Corner</td>
</tr>
<tr>
<td>11</td>
<td><em>Ficus tinctoria</em> G. Frost subsp. gibbosa (Blume) Corner</td>
<td><em>Ficus gibbosa</em> Blume.</td>
</tr>
<tr>
<td>13</td>
<td><em>Maclura cochinchinensis</em> (Lour). Corner</td>
<td><em>Cudrania cochinchinensis</em> (Lour) Kudo et Masam</td>
</tr>
<tr>
<td>14</td>
<td><em>Morus alba</em> L.</td>
<td><em>Morus australis</em> Poir.</td>
</tr>
</tbody>
</table>

5.2. Variation of morphological characters and its taxonomic Use:
2 cm to 30 cm in breadth with the smallest leaves in *F. abelii* and largest in *F. auriculata*. Within the subgeneric level such variations of size can successfully be employed in delimitation of species. Another feature of leaves having a clearcut variation is the number of lateral veins. The numbers of veins range from 3-4 pairs in *F. assamica* it is up to 30-40 pairs in *F. elastica*. Stipules are the key identifying characters of the family Moraceae. In the genus *Ficus* although stipules are mostly caducous but when observed in young shoots, they aid in identification of species because of their variations particularly in their size i.e. length. The longest stipule is observed up to 20 cm (*F. elastica*) while in some species it may structured to a minute stipule with 0.3 cm (*F. heterophylla*). When this stipule of two species has similar size they may differ in their glabrous or hirsute nature. For instances *F. auriculata* and *F. conglobata* have almost same size of stipules (1.5-3 cm) but the latter shows hairy while the former have glabrous stipules. The stipules have also been employed as the main basis of grouping by many workers like Prain (1903), Kanjilal *et al.* (1940), Grierson & Long (1983), etc.

The fig is the major dominating identifying character of the genus *Ficus*. Various characters of the inflorescence have been found to be very significant in specific determination. Particularly they exhibit clearcut variations in their position, shape, size and mature color. Although in majority of species the position is axillary, occurrence of figs on stem (cauliflorus) older trunk and in stolon is found in many species. The size mostly ranges from 1-2 cm in diam but in species like *F. pumila*, *F. auriculata*, *F. hirta* and *F. racemosa* bigger figs with 3-6 cm in diam. are found. In *F. cyrtophylla*, *F. elastica*, *F. filicauda*, *F. gasparriniana*, *F. heteropleura*, *F. langkokensis*, *F. nerifolia*, *F. religiosa*, *F. rigida*, etc. the figs are minute with less then 1 cm diam.. Again when the size of the fig overlaps the length of peduncle and mature color can be used for differentiation. The fruit may be sessile in some species or when pedunculate the peduncle ranges from 0.5 (*F. elastica*) to 6 cm (*F. auriculata*) in length. The ripe color is ether black, yellow, purple, orange or red. For instance *F. geniculata* can be distinguished with its black fruits while *F. heterophylla* and *F. semicordata* for their bright red fruit. At the same time the two
species with red fruit show variation in their position as in the former the figs are axillary while in the later they are in stolon. The present study confirmed that if the figs or receptacle are examined properly, can serve as the best character for differentiation of species.

The application of flower character in species differentiation is a challenging task because of the minute flowers arranged within the receptacles. Particularly in the species with minute receptacle it is never been easy to find out the very minute aehlamydous unisexual flowers. In the present study the flowers are dissected out and observed carefully to examine the structural features and variations. Structuraly occurrence of numerous female and gall flower with long style and a few male flowers have been found. However the number of male flowers are very limited and when observed found to be less then 10 in number. No significant variations among the flowers in relation to ovary and style in female flowers and anther in male flowers have been observed. Most of the subgenera Urostigma and Pharmcosycea other subgenera are dioecious. In the dioecious plant the female receptacle with long style flowers is the most common one while the male receptacle with long styled flower is very difficult to come across.

Present study revealed that the characters like shape and size of the leaves; length of the petiole, number of lateral veins and the size and texture of stipules show good variation among the taxa and can be used for specific determination in the absence of inflorescence, flower and fruits. Moreover the four distinct types of habit of the species of the region is another useful character for grouping. The genus can be divided into hemiepiphytic and medium size trees (17 taxa each), shrubs (7), climbers or scadent (6) and three large tree based on the diverse forms of the habit. As all these characters are easily observable in the field as they are more helpful in the field identification of the taxa than the microscopic floral attributes.

