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THE RIDDLE OF SHOLA

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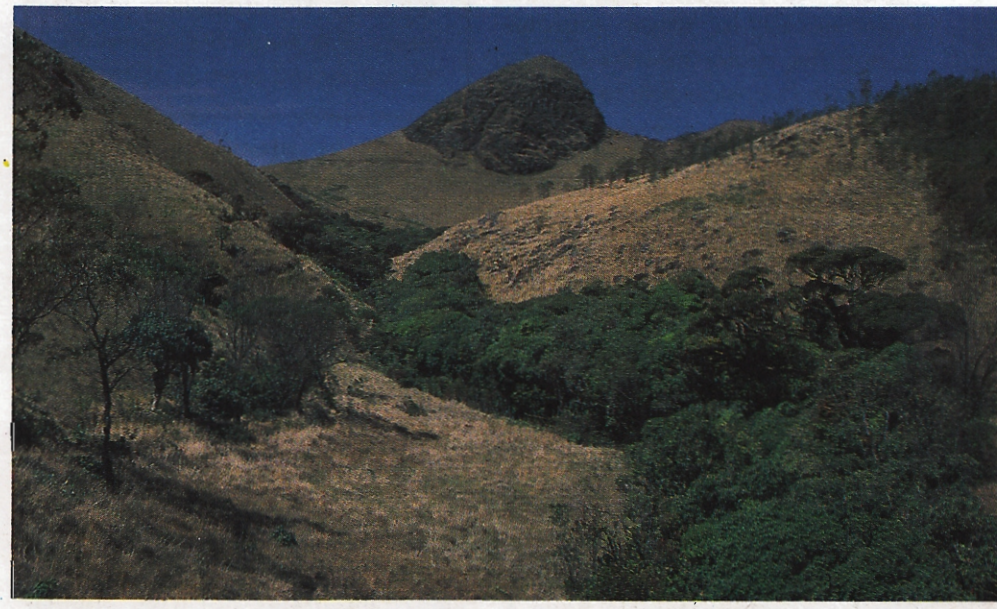
Shola forests have lately received considerable attention in Kerala with the Forest Department aiming to document their unique biodiversity and evolve strategies to conserve this important ecosystem which makes stunningly beautiful landscapes in the high ranges of Kerala. KFRI is contributing to this effort by initiating work on a number of research projects in the sholas and the adjacent grasslands. This article brings to the readers a host of interesting information on the sholas of Kerala.

Western Ghats, the 1600 km long continuous chain of mountains in peninsular India, stretching from the mouth of the river Tapti in the North to Kanyakumari in the South, are ecologically interesting in many ways. Many hillocks of the Ghats are quite high with chilling cold, lashing winds and heavy thunderstorms common in these mist veiled mountain tops. Here, one can see vast expanses of grasslands interspersed with small, dark green islands of stunted forests. They are found mainly in the sheltered ravines, troughs, hollows and other depressions, where there is abundance of moisture, and are occasionally seen 'flowing' to the valleys along with the streams. These are called 'Sholas', a term which glorified ancient Tamil literature, songs and films, and a popular term discussed very often, nowadays.

CONTENTS



A shola-grassland landscape from the Western Ghats of Kerala. (Photo: Dr K. K. Ramachandran)

Ecological Classification

Scientifically speaking, 'Sholas' are 'Tropical Montane Forests' situated in the higher mountain tracts of Western Ghats, above 1500 m, interspersed with rolling grasslands (Southern Montane Wet Grasslands). They are the continuation of the 'West Coast Tropical Wet Evergreen Forests' in the higher altitudes. Ecologists including Champion and Seth (1968) have classified them under 'Southern Montane Wet Temperate Forests'. Upper reaches of the 'Southern Subtropical Broadleaved Hill Forests' above 1500 m, were also referred by them as 'Sholas', since the vegetation was almost similar and a clear cut demarcation with respect to altitude was not possible always. So, the sequence of the forests with respect to altitude is Wet Evergreen Forests→ Subtropical Broadleaved Hill Forests → Montane Wet Temperate Forests.

These forests were named so, because diurnal temperatures resembling 'subtropical' and 'temperate' latitudes are experienced in these regions during the cooler months due to elevation. But, according to Meher-Homji (1965), these forests situated in the tropical latitudes, should not be referred as 'subtropical' or 'temperate', which are terms referring to latitudes. Moreover, in a strict sense, such a situation does not exist in the sholas, with respect to the temperature and photoperiodic regimes. The structural, functional and distributional patterns of the vegetations are also different. Hence, 'Tropical Montane Forests" is currently used to refer Sholas. Similar montane forests have a wide range of distribution in other parts of the tropics and are encountered in Central and South America (Eucador, Mexico, Venezuela, Columbia, Cuba, Jamaica, British Guayana, Costa Rica), Tropical Africa (Cameroon, Uganda, Madagascar) and Tropical Asia (India, Sri Lanka, Laos, Borneo, New Guinea, Malaysia, Thailand and Vietnam).

