A study on diversity and distribution of *Ficus* L. (Dicotyledonae: Moraceae) species at Forest Research Institute (FRI), Dehradun (Uttarakhand), India

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INTRODUCTION

Plants are known as producers and important for reduction of pollution level. These are also a foremost source of energy by trapping solar radiations to convert in to chemical energy in their photosynthesis activity. Linnaeus (1753) proposed the genus *Ficus* for the first time. The Latin word *Ficus* is derived from the Indian
The genus is distributed throughout the world primarily in subtropical and tropical regions (Berg and Corner, 2005). Around 511 of these are occurring in Indo-Australian region (Asia, Malaysia, Pacific Island and Australia) and approximately 132 species in Neotropical region (Central and South America) (Berg, 2003; Berg and Corner, 2005; Kumar et al., 2018). In India, the Banyan tree (F. benghalensis) is being cultivated as an avenue tree along roadsides for generations. The different species of Ficus are known for their pharmacological and ethnomedicinal properties and used in modern medicine and pharmaceutical applications (Adebayo et al., 2009; Abdulla et al., 2010; Sharma et al., 2016). F. racemosa applied profoundly for the treatment of wound healing and skin cancer (Lalla, 2005; Singh et al., 2019). The fruit extracts of F. benjamina, F. benghalensis and F. religiosa have significant antimicrobial and antibacterial activities (Mousa et al., 1994; Sharma et al., 2016; Singh et al., 2020a,b,c). The aqueous extract of fruit and bark (F. religiosa) possess potent antihistaminic effect includes parasitic round worm Aecidia galli, etc. (Tiwari et al., 2014; Upadhyay, 2016a,b,c; Tiwari and Talreja, 2020). The ethnomedicinal significance of trees, shrubs and climbers was also evaluated and reported yesteryears investigation by different schools (Aggarwal et al., 2020; Devi et al., 2020; Sharma et al., 2020; Singh et al., 2019; Singh et al., 2020c,d,e).

The first systematic account of the Indian Ficus L. is available in King (1887, 1888) and recorded 113 species and 47 infra-specific taxa from whole British India. Only 75 species and 16 infra-specific taxa were reported from the present political boundary of India. However, till date no separate account of the Indian species of Ficus except some scattered works (Rani 1985; Shree Kumar, 1998; Priyadarsana, 1999; Kumar et al., 2011; Chaudhary et al., 2012). Therefore, the present study was designed to carry out phytodiversity and distribution of Ficus L. in the Forest Research Institute (FRI) campus, Dehradun (Uttarakhand), India on the basis of significant morphotaxometric assessment including tree habits, leaves shape, leaves size, fruiting positions etc. The socioeconomic and ethnomedicinal values of the recorded 16 species were documented as well during this investigation.

**MATERIALS AND METHODS**

**Site of investigation**

Present study on the phytodiversity and distribution of Ficus L. (Dicotyledoneae: Moraceae) based on the scientific survey done at Forest Research Institute (FRI), Dehradun (Uttarakhand), India (Fig. 1). The vegetation is deciduous and evergreen spread over more than 1100 acre noncultivated sub-valley circumference of campus and presently known as New Forest.

**Geolocation and area of site**

It is situated between N30°20’31.56” Latitude and Longitude E77°59’50.28” having expansion stretch up to 4.45 km². The climate is marked by hot summer, well distributed rainfall [7.7mm–868.4mm (360± 109.6mm)] during South-West Monsoons and cold winter with small amount of winter rain.

**Survey and study of phytodiversity**

The overall campus thoroughly surveyed viz. Beeson Road, Canning Road, Chaturvedi Road, Circular Road, Parker Road, Takle Road, Hospital Road, Howard Road, Tierman Road, Lace Road, Teak Road, Trevor Road, Troop Road, Shalich Road, Rao Road, Hart Road, Mason Road, and Wilmot Road after onsite in situ morphological examination followed by validation of the taxonomic position through comparative analysis using available keys and herbarium to the plant taxonomy housed in Systematic Botany Discipline, FRI, Dehradun. The wild as well as cultivated plant species of the family have been considered for study as the vegetation of this campus is mostly planted. Under each species, the complete citation, synonyms, short description, phenology, common name and English name and economic importance of every species have been provided (Table 1).

