



Mini Forest - An approach to evaluate the adaptability of Western Ghats species for afforestation

Sankara Rao K., Harish R. Bhat, Varsha A. Kulkarni and T. V. Ramachandra ✉

Received: 05.01.2011

Accepted: 15.03.2011

Abstract

Saplings of forty nine species of trees from Western Ghats forests were planted on a 1.5 hectare tract of Deccan plateau (in the campus of Indian Institute of Science, Bangalore) and their performance was monitored for 23 years. The objective was to evaluate their adaptability to a habitat and conditions apparently alien to these species. The study was also meant to understand the linkages of these trees with the surrounding environment. Contrary to the belief that tree species are very sensitive to change of location and conditions, the introduced trees have grown as good as they would do in their native habitat and maintained their phenology. Further, they have grown in perfect harmony with trees native to the location. The results showed that the introduced species are opportunistic and readily acclimatized and grew well overcoming the need for the edaphic and other factors that are believed to be responsible for their endemism. Besides *ex situ* conservation, the creation of miniforest has other accrued ecosystem benefits. For instance, the ground water level has risen and the ambient temperature has come down by two degrees.

Keywords: *Western Ghats, Ecological services, Mini forest*

Introduction

It is general belief that tree species are adapted to such specialized natural conditions that they are unsuitable for translocation, particularly to planting in urban environs. Contrary to this opinion, it has been observed in the present study that trees have a remarkable ability to adapt to change in locations which are totally alien, a fact that was demonstrated by scores of exotic species naturalised and flourishing in parts of the world other than the region of their origin or nativity (Sankara Rao, 2008, 2009, Hanumaiah *et al.*, 1967). There has been an almost continuous process of introduction of alien trees into Karnataka state, especially to Bangalore (Hayavadana Rao, 1930). Within a short time, species such as Paper mulberry (*Broussonetia papyrifera* Vent.), Tabebuias (*T. aurea*, *T. chrysotricha*, *T. impetiginosa*, *T. pallida*, *T. rosea*), Leucaena (*Leucaena latisiliqua* L. Gillis) and some Australian Acacias (*Acacia auriculiformis* Cunn. ex Benth.) have come to dominate Bangalore's tree flora and become the principal cause for a number of native species in the city edging towards local extinction. There is a growing concern that we should be helping to maintain our native woodland

land and in cities which are suffering from a continuous process of attrition, particularly in the urban spaces in the face of modern developments. Flora of India belongs to diverse vegetation types. Virtually it supports every kind of vegetation, tree species, small and big, deciduous and those that remain leafy most part of the year. The species diversity is enormous and as such, there is no dearth for selection of species among these native trees for afforestation and urban greening. There is also the impending danger of climate change, which is likely to affect some of our native tree species and their phenology and thereby effecting further regeneration and continuity of the species, which would result in loss of diversity. It might therefore become necessary to bring different wild indigenous species to other locations and also into city confines where they might have better opportunity to thrive under a watchful eye. With this conservation strategy in mind, creation of miniforest was mooted three decades ago at the Centre for Ecological Sciences (CES), Indian Institute of Science (IISc), Bangalore and tree species of Western Ghats forests were sought to be evaluated for their performance in the Deccan plateau region of which Bangalore is a part. A small vacant space (about 1.5 hectare) that was beset with scrub vegetation opposite to the CES in the campus of Indian Institute of Science was

Author's Address

Energy and Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India
E-mail: cestvr@ces.iisc.ernet.in

chosen for planting tree saplings from the forests of the Western Ghats that came to be known as the miniforest. Saplings (480 no's.) belonging to forty nine species (Table-1) which were raised at the CES Field Station Nursery at Sirsi, Uttara Kannada district were obtained and planted along with few species already existing on the plot with a spacing of 3 x 3 m.



Figure 1: Picture showing the type of terrain on which the miniforest was raised

Table 1: List of tree species in the miniforest

S No.	Tree Species
1	<i>Adenantha pavonina</i> L.
2	<i>Adina cordifolia</i> (Roxb.) Hook.f. ex Brandis
3	<i>Ailanthus triphysa</i> (Dennst.) Alston
4	<i>Albizia amara</i> (Roxb.) Boiv.
5	<i>Alstonia scholaris</i> (L.) R. Br.
6	<i>Areca catechu</i> L.
7	<i>Artocarpus heterophyllus</i> Lam.
8	<i>Artocarpus hirsutus</i> Lam.
9	<i>Artocarpus lacucha</i> Roxb. ex Buch.-Ham.
10	<i>Bambusa arundinacea</i> (Retz.) Willd.
11	<i>Bombax malabaricum</i> DC.
12	<i>Broussonetia luzonica</i> Bureau
13	<i>Butea monosperma</i> (Lam.) Taub.
14	<i>Calamus prasinus</i> Lak. & Renuka
15	<i>Calophyllum apetalum</i> Willd.
16	<i>Calophyllum inophyllum</i> L.