Functional Aspects

Shola forests have high ecological significance in protecting the head waters of rivers. They have the capability of holding up of water received by precipitation, like a sponge and thus preventing rapid run off. The vegetation is also very characteristic. The trees are stunted with an umbrella shaped canopy. The branches are crooked and densely covered with epiphytic mosses, ferns, lichens and orchids. The species are basically of a tropical stock. But, fire resistant temperate species dominate the forest ecotones, which act as a natural fire belt.

'CHOLAI'

The term 'Shola' owes its origin to the Tamil word 'Cholai', meaning a stream or a cool, shady place. Gradually , 'Cholai' transformed to 'Shola', through the intermediary form 'Sholai', and began to be used to refer to both 'streamlets' and 'forests associated with the streamlets'. Later Schimper (1903), a well known plant geographer, borrowed this popular term and incorporated into forest typology. The etymology of this name has been discussed by Swarupanandan et al. (1998).

Woody species in the open grasslands are cold resistant and have a wider geographical range extending to the higher altitudes in the Himalayas or other temperate regions. However, as majority of species are of tropical stock, they cannot withstand the low temperature in an open eco-climate, and are consequently eliminated. The situation is worse in the eastern and southern slopes which are more prone to the effects of morning sun. So, Sholas in these regions are comparatively small, the trees are more stunted and crooked, their leaves being more coriaceous and recurved.

Environmental Factors

Frost, fire and wind are the three main factors determining the distribution of the sholas. In the open grasslands when frosts occur during winter nights and temperature goes subzero, it is invariably above 0°C inside the sholas (Legris & Blasco, 1969). The nocturnal temperature was so low that a drop of about –16°C has been reported from the grasslands of Nilgiris (Ranganathan, 1938). The plants are then subjected to intercellular crystallisation. In contrast to the climate that prevails in the temperate latitudes, a frosty night is followed by a hot day, and the bright morning sun promotes rapid thawing of the crystallised water, which is quickly transpired by the plant. At the same time, the top soil will be in a frozen state, so that the plants experience difficulty to absorb water to compensate the transpiratory losses. This results in water stress, analogous to physiological dryness, which in turn causes wilting and death of the plant. Seedlings are the most affected, since they have only shallow root system, but the trees once established manage to survive, with less damage. However, various

levels of frost hardening are exhibited by the shola plants and so most of them, especially those found in the periphery have slightly recurved, coriaceous leaves. At the same time, grasses that have perennial rootstock and leaves with bulliform cells, can withstand these extremes of frost, by rolling their leaves to reduce traspiration rate and spreading quickly by vegetative means, even if badly damaged by frost.

Fires, usually having an anthropogenic origin, have a vital role in shaping the spread of sholas to a certain extent. Fire once lit finds its way up, swallowing the grasslands, very often entering the sholas through the reed zones. In this process, it wipes out practically the last seedling which had escaped the dangerous effect of frost and got established in the open grasslands, thereby preventing the expansion of the sholas. Tribals, the early inhabitants used to lit fire to the grasslands, in order to attract herbivores like Tahrs, Gaurs, Sambhars that come in search of the new flushes emerging after fire. Improved visibility helped the tribals to shoot the animals, sitting in ambush in the sholas. This hunting method is followed even now by some of the native people. Nowadays, fires are ignited purposely by people down in the settlements, so that fertile ash from the grasslands may reach their cultivated land during the following rainy season.

Lashing winds are of common occurrence in the sholas where erosion is high and soil depth is poor. Shola trees always remain shallow rooted even in regions of considerable soil depth. Therefore, there are ample chances of heavy wind fall. This limits the expansion of the sholas into the grasslands where they are more prone to the effects of wind and hence found restricted only in regions protected from wind, such as hillfolds and depressions.

The presence of adequate amount of soil moisture is another essential condition for the growth of the shola, especially in regions where ground frost occurs. Good drainage is also as important as availability of soil moisture.

The aspect of the hills also influence the distribution of sholas and in reality it is an effect of temperature. Eastern slopes are cooler than the western slopes, so that the incidence and intensity of frost is not only greater on the eastern slopes, but the damage is also greater as such slopes are exposed to the morning sun, which is known to intensify frost damage.

Regeneration

There is profuse regeneration inside the sholas, where frost damage is negligible. However, seedling mortality is high during winter, due to low temperature and high moisture stress. As majority of the tree species belong to families of Lauraceae, Myrtaceae, Rubiaceae and Oleaceae, all bearing drupaceous fruits, which are recalcitrant, viability period of the seeds is low. Such seeds which are shed at relatively high moisture contents are highly susceptible to desiccation and chilling injuries, and hence the viability period is cut short to a few weeks from few months depending on the species (Kumar & Chacko, 1999). This poses a serious problem in the regeneration dynamics of sholas.