Besides the interspecific variations very distinct itraspecific variations have been observed in some species even when it is collected from similar climatic conditions. Species like F. semicordata, F. racemosa and F. oligodon exhibit
remarkable intra-specific variation in leaves, stipules and receptacles and this variation can be used to raise a new taxonomic intraspecific rank like new variety, subspecies or even to create a new species.

From the critical observation and comparison of morphology of the genus *Ficus*, it is highlighted that particularly the characters found taxonomically more significant in delimitation of various species are as follows.

I. Leaf (shape, size and veins) II. Stipule (size) and III. Receptacle (Position, size, colour and nature)

**5. 3. Distribution and phytosociology**

Moraceous species have been reported to occur in tropical and subtropical regions of the world. The vegetational zones in the state comprise all the type of forest with domination of both tropical and subtropical forests. The study of the distribution of the species reveals that the species of Moraceae commonly grow in these forests. As per the earlier distributional records from north east India (Hooker, 1888; Kanjilal, *et al.*, 1940; Haridasan and Rao, 1987; Giri *et al.*, 2008) Moraceae members are found to be distributed mostly upto an elevation of 2000 m except few exception. However in the present investigation, the distribution of a few species like *Ficus filicauda, F. nerifolia* and *F. hookeriana* are recorded beyond 2000 m. upto an elevation of 2700 m. In general majority of the species are found to occur below 1500 m with major concentration between 100-1000 m. Habitat wise the species are found to be abundant in the peripheral zones of the forest along the rivers and rivulets and in degraded land and nearby human habitats. It is found that they prefer secondary and degraded forests land for their growth. In comparison to the *Ficus* species, the species of *Artocarpus, Morus* and *Broussonetia* also show good population in dense canopy of the forests. A few species like *F. semicordata, F. drupacea* var. *pubescens* grow luxuriantly in the hill slopes. The observation of number of the species show that majority of the species are found with scattered population with few showing good sizeable population with high density. Species like *Ficus conglobata, F. hookeriana, F. prostrata, Morus macroura* are seen having
only one or two individuals in a locality whereas species like *F. semicordata*, *F. cyrtophylla* and *F. subincisa* formed dense population.

The species are found commonly throughout the state in almost all the forest types. The district wise survey of the species reveals that Tirap, Papumpare and Lohit exhibit the maximum concentration of the species where the occurrence of more than 30 species has been reported. Among the studied districts the Lower-Subansiri and East Kameng represent the lowest number of species less than 15 each. A simple statistical figure of the species located in different districts with the dominant species of the districts is presented in the following table. (Table 5.4) and (Fig. 5.1.)

**Table : 5.4.** District wise distribution of Moraceous species in Arunachal Pradesh.

<table>
<thead>
<tr>
<th>District</th>
<th>No. species</th>
<th>* % of occurrence</th>
<th>Dominant species</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Kameng</td>
<td>20</td>
<td>38.46</td>
<td><em>F. semicordata</em> and <em>F. subincisa</em></td>
</tr>
<tr>
<td>East Kameng</td>
<td>11</td>
<td>21.15</td>
<td><em>A. chaplasha</em> and <em>F. auriculata</em></td>
</tr>
<tr>
<td>Papumpare</td>
<td>33</td>
<td>63.46</td>
<td><em>F. heteropleura</em> and <em>F. nervosa</em></td>
</tr>
<tr>
<td>Lower Subansiri</td>
<td>12</td>
<td>23.08</td>
<td><em>F. auriculata</em> and <em>F. semicordata</em></td>
</tr>
<tr>
<td>West Siang</td>
<td>19</td>
<td>36.54</td>
<td><em>F. semicordata</em> and <em>F. cyrtophylla</em></td>
</tr>
<tr>
<td>Lower Dibang Valley</td>
<td>15</td>
<td>28.85</td>
<td><em>F. oligodon</em> and <em>F. auriculata</em></td>
</tr>
<tr>
<td>Tirap</td>
<td>36</td>
<td>69.23</td>
<td><em>F. langkokensis</em> and <em>F. lamponga</em></td>
</tr>
<tr>
<td>Changlang</td>
<td>13</td>
<td>25.00</td>
<td><em>F. hirta</em> and <em>F. fistulosa</em></td>
</tr>
<tr>
<td>Lohit</td>
<td>30</td>
<td>57.69</td>
<td><em>F. geniculata</em> and <em>F. variegata</em></td>
</tr>
<tr>
<td>East Siang</td>
<td>24</td>
<td>46.15</td>
<td><em>F. squamosa</em> and <em>F. ischnopoda</em></td>
</tr>
<tr>
<td>Upper Siang</td>
<td>13</td>
<td>25.00</td>
<td><em>F. auriculata</em> and <em>F. filicauda</em></td>
</tr>
</tbody>
</table>