17	<i>Cananga odorata</i> (Lam.) Hook. f. & Thoms.
18	<i>Canarium strictum</i> Roxb.
19	<i>Ceiba pentandra</i> (L.) Gaertn.
20	<i>Chukrasia tabularis</i> A. Juss.
21	<i>Commiphora wightii</i> (Arn.) Bhand.
22	<i>Duabanga grandiflora</i> (Roxb. ex DC.) Walp.
23	<i>Elaeocarpus serratus</i> L.
24	<i>Elaeocarpus tuberculatus</i> Roxb.
25	<i>Entada rheedei</i> Spreng.
26	<i>Ficus benghalensis</i> L.
27	<i>Ficus racemosa</i> L.
28	<i>Garcinia indica</i> (Thouars) Choisy
29	<i>Holigarna grahamii</i> (Wight) Kurz
30	<i>Holigarna arnottiana</i> Hook. f.
31	<i>Hopea ponga</i> (Dennst.) Mabb.
32	<i>Lagerstroemia lanceolata</i> Wall. ex C. B. Clarke
33	<i>Lophopetalum wightianum</i> Arn.
34	<i>Madhuca longifolia</i> (Koenig) Macbr.
35	<i>Mallotus philippensis</i> (Lam.) Muell.-Arg.
36	<i>Mangifera indica</i> L.
37	<i>Memecylon umbellatum</i> Burm. f.
38	<i>Mimusops elengi</i> L.
39	<i>Mitragyna parvifolia</i> (Roxb.) Korth.
40	<i>Pajanelia longifolia</i> (Willd.) K. Schum.
41	<i>Sterculia guttata</i> Roxb. ex DC.
42	<i>Syzygium cumini</i> (L.) Skeels
43	<i>Syzygium laetum</i> (Buch.-Ham.) Gandhi
44	<i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn.
45	<i>Terminalia crenulata</i> Roth
46	<i>Vateria indica</i> L.
47	<i>Vitex altissima</i> L.f.
48	<i>Xylia xylocarpa</i> (Roxb.) Taub.
49	<i>Ziziphus rugosa</i> Lam.

The area encompassing Western Ghats is recognised as one of the most eco-sensitive regions of the world and is one among the 34 biodiversity hotspots on the basis of its species richness (Myers et al., 2000). Western Ghats run along the West

coast of India from the Vindhya-Satpura ranges in the North to the southern tip of the peninsula to a stretch of 6000 km, covering an area of nearly 1, 59,000 sq. km and consist of mountains ranging from 50 m to 2695 m in height. Western Ghats receive an average of 6000 mm of rainfall every year. The vegetation is quite diverse, broadly having evergreen, semi-evergreen, deciduous, scrub forests, sholas, grasslands and bamboo clumps. Factors including sunlight, rainfall, humidity, altitude, topography and location contribute to the uniqueness of this habitat, its animal and plant diversity. Plants such as *Holigarna grahamii* (Wight) Kurz, *Garcinia* sp., *Mitragyna parvifolia* (Roxb.) Korth., *Lophopetalum wightianum* Arn., *Syzygium leatum* (Buch.-Ham.) Gandhi, *Entada rheedei* Spreng., *Calamus prasinus* Lak. & Renuka and the like represent evergreen, semi evergreen and moist deciduous species of the Western Ghats (Pascal and Ramesh, 1987; Pascal, 1988). Outside the habitats in Western Ghats and the unique climatic and edaphic factors therein, these species are not generally found thriving in other plateau regions.

It is observed that in less than 25 years, the experimental plot, now termed 'Miniforest' on account of the limited area, is transformed into a lush green forest on a terrain that was originally a scrub vegetation of the Deccan plateau type with apparently conditions alien to most of the species that have been introduced. The miniforest, in this respect, presented an opportunity to study the adaptations and succession of the Western Ghats forest species (Table-1) in comparison with native species existing in the area. The species composition that emerged in the experimental plot is quite interesting. Majority of them are the Western Ghats species whereas the others, the native to scrub vegetation, both found growing in perfect harmony, in spite of the difference in rainfall (850 mm), humidity, temperature and soil conditions for the former species (Fig.-2). The miniforest trees exhibited normal robust growth, flowered and set fruit as they would do in their native habitat. Some of the trees, for example *Mitragyna parvifolia* (Roxb.) Korth., *Chukrasia tabularis* A. Juss., *Duabanga grandiflora* (Roxb. ex DC.) Walp., *Garcinia indica* (Thouars) Choisy, *Holigarna grahamii* (Wight) Kurz, *Lophopetalum*

wightianum Arn. and *Syzygium laetum* (Buch.-Ham.) Gandhi (Fig.-3) have grown as well as they would do in the evergreen forests.