'Living Fossil Community'

All these problems contribute to the shola forests to be rightly designated as a 'living fossil community'. They are considered as a relict of an evergreen forest climax, pushed back to damper sites, by the combined effects of fire, frost, grazing, clearance for agriculture and the prevention of regeneration by the rapid erosion of the soil.

RHODODENDRON

Rhododendron, a temperate species of the shola fringes, is fire hardy and is apparently not destroyed by the annual fire. The scattered *Rhododendron* trees which we see in the shola-grassland ecotones are considered to be the vestiges of sholas which were destroyed by fire in the past. They can also be pioneers which establish first in the grasslands due to their inherent frost and fire hardy nature. Once they are established, they produce a microclimate suitable for other tropical shola species to come up under their shade. Thus, a shola starts its formation and gets established if other climatic and edaphic features are also favourable. *Rhododendron* trees are strong light demanders and cannot regenerate themselves under the dense sholas and even the pioneers get eliminated in the due course, with the growth of the sholas.

Diversity

Plant diversity of the montane forests of the Nilgiris is relatively lower than other comparable sites in the neo-tropics. However, this is contradictory to the findings of Jose et al. (1994). This low diversity values could be related to turn over of species as the forests expand and contract in response to climatic oscillations. Species extinction could also be higher in patchy montane sholas in conformity with the

prediction of the 'Island Biogeography theory.'

The activity of microorganisms and the decomposition rate are low in these montane regions. So, in many regions one could find, huge deposits of undecomposed organic carbon in the form of 'peat'.

Flora

Floristic richness and affinities of shola forests are well documented. Perhaps the first floristic account on the shola forests was that of Fyson's (1915-1921) 'Flora of the Nilgiri and Pulney Hill tops'. Thanks to Botanical Survey of India, various universities and research institutions, floristic details of other high altitude vegetation are also available.

Shola species are mostly of tropical stock with temperate species predominating the forest fringes. The principal tree species are *Neolitsea zeylanica, N. scrobiculata, Cinnamomum wightii, Actinodaphne bourdillonii, Litsea wightiana, L. ligustrina, Elaeocarpus serratus, Ilex denticulata, I. wightiana, Rapanea thwaitesii, R. wightiana, Ligustrum perrottetii, Michelia nilagirica, Microtropis ramiflora, Glochidion neilgherrense, Syzygium densiflorum, S. arnottianum, Symplocos pendula, Schefflera racemosa* etc. Species such as *Ilex wightiana, Gordonia obtusa, Fagraea ceylanica, Schefflera racemosa, Prunus ceylanica* and 'Tree ferns' such as *Cyathea crinita, C. nilgirensis* etc have more affinity to water and are found along the streams.

In the shola fringes, trees such as *Rhododendron nilagiricum, Vaccinium leschenaultii, Lasiosiphon eriocephalus, Elaeocarpus recurvatus, Photinia notoniana, Eurya nitida, Symplocos laurina, Ternstroemia japonica, Daphniphyllum neilgherrense* etc dominate. Shrubs and herbs found here are *Rhodomyrtus tomentosa, Hypericum mysurense, Dodonea viscosa, Berberis tinctoria, Maesa perottetiana, Gaultheria fragrantissima, Euphorbia laeta, Jasminum bignoniaceum, Leucas lanceafolia, Moonia heterophylla* etc.

In low altitude shola regions, *Hydnocarpus alpina, Chionanthes linocieroides, Mastixia arborea, Garcinia cowa, Elaeocarpus munronii, E. tuberculatus, Acronychia laurifolia, Beilschmedia wightii, Bhesa indica, Bischofia javanica, Isonandra candolleana, Gomphandra coriaceae, Syzygium cumini, Persea macrantha* etc. dominate. The major undergrowths here are *Lasianthus acuminatus* and *Ardisia rhomboidea*, in addition to different species of *Strobilanthes*.

Strobilanthes which is the major undergrowth inside the sholas, shows habitat preference in accordance with the availability of light. *S. homotropa*, which is the dominant undergrowth, is found under the dense canopy, whereas *S. micranthes* and *S. luridus*, the other two dominant species, prefer more exposed regions, such as shola margins. The famous 'Neelakkurinji', *S. kunthianus* is found only in fully exposed regions, such as grasslands.

As the extent of sholas is so small and as they occupy very inaccessible mountain tops, having a very hostile climate, there are still some regions, which remain unexplored. These shrinking ecosystems abode a lot of rare, endangered and endemic species, many of which face danger of extinction.