*Only the 52 species collected in the present study are considered.*
As per present survey and studies on status distribution, the species like *Ficus conglobata*, *F. prostrata* and *Streblus asper* are the rarest one, while the *Artocarpus chama*, *A. heterophyllus*, *A. lacucha*, *Ficus altissima*, *F. auriculata*, *F. hirta*, *F. hispida*, *F. tinctoria* sub sp *gibbosa*, *F. semicordata* and *F. religiosa* are common throughout the state.

To understand the population structure of the species two forest stands have been selected with higher diversity of Moraceous species one in Denim reserve forest of Lohit district and in other is Tewai forest of Tirap district. The detailed phytosociological studies have been conducted in these two selected forest stand with calculation of the frequency, density, IVI etc. Altogether 185 species under 73 families were recorded in Tewai forests stands while 141 species under 63 families were recorded in Denim reserve forest stands. The species richness index was found high in Tewai forest stand with 3.156 while in Denim reserve stand it was 2.77 representing 25 and 15 species of Moraceae respectively. In stand I the higher frequency, density and IVI are represented by *Ficus* species while in stand II it is represented by *Artocarpus* species. The two *Artocarpus* species (*A. chama* and *A. lacucha*) that are represented in both the stand show higher frequency and density of distribution in stand II (IVI >6) than stand I (IVI <5). However the overall density and frequency of distribution is found to be higher in stand II. The stand I i.e Tewai

![District wise distribution of the Moraceous species in Arunachal Pradesh](image-url)
forest is a secondary forest and is a community reserve forest while the stand II i.e. Denim Reserve forest is a primary forest. The result of the community analysis reveals that the species diversity and density of population of Moraceae members are higher indicating their preference in secondary forests. The luxuriant growth of species under both the genera *Ficus* and *Artocarpus* are found in the secondary forests.

The phytogeographical affinities of the species show that, distribution of most of the species of the region are commonly found in other parts of the North East region (including Sikkim), its adjacent countries like Bhutan, China, Nepal, Myanmar, Bangladesh as well as in Southern India and Western Himalaya. Most of these are found to have extended their distribution to Indo-China or Indo-Malayan region. It is interesting to note that except *M. macroura* var. *laxiflora* which is endemic to the state almost all the species occurring in Arunachal Pradesh are also found in Indo-Malayan and Indo-China region including the countries China, Bhutan, Nepal, Malaysia, Thailand, Vietnam etc. This indicates that more then 90% of the species found in the state are distributed in Indo Malayan region including China. However a few specis like *Ficus conglobata*, *F. cyrtophylla*, *F. filicauda* *F. gasparriniana* var. *laceratifolia*, *F. pubigera* var. *maliformis* are found to be endemic to greater Eastern Himalaya including Myanmar and Bangladesh. A few species like *Ficus benjamina*, *F. racemosa*, *F. virens*, *Maclura cochinchinensis*, *Artocarpus heterophyllus* have extended their distribution to Australia representing about 10% of species having wider distribution representing Indo –Malaya to Australian region.

The study of detailed distributional status of each species in the state shows that a number of species have gained the status of endangerment in the state due to continuous and alarmingly rate of forest exploitation because of the population pressure and urbanization. It is found that the species *Ficus conglobata*, *F. hookeriana* and *F. geocarpa* are the highly threatened species with very limited distribution and population. Of these three species *Ficus conglobata* is recorded here as new to India described and reported from in Malaysia only and the others are of
rare occurrence. The habitats are already disturbed and the species can become extinct from the nature at any time and thus qualify to be included in the Red Data Book. However no *Ficus* species have been listed in Indian Red Data Book (Nayar and Sastry, 1987, 1988 and 1990). Development of an early action plan, to evolve appropriate measures to conserve the valuable *Ficus* wealth of the region is the need of the hour.