Figure 2: A view of Miniforest

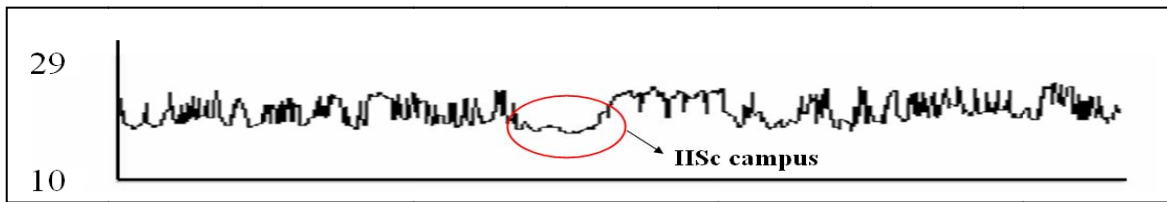
A gigantic liana *Entada rheedei* Spreng., that was not known to grow outside the moist forests has thrived very well and spread prolifically to nearby areas (Maheshwari *et al.*, 2009) and flowered since 2001 (Fig.-3). *Calamus prasinus* Lak. & Renuka, being a rattan, which is rarely reported to survive in drier tracts, has also grown considerably well exhibiting normal flowering (Bhat, 2003). These observations provide evidence that most of the trees of the Western Ghats forests are opportunistic and grow under factors largely different from those believed to be responsible for their endemism. A microclimate prevails in the plot, the miniforest. There is a slight dip in temperature, an increase in humidity and humus enrichment on account of the survival of many moist evergreen species and their good canopy cover. The miniforest plot is kept undisturbed. Progressively, the area developed rich micro- and macro-fauna, from insects, frogs, snakes to birds and smaller mammals like the most elusive Slender Loris. Smaller plants such as mosses, algae, fungi, ferns, herbaceous plants and climbers have grown well adapting to the change. The entire plot is amazingly transformed into the type of a habitat that prevails in the moist forests of Western Ghats. Other ecological benefits have resulted from creating the miniforest. Temperature profile analysis through the computation of Land Surface Temperature (LST) using LANDSAT ETM thermal regions (Fig. 4). The water table at this location was



Figure 3: A gigantic liana *Entada rheedei* Spreng. (with fruits)

in the range of 60-70 m depth before creating the miniforest. Present monitoring of water table has showed that the level of water is at about 3 to 3.5 m below the ground. This indicates that land cover dynamics play a decisive role in recharging the groundwater sources. Four families of Slender Loris (*Loris tardigradus*) inhabiting here is an indication of total wilderness prevailing in the miniforest, further confirming the ecological richness of the habitat.

Figure 4: Temperature profile of IISc campus (Transect passing through miniforest)



Syzygium laetum (Buch.-Ham.) Gandhi



Lophopetalum wightianum Arn.



Holigarna arnottiana Hook. f. (Fruiting)



Garcinia indica (Thouars) Choisy (Fruiting)

Figure 5: Evergreen species of miniforest

The results have further showed that the experiment of the miniforest can be replicated to create such green pockets in and around other urban spaces. This kind of green patch not only can be an arboretum for evergreen tree species but also serves as a home for several refuge fauna and adaptable

species. The patch will also serve as an efficient carbon sink, trapping free carbon in the atmosphere, bringing the temperature to less than a degree, thus helping in mitigating climate change issues. Similar experiments also can be valuable in establishing germplasm banks to offset any loss of species in the wild due to climate change and other factors.

Acknowledgement

Authors are grateful to the Ministry of Environment and Forests, Government of India and Indian Institute of Science for the sustained financial and infrastructure support. We thank Dr. D. M. Bhat, CES Research Station at Sirsi for providing saplings and Mr. Venkatiah and Ms. Venkatalakshmi who helped us during the initial stages in the regular upkeep of the arboretum. Mr. Raghavendra Rao, Mr. Venkatappa, Mr. Manjunath and Mr. Murugesachar voluntarily helped in fencing the area and also for regular monitoring.

References

Gopalakrishna, Bhat, K., 2003. *Flora of Udupi*, Indian Naturalist (Regd.), Inchara, Chitpady, Udupi,

Hanumaiah, L., Aiyappa, K. M., Rajanna, B., Marigowda, M. H., Devaiah, S. T. and Krishnappa, K. T., 1967. *Horticulture in Mysore State*, Department of Horticulture, Lal-Bagh, Bangalore,

Hayavadana, Rao, C., 1930. *Mysore Gazetteer*, Vol. V, Government Press, Bangalore, 5-9.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403, 853–858.

Pascal, J.P., 1988. *Wet evergreen forests of the Western Ghats of India: Ecology, structure, floristic composition and succession*, Institute Francais de Pondichery, India,.

Pascal J.P. and Ramesh B.R. 1987. *A field key to the trees and lianas of the evergreen forests of the Western Ghats (India)*, Institut Francais de Pondichery, India,.

Ramesh, Maheshwari, K. Sankara, Rao and Ramachandra, T. V., 2009. Structural characteristics of a giant tropical liana and its mode of canopy spread in an aerial environment, *Curr. Sci.* 96 (1) 58-64,

Sankara, Rao, K., 2008. *IISc Campus: A Botanist Rs Delight*, IISc Press, Bangalore,

Sankara, Rao, K., 2009. *Flowering Plants of Indian Institute of Science: A Field Guide*, Vol. I & II, IISc Press, Bangalore.