Studies of KFRI

Recent studies conducted in various shola forests of Kerala, have brought out some interesting results. Out of the 554 species collected, which include pteridophytes also, 117 were found 'endemic' to Western Ghats. 176 species belonged to the 'rare' plants category and 34 under the 'threatened'. There are 43 rare and endangered pteridophytes, of which thirteen species have been recorded for the first time from the sholas of Kerala. Very rare herbs such as, *Pimpinella pulneyensis* (Apiaceae), that was considered as possibly extinct and *Helichrysum perlanigerum* (Asteraceae), formerly collected from the high altitude grasslands in 1857 and relocated in 1980, were collected from Mannavan Shola. Similarly *Sinarundinaria microphylla* (Poaceae), a dwarf bamboo, which is endemic to Bhutan and Khasia hills of eastern Himalayas was collected from the grasslands of Eravikulam National Park, and is a new record to Peninsular India. Ethnobotanical importance of 103 shola species including pteridophytes has also been gathered, which is a pioneering work. Certain interesting specimens which remain unidentified at present, may turn out to be new taxa.

Threats to the Shola

It is depressing to note that such floristically and ecologically important vegetation-types are facing dangers of destruction. Surprisingly large regions of shola forests and grasslands in the Western Ghats had been transformed to plantations of tea, wattle, eucalypt, silver oak, pine, lemon grass, horticultural crops, etc. not to mention the threats due to construction of roads and settlements. This process is still continuing. The high amount of tannin present in the leaves and bark of some of these species, retards decomposition of litter and thus impoverishes the soil which in turn prevents the regeneration of the native species.

Sholas were neglected for a long time because the trees have very

little timber value, and less accessibility. When the importance of the sholas were highlighted, strict measures to conserve these treasure-houses got momentum. As a result, majority of shola forest regions that we now encounter are located in protected areas such as Biosphere Reserves, National Parks and Sanctuaries.

In Kerala, shola forests occupy an area of about 70 sq. km. as against a total forested area of 9400 sq. km. and are distributed mostly in the high ranges of Idukki District. They are also found at high altitudes of Wayanad, Periyar, Silent Valley, New Amarambalam, Agasthyamala etc, majority of which are protected areas.

More research on shola forests presently undertaken by the Kerala Forest Research Institute (KFRI), on the endemic species, canopy gap dynamics, entomology, macro-invertebrates, soil micro-organisms, soil fungi, run off studies, vegetation mapping of sholas using Geographic Information System (GIS), etc. will bring forth comprehensive information which will certainly unravel more mysteries of this interesting ecosystem.

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Compost as Potting Medium in Root-trainer Nurseries - Problems and Remedies

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Compost is an ideal, nutrient rich potting medium having several desirable characters like light weight, good porosity and high water holding and cation exchange capacity. As per the recommendations of the World Bank, now compost is used routinely as the growth medium in the central nurseries of the Kerala Forest Department. During 1997-98, fixed ratio of soil, sand and compost was used in root trainers. Healthy and vigorous seedlings of eucalypts and teak were grown in such root trainers. Although, attack by soil-borne pathogens and nematodes were reported on seedlings, the incidence was very low.

During 1998-99, the practice of mixing soil and sand with compost was discontinued and the compost alone was filled in root trainers as the growth medium in central nurseries located at Kulathupuzha, Kodanad, Nilambur and Wayanad. High incidence of unforeseen problems like extremely slow growth, yellowing and death of young seedlings have been reported from these nurseries. Heavy pre-monsoon rains during the month of May worsened the situation. The problems were referred to us and we had visited the nurseries at Kulathupuzha, Kodanad and Nilambur and had investigated the problem and recommended remedial measures.

A large number of seedlings of *Acacia mangium*, *A. auriculiformis* and teak were found to be unhealthy and showing yellowing, crinkling and cupping of leaves, necrotic leaf spots and defoliation; heavily defoliated seedlings dried up. No infection of roots was observed. Seedlings of *A. mangium* and *A. auriculiformis* were the worst hit . Even though, these two species are

capable of meeting their N_2 requirement by atmospheric nitrogen fixation, they did not produce root nodules apparently due to absence of appropriate *Rhizobium* in the potting medium. In some plants, by about 6-8 weeks, even if some nodules were formed, they were ineffective. Such nodules were pale and did not show the purple coloration inside, characteristic of effective N_2 fixation. Fungal injection on leaves appeared to be of secondary origin.

Possibly, mineral deficiency caused by the non-availability of nutrients to the plants through root system, even though the compost is nutrient rich, was responsible for the manifestation of the disease like symptoms. Perhaps, available mineral nutrients are utilized by the large population of microorganisms present in the compost and, hence, nutrients remain immobilized/ locked up in the microbial biomass. This leads to an asynchrony of the mineral requirements of growing seedlings and the mineral avail ability in the compost. Consequently, the seedlings become deprived of mineral nutrients with the result, they grow stunted and show various deficiency symptoms. Once the rapid growth of microorganisms ceases and they die and decompose, nutrients trapped within the microbial biomass will gradually mineralize and become available to the plants.