Of the total ca.140 species that are reported from India, occurrence of about 70 species is assumed presently from the north east India (Chaudhary *et al.*, 2012). Out of the 70 species, occurrence of minimum of 60 species (80%) are confirmed by the present study. Besides Arunachal Pradesh, Assam and Meghalaya are the two other Northeastern states that have more concentration of the species.

5.4. Socio-economic importance and ethnobotany

The rich species diversity of the Moraceae is found to be well and strongly associated with the rich culture and tradition of local tribal communities. Although the uses of some species like jack fruit and mulberry plants have been well known, the present study reveals that many wild growing species of Moraceae are used by the people in different ways. Total 43 species have been found useful to the communities for various purposes. In the present investigation, it is established that besides the commercially well known species like *Artocarpus heterophyllus* (Jackfruit), *A. chaplasha* and *Morus alba* (Mulberry), some other wild species like *Artocarpus lacucha, Ficus semicordata, F. auriculata, F. hirta* and *Morus macroura* are also found useful for timber and wild-edible fruit. 43 species are used for fodder, fuelwood, edible plants as fruit and vegetable, timber and as medicine. Besides, the species are also used for sericulture, gum, fishing, etc. It is also observed that 10 species are treated as sacred trees. The pattern of use with the number of species used is presented below (Fig. 5.2). Among these 15 species are also found commonly in avenue plantation and other plantations. *Ficus semicordata* and *F. auriculata* are mostly used as wild edible fruit in almost all tribal communities of the state. *Morus macroura* is one of the best timber species in the Northeast India as well as in the state and the same is used as important ethnomedicinal plant. The bark is used to
treat cough, wheezing, eczema, and to promote urination. It is also used to treat fever, headache and red dry and sore eyes. The bark of *Artocarpus lacucha* is commonly used as masticatory by the local people.

<table>
<thead>
<tr>
<th>Different utilization pattern of Moraceae family in Arunachal Pradesh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edible Fruit</td>
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<tr>
<td>13</td>
</tr>
</tbody>
</table>

**Fig. 5.2.** Bar diagram of different utilization pattern of the family Moraceae.

*Ficus* is the most popular of bonsai trees grown as indoor bonsai and are popular for their ability to tolerate freezing temperatures. There are many fig species of *Ficus* that can be grown as bonsai trees and nearly any fig species with relatively small leaves can be used to grow a *Ficus* bonsai from a cutting or seedling. The species like *Ficus virens*, *F. curtipes*, *F. altissima*, *F. drupacea*, *F. maclellandii* var. *rhododendrifolia*, *F. elastica*, etc. are very commonly grown in the region because of their socio-economic relation. An can be used for bonai.

*Ficus* group is associated with cultural belief of the local tribal people. It is believed that the plant is associated with God and Goddesses and its leaves form integral part of ritual and cultural performances. *Ficus* species particularly the tree with huge hanging prop roots are specially treated as a sacred plants and it is believed that the plants save communities from any unexpected difficulties and from enemies. During hunting period the hunters take rest under such trees with a belief that the tree will protect them from evil spirit. Traditionally fig trees are not felled. If it is to be felled because of its unfavorable influence on the surrounding settlement and agriculture a traditional ritual is performed before felling the tree to ward off the terrible evil that may be fall on the people who cut the tree. Tribes like Digaru
Mishimi, Nyshi, Adi, Galo believe the *Ficus* species as home of God or Ghost and believe that the species may harm if they do harm to the plants and protect the communities if they take care of the plants. Total 10 such species of *Ficus* having religious importance with respect to traditional belief and taboos have been recorded.

Such traditional associates of the Moraceae species with the local communities as well as the ethnobotanical values contributed significantly in the conservation of the species in both in-situ and ex-situ conditions. The local communities of the state have shown a good example of biodiversity conservation based on the local and traditional belief and association. Overall it has been found that the rich diversity of Moraceous species has also a strong link with the cultural and traditional background of the local community of the state where more than 60% species are found useful in various ways. All these species are being used from food to furniture including medicine, religious, bonsai, etc. The conservation effort of local communities deserves support from the government and non-governmental organizations.