**RESULTS**

The findings of the present study done in New Forest campus of Dehradun indicated the campus abundant of...
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Ficus species wild and planted. Out of 16 species, it was found that Ficus racemosa, F. auriculata, F. pomifera, F. rumphii, F. palmata var. vigrata, F. benghalensis, F. hispida, F. virens and F. religiosa mostly growing as a wild population. On contrary F. drupacea, F. pumila, F. benjamina, F. elastica, F. krishnae, F. retusa and F. semicordata are planted as avenue plantation (Figs. 2,3; Table 1). Out of studied species, one species was found as straggler shrubs (F. pumila) and the remaining species were small tree to big free standing trees. During investigation, several figs were good examples of parasitism as strangler (F. benghalensis, F. religiosa, F. virens, F. racemosa, F. benjamina, F. rumphii).
| S.N. | Botanical Name | Common Name | Location | Taxonomic Feature | Leaf Size (cm) | Leaf Shape | Leaf Margin | Leaf Apex | Fig Position | Fig Size (mm) | Bark Colour |
|------|----------------|-------------|----------|------------------|----------------|------------|-------------|-----------|--------------|---------------|-------------|
| 1    | *F. racemosa*  | Gular       | Botanical Garden, Hart road, Rao road, Hill road, IMA road | Tree             | 10-14 x 5-4.5  | Ovate      | Entire      | Acuminate | Stem         | 2-2.5         | Grayish Brown |
| 2    | *F. pumila*    | Creeping fig | Botanical Garden, Near bungalow no. 9, In front of Officers Rest House | Climber          | 5-12 x 2.5-4   | Ovate      | Entire      | Acuminate | Axillary     | 0.5-1         | Gray         |
| 3    | *F. auriculata*| Fagoora, Timila | Silviculture Nursery (Rao road) | Shrub            | 15-30 x 15-27 | Round      | Obtuse, Acute, Pinnate | Acuminate | Axillary | 0.3-0.6       | Grayish brown, rough |
| 4    | *F. religiosa* | Pipal       | In front of DFE, Botanical Garden, Deemed University, IMA road, Hill road, Pearson road, Rao road, | Tree             | 10-18 x 8-10  | Ovate      | Entire      | Acute     | Axillary | 1.5-2         | Grey         |
| 5    | *F. krishnae*  | Makhan katori Bargad | Botanical Garden | Tree             | 25-27 x 7-10  | Elliptic, Cup | Entire      | Acute     | Axillary | 1-2.5         | Pale Grey |
| 6    | *F. benghalensis* | Trevor road | Trevor road, Hill road, Pearson road | Tree             | 18-20 x 8-15  | Ovate      | Entire      | Mucronate | Axillary | 1-2.5         | Greyish White |
| 7    | *F. virens*    | Pakhad      | Botanical Garden, IGNFA stadium gate, Blashcheck road, Systematic Botany Discipline, Botanical Garden, Rosewood hostel | Tree             | 10-20 x 4-7   | Elliptic    | Entire      | Acuminate | Axillary | 0.7-1.2      | Grey         |
| 8    | *F. elastica*  | Rubber plant Paras pepar | Botanical Garden, Rosewood hostel | Tree             | 8-30 x 7-10   | Elliptic    | Entire      | Acute     | Axillary | 0.5-1         | Pale Grey |
| 9    | *F. drupacea*  | Gobra, Kthgular | Botanical Garden | Tree             | 15-18 x 5-9   | Elliptic    | Entire      | Acuminate | Axillary | 1.5-2         | Grayish-White |
| 10   | *F. hispida*   | Gobra, Kthgular | Near silviculture nursery, Rao road, | Shrub            | 10-25 x 5-10  | Elliptic    | Entire      | Acuminate | Axillary | 1.2-3         | Dark grey |
| 11   | *F. semicordata* | Khinwa  | Silviculture Nursery | Tree             | 16-22 x 5-9   | Elliptic    | Entire      | Acuminate | Axillary | 0.8-1         | Dark Brown |
| 12   | *F. palmata*   | Abjiri, Bedu Pilkhan | Silviculture Nursery, Botanical Garden wild in different place | Tree             | 6-13 x 6-11   | Natate      | Entire      | Mucronate | Axillary | 1-1.5         | Pale brown |
| 13   | *F. rumphii*   | Kamanup     | Botanical Garden, DFE gate, Hart road, Chaturvedi road | Tree             | 4-8 x 3-4     | Elliptic    | Entire      | Acuminate | Axillary | 1.5-2         | Grey         |
| 14   | *F. retusa*    | Kamanup     | FRI main building ground, Hart road | Tree             | 4-12 x 2-6    | Elliptic    | Entire      | Acuminate | Axillary | 0.8-2         | Grey to greyish white, smooth |
| 15   | *F. benjamina* | Pukar       | FRI main building gate, Boundary SFS College, Rao road, | Tree             | 4-12 x 2-6    | Elliptic    | Entire      | Acuminate | Axillary | 0.8-2         | Grey to greyish white, smooth |
| 16   | *F. pomifera*  | Giant Indian Fig, Raj dimri | Near Kaulagarh gate | Tree             | 5-14 x 2-7    | Elliptic    | Entire      | Acute     | Axillary | 0.5-1.5       | Brownish grey |
The *Ficus* exhibited and characterized by alternate stipulated leaves (with 'pearl glands' or without 'pearl glands') with distinct stipule and milky latex in all parenchymatous tissues. Cystoliths were very commonly present (especially in the epidermis, variable in size and shape). The 'flowers' of Moraceae are often pseudanthia (reduced inflorescences). The functionally fertile male and female flowers have axillary inflorescences; mostly with the small flowers packed into spikes, in heads or hollow receptacles, on disks etc. with or without involucral bracts and pseudanthial, or nonepseudanthial. Flowers small (reduced); regular; cyclic with monoecious, or dioecious lineages. Fruit fleshy, or non-fleshy; indehiscent; a drupe, or achene like; enclosed in the fleshy receptacle (often, and the inflorescence axis often constituting a common