Relatively high pH (>7.5) of compost , except for samples from Kulathupuzha, could be another factor which reduced the availability minerals like iron, sulphur, boron, etc. to plants. Moreover, the quality of the compost used as the potting medium was also found to be low, indicated by the C/N ratio, far higher than the value of nutritionally balanced compost.

Remedial measures

The affected seedlings can be recouped by adopting the following appropriate remedial measures. Encouraging results have been obtained at Kulathupuzha nurseries as a result of these measures. However, due to unknown reasons

Teak seedlings grown in root-trainers showing symptoms of iron deficiency

A. mangium seedlings respond only slowly.

1. Application of 0.25 % solution of di-ammonium phosphate (DAP) as foliar spray profusely on the foliage for providing additional N and P to the seedlings.
2. Application of *Multiplex*, a mixture of various inorganic salts after appropriate dilution as foliar spray in order to augment mineral nutrient availability to seedlings.
3. Avoiding excess moisture in the potting medium so as to enhance mineralization process.
4. Application of appropriate concentration of fungicides like Dithane M-45 and Bavistin 50 WP for controlling foliage fungal infection.

Since poor quality of the compost is responsible for the abnormal growth and mortality of seedlings, it is essential that the following corrective measures are taken to improve the quality of the compost.

1. Chemical analysis of potting medium to ensure optimum nutrients and optimum pH of of 6.0 - 7.0 before sowing the seeds. The reason for the occurrence of high pH in the potting medium used in central nurseries has to be ascertained and necessary changes in the composting protocol need to be made.

The decomposition of raw organic material in the compost should be complete and the C/N ratio optimum.

Even though, *Acacia* species are capable of fixing atmospheric nitrogen in root nodules, this has not occurred apparently due to lack of *Rhizobium* (in the compost) required for effective nodule formation and nitrogen fixation. Hence, it is appropriate to mix soil to the compost to facilitate root nodule formation if N_2-fixing seedlings are raised in compost.

SPOTTED DEER MENACE IN YOUNG TEAK PLANTATIONS

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Spotted deer *(Axis axis)* pose a serious threat to young teak plantations causing damage to the plants. The damage is caused in two ways: (i) browsing of the leading shoot of young saplings and (ii) stem injury in more grown up plants, caused by the rubbing of head of the animals (see photo). Rubbing of head against the tree usually precedes the emergence of antlers (during this period the animal is said to be in 'velvet'). In an experimental plantation (2.41 ha; about 4500 plants) raised during June 1997 at the Veluppadam Field Research Centre of KFRI, 76% of the plants suffered deer damage during the initial 21 months. Damage due to leading shoot browsing was 52% and that due to bark injury was 24%. It was interesting to note that the bark injury was mostly on trees without side branches. Side branches probably prevent the animals from having a close brush with the tree. Conversely, pruning the lower side branches can also facilitate bark injury. Although deer damage does not necessarily result in casualty, leading shoot damage prevents apical dominance; bark damage results in death of plants above the injured portion. In both the types of damages, growth is retarded. Deers visit the plantation during dawn and dusk from nearby forests. Although the exact size of the deer population causing damage to the experimental plantation is not known, 32 deers were sighted on 26 October 1998.

A young teak plant showing bark damage caused by spotted deer.

Deer damage occurred in spite of watch and ward and a 1.80 m high eight-strand barbed wire fencing around the plantation. A few plants which were given individual protection with tree guards, were not damaged; however, these are expensive and cause inconvenience for operations such as weeding and growth measurements. The wildlife experts may take it as a challenge and suggest ways and means to protect plants from deer damage.

Occurrence of lac insect in Kerala

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Lac is one of India's most important non-wood forest products and about 85 per cent of the world's total output is grown in the country. The well known Indian lac insect *Kerria lacca (=Laccifer lacca)* is used for commercial production of lac in India and other countries like Thailand, Philippines, Sri Lanka, etc. In India, the States of Madhya Pradesh, Orissa, Bengal and Bihar are the important lac producers. Not much information is available on the occurrence of lac insects in Kerala. In a recent observation, a species of lac insect , *Kerria* sp. was recorded on *Amherstia nobilis* tree . *A. nobilis*,

*Encrustations of the lac insect on the twigs of **Amherstia nobilis** found in Thrissur Zoological Park.*

known for its beautiful flower, is a moderately sized evergreen species, native of Myanmar and is grown in gardens in India and elsewhere. Among the three trees grown in the Thrissur Zoological Park, one of the trees was found harbouring lac insects in January. They were found on twigs emerging from several branches. The cylindrical and elongate encrustations were fresh and well developed with life stages of the insect developing inside. The infestation begins with the young larvae establishing on tender branches. They feed on the sap of the tree and develop and in due course secrete a resin which covers their body as a protective layer, which gradually develop into lac encrustations over the infested branches. Detailed studies are called for establishing commercial rearing of the lac insect in Kerala.

Forest Trees for Homesteads

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Recently, there has been an increasing interest among farmers for planting forest trees in their homesteads and farm lands. Though a number of species are available for this purpose, the diverse vegetative characteristics and user needs calls for care in the choice of species.

Planting of trees along with annual agricultural crops has been a well known practice prevalent among the farmers of Kerala from time immemorial. These trees were grown for timber, poles, firewood, green manure, fodder, food and materials of medicinal and religious importance. The farmers used to meet most of their timber requirements for house construction, furniture and agricultural implements from these trees. Similarly, these trees supplied the green manure for their agriculture crops and fodder for the domestic cattle. Fruits and leaves from many of these trees were used as food. Fire wood required for cooking purposes was obtained from branches and twigs. Some trees were grown for their medicinal and religious importance. Besides, trees often helped in the cultivation of other agricultural crops by providing shade and support. In addition, the timber helped the farmers as a source of income to be saved for the lean seasons and special occasions. However, during the last few decades, planting of miscellaneous trees along with agricultural crops got neglected due to the shift towards monoculture cash crops. Conversion of many farm lands to smaller holdings was also a factor which resulted in neglect of the earlier farming practice.

Lately, as a result of acute shortage and high price of various materials such as timber, fire wood, green manure and fodder, farmers have again started taking keen interest in planting forest tree species in their home gardens and agricultural lands. The increasing awareness to environmental problems also acted as a catalyst for increasing this interest in tree planting. Consequently, the Institute receives several enquiries from farmers in different parts of the State for tree species suitable for their diverse needs.

Various characteristics of trees such as the root system, stem form, crown, flowering, fruiting and leaf shedding habits, allelopathy, etc. need careful attention while choosing species. Trees such as *Ficus* with a large crown and root system, though may be suitable for large compounds of schools, hospitals, and temples, they are not preferred for homesteads with limited space. Similarly, bamboos with thorns and aggressive root system though may be planted in large house compounds and agriculture lands, are not suited for small holdings. Again, versatile exotic species such as *Acacia auriculiformis*, though may be suited for areas with heavy biotic pressure (such as cattle browsing), may not be advisable for homesteads where other indigenous trees of better use and value can thrive well.

While selecting species for planting, the final product from trees planted also requires careful consideration. Depending on preference among the various requirements such as timber, poles, fire wood, fodder, green manure, medicines, religious importance, support to climbers such as pepper vines, shade to agriculture crops, fence, soil and water conservation and aesthetic value, one has to select trees suitable for each purpose. Though different species are required for different purposes, in many cases, one can think of multi-purpose species suited to the situation.

List of trees suggested for Kerala homesteads, their growth characteristics and end uses are given in table below:

List of trees suggested for homesteads, their growth characteristics and end uses

Sl. No.	Species	I=indigenous E=Exotic	Rate of growth S=Slow M=Moderate F=Fast	Uses						
				Timber	Fire-wood	Fruits	Fodder	Green manure	Pepper stand	Match wood
1	*Adina cordifolia*	I	F	*					*	
2	*Aegle marmelos*	I	S							
3	*Ailanthus triphysa*	I	F						*	*
4	*Albizia lebbeck*	I	F	*						
5	*Artocarpus heterophyllus*	I	M	*	*	*	*			
6	*Artocarpus hirsutus*	I	M	*	*	*			*	
7	*Azadirachta indica*	I	S	*						
8	*Bambusa arundinacea*	I	F		*					
9	*Bambusa balcoa*	I	F		*					
10	*Bambusa vulgaris*	I	F		*					
11	*Bombax ceiba*	I	F							*
12	*Cassia fistula*	I	M							
13	*Casuarina equisetifolia*	E	F		*					
14	*Dalbergia latifolia*	I	S	*						
15	*Emblica officinalis*	I	S	*	*	*				
16	*Erythrina indica*	I	F						*	*
17	*Garcinia gummi-gutta*	I	S			*				
18	*Gliricidia sepium*	E	F		*			*		
19	*Gmelina arborea*	I	F						*	
20	*Leucaena leucocephala*	E	F		*		*	*	*	
21	*Macaranga peltata*	I	F					*		*
22	*Mangifera indica*	I	M		*	*				
23	*Muntingia calabura*	E	F			*				
24	*Spondias pinnata*	I	F			*		*		
25	*Syzygium cumini*	I	M	*	*	*		*		
26	*Tamarindus indica*	E	S		*	*				
27	*Tectona grandis*	I	M	*					*	
28	*Terminalia catappa*	E	M			*				
29	*Thespesia populnea*	I	M	*	*			*		
30	*Wrightia tinctoria*	I	S		*			*		

WEATHER DATA FROM PEECHI (1998)

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Plant Physiology Division

The recording of weather parameters at KFRI, Peechi weather station is continued using an automated weather station manufactured by Skye Instruments, U.K. Various weather parameters are being monitored at 30 seconds interval and averaged over an hour. Accurate data for temperature (oC), relative humidity (%), wind velocity (m/s) , rainfall (mm), solar radiation (MJ/m^2), soil temperature (oC) at two depths are available for 24 hours of the day for all the months of the year of the reporting period. Hourly data on the various weather parameters are stored in the computer.