**Fig. 3.** Phytodiversity of *Ficus* sp.: *F. drupacea* (9), *F. hispida* (10), *F. semicordata* (11), *F. palmata* (12), *F. rumphii* (13), *F. retusa* (14), *F. benjamina* (15), *F. pomifera* (16).

**Fig. 4.** Leaf area, length, breadth and fig size of the different *Ficus* species.
fleshy receptacle), or without fleshy investment external to the original ovary. The drups with one stone and gynoecia of adjoining flowers combined to form a multiple fruits (frequently), or not forming a multiple fruits. The maximum leaf size (30×27cm$^2$) was reported in *F. auriculata*, followed by *F. semicordata* (28×10cm$^2$), *F. benghalensis* (25×11cm$^2$). However, the minimum leaf size was recorded in *F. benjamina* (4×2cm$^2$), and *F. retusa* (4×3cm$^2$) (Figs. 4, 5). Out of 16 species of *Ficus*, 11 species were trees, 3 shrubs and 2 species climbers in nature (Table 1). Out of 16 species, 15 species having axillary fig (Fruit) arrangement and one species with stem position (*F. racemosa*).

DISCUSSION

A large number of works have been carried out either at regional or global levels for the systematics and distribution of *Ficus* L., but the literature on confined locality scares (Corner, 1975, 1981; Kochummen, 1998; Chang and Wu, 1998; Berg, 2001, 2003, 2004, Dixon, 2003; Wu et al., 2003; Berg and Corner, 2005; Berg et al., 2006; Tzeng et al., 2009). The yesteryears studies bringing substantial changes in identification, circumscription, nomenclature, distributional pattern and socioeconomic significance of the of the selected species which corroborated to the current findings at FRI campus (King 1887, 1888; Tzeng et al., 2009; Chaudhary et
Ficus (Moraceae) is arguably one of the most important plant genera in the campus of FRI, Dehradun. The findings reflected 10 wild native species of Ficus L. viz., F. racemosa, F. virens, F. benghalensis, F. auriculata, F. pomifera, F. semicordata, F. palmata subsp. virgata, F. hispida, F. religiosa, F. rumphii and 6 planted exotic species including F. krishnae, F. benjamina, F. retusa, F. pumila, F. drupacea and F. elastica (Molbo et al., 2003; Machado et al., 2005; Kislev et al., 2006; Kumar et al., 2012; Moustafa, 2020; Mustafa et al., 2020).

The plantation of Ficus L. was adequate to dot every road on the FRI campus with at least one species. Plant habits ranged from shrubby pioneers 1 to 2 meters (F. hispida), through small (F. palmata subsp. virgata), to emergent trees (F. religiosa, F. benjamina, F. benghalensis, etc.), climbers (F. hederacea and F. pumila) and hemiepiphytes (F. religiosa, F. virens, F. benjamina, F. racemosa and F. benghalensis). Members of this genus were difficult to distinguish by their flowers but can be differentiated by habit, leaf shape, and their figs (Whistler, 2000). In the present study, the authors found that the largest fig size was 6-8 mm (F. retusa). However, smallest size 0.3-0.6 mm (F. auriculata) was documented (Fig. 6-7). The leaf shape of F. krishnae was cup shaped, which shows the unique feature of the Ficus species and also known as makhankatori.

**Conclusion**

Ficus L. is a keystone species in the ecosystem because its fruit is beneficial for birds, insects and animals. Fruits are nutritious, energetic, healthy and having socio-economic and ethno-medicinal values as well. There are 16 Ficus species recorded from New Forest FRI campus Dehradun. Among them, 10 were native wild species; however, 6 planted non-native species were documented during the present investigation. The current finding is a pioneer study to present a glimpse of such immense species of single genera from the sub-valley area. There are 11 species recorded as trees, 3 shrubs and 2 climbers inhabit. Most of the observed species had axillary fruit arrangement, while one species F. racemosa with stem position. These plants are promising candidates in ethno-pharmaceutical biology to develop and formulate new drugs to future clinical uses. Therefore, more pre-clinical and clinical studies for establishing better quality control methods must be conducted to elucidate the unexplored potential of these plants.

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**Conflict of interest**

The authors declare that they have no conflict of interest.

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