The total rainfall at Peechi amounted to 3437.4 mm during the year showing an increase of 836.1 mm over the previous year. Rainfall was almost equal in June and July, 792.2 and 792.8 mm respectively. The number of rainy days, when rainfall was greater than 10 mm, was 95 days showing a lead of 16 days over the previous year. Even though the months of January and February did not receive any rain, rainfall started in March itself giving 27.6 mm. Apart from the monsoon occasional depressions formed in the Bay of Bengal, coastal Andhra Pradesh, Arabian sea etc. increased the availability of rain during the year. Compared to the previous year, North East Monsoon also was more favourable in 1998.

Atmospheric temperature varied between 18.3°C and 38.4°C during the reporting period. Months of March, April and May had comparatively higher atmospheric temperatures. Averages of monthly relative humidities varied between 74.7% (Feb) and 97.7% (July). The total solar energy received per square meter for the year in this station amounts to 6508 MJ/m^2. Of this, the months starting from January to April contributed comparatively higher solar radiation, March being the highest. Maximum solar energy was received on April 5th (27.2 MJ/m^2). Average wind speed was more in January and February. The upper 15 cm layer of soil showed an average temperature of 28.8°C. Monthly variations between minimum and maximum soil temperatures in the upper 15 cm were 23.6 and

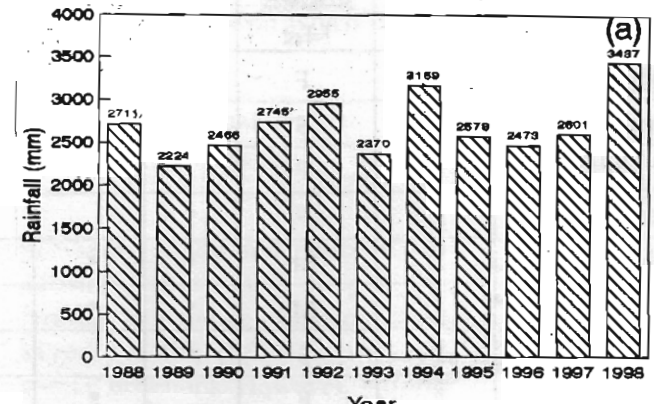
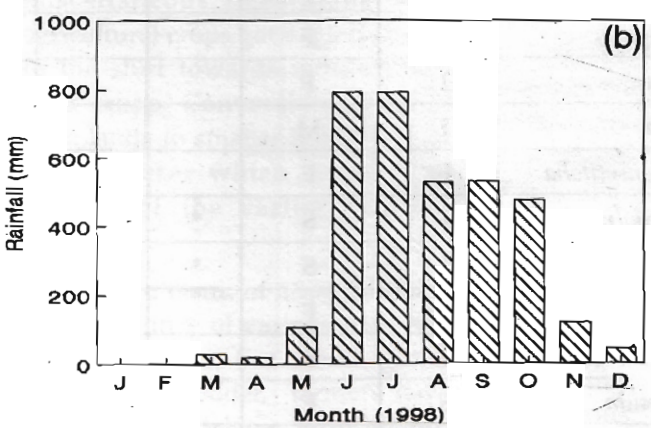


Fig.1 (a) Cumulated annual rainfall from 1988 to 1998 at Peechi



(b) Cumulated monthly rainfall for 1998 at Peechi.

Table 1. Highlights of weather data

Total rainfall for the year	:	3437.4 mm
Total number of rainy days (>=10 mm)	:	95 days
Day with maximum rainfall	:	24thAugust (115.4 mm)
Month with maximum rainfall	:	July (792.8 mm)
Month with maximum rainy days	:	July (23 days)
Day with maximum temperature	:	6th April (38.4°C)
Day with minimum temperature	:	16th January (18.3°C)
Month with highest mean temperature	:	April (30°C)
Day with maximum wind speed	:	4th January (6.7 m/s)
Month with maximum sunshine	:	March (748 MJ/m^2)
Month with minimum sunshine	:	June (397 MJ/m^2)

38.7°C. At 30 cm depth soil showed an average of 29°C giving only a meagre difference between upper and lower strata within 30 cm depth. Similarly the lower soil layer had a minimum temperature of 24°C which is almost equal to that of the upper layer. The highlights of weather data are presented in Table 1 and the monthly averages of the various weather parameters measured in Table 2. The annual rainfall for the last 10 years and the monthly rainfall for 1998 are presented graphically in Fig.1a and b respectively.

Table 2. Monthly averages of weather parameters for 1998 at Peechi

(Latitude 10°32'N; Longitude 76°20'E; Altitude 100 m)

Month	Temp (oC)			r.h. (%)			Rainfall (mm)		Wind speed (m/s)			Solar radiation (MJ/m^2)	Soil temperature (30 cm) oC		
Jan	18.3	26.8	33.5	31.2	75.3	100	0.0	(0)	0.0	2.2	6.7	666	27.3	29.5	31.2
Feb	21.5	27.6	35.1	29.1	74.7	100	0.0	(0)	0.0	1.5	6.3	637	29.4	31.0	33.3
Mar	22.6	28.8	37.6	23.2	78.2	100	27.6	(1)	0.0	1.0	4.6	748	31.8	33.6	35.2
Apr	22.2	30.0	38.4	28.5	83.1	100	18.2	(1)	0.0	0.8	4.8	657	31.4	33.6	35.6
May	23.0	29.3	36.6	44.7	88.5	100	107.8	(4)	0.0	0.7	3.2	599	27.9	30.6	34.1
Jun	22.6	26.2	35.0	69.5	96.2	100	792.2	(17)	0.0	0.8	2.8	397	24.7	27.4	30.8
July	22.0	25.5	31.4	73.1	97.7	100	792.8	(23)	0.0	0.7	2.5	416	24.0	26.4	27.9
Aug	23.2	25.9	31.4	78.5	97.1	100	529.4	(15)	0.0	0.6	2.1	450	25.0	27.2	28.4
Sep	22.5	25.3	31.0	75.1	97.4	100	530.4	(18)	0.0	0.5	2.0	437	25.4	26.9	27.8
Oct	21.3	25.3	31.4	65.5	96.4	100	474.2	(11)	0.0	0.5	1.9	445	24.5	26.8	28.4
Nov	21.0	25.8	32.4	62.2	94.0	100	121.2	(3)	0.0	0.6	3.5	509	25.1	27.8	29.0
Dec	19.8	25.4	31.1	51.5	89.2	100	43.6	(2)	0.0	1.8	5.1	547	25.6	26.9	28.5

Note: r.h. = Relative humidity; The figures in parentheses indicate the number of rainy days when rainfall was >=10 mm.

BOOK REVIEW

Siyag, P.R. 1998. The Afforestation Manual: Technology and Management. Tree Craft Communications, Jaipur (India), xivi+585 p. Rs. 1,450/- (US$ 55), ISBN 81-901032-0-2.

Afforestation of underutilized non-forest lands and reforestation of denuded forest lands are of great priority especially in arid and semi-arid zones. Several afforestation programmes supported by government and non-government agencies are implemented in India by many organizations and individuals. Most of them heavily depend on external professional support for planning and implementation. Even the forest departments, with technically trained staff, look for professional expertise in areas such as organizational set-up, planning, monitoring, evaluation, review and quality control. In this context, the publication of Afforestation Manual : Technology and Management is timely.

The book is broadly divided into five parts with thirty two sections. Part I (Technical Manual) has ten sections covering nursery techniques, site selection, survey and preparation of site plan, design of the treatment plan, execution of fencing, soil and water conservation works, planting work, aftercare and maintenance, tending the rootstock, tackling problematic soils and agroforestry in afforestation programmes.

Part II (Management Manual) has seven sections which deals with organisational framework, planning for time-critical activities, monitoring, evaluation and review, quality control, recordkeeping and documentation, people's participation, and utilisation and management plan.

Part III displays technical charts and tables through seven sections. Section 18 provides silvicultural charts and tables. A list of 169 species for planting in arid (<500 mm annual rainfall, @ 20 days rainfall) and semi-arid zones (500 mm-800 mm) under different site conditions is provided. Section 19 deals with nursery operations, sec. 20 on fence designs, sec. 21 on designs of soil and water conservation structures. Section 22 gives a model basic schedule of rates, and sec. 23 gives treatment plans for degraded forest, barren hills fuel and fodder plantations, etc. Section 24 gives units of measurement and conversion tables.

Part IV provides management charts and tables on various aspects in seven sections such as model organisational structure, management networks, schedules and calendars, a model quality control programme, information formats and management information system, recordkeeping and documentation, a framework for institution building and a model plantation management plan.

Part V (Tree Planting Guide) has only one section on a citizen's guide to tree planting which provides general guidelines on why, where, what, when and how to plant and care trees.

At the end, 32 photographs of various afforestation activities, a glossary of about 700 terms, a bibliography of 13 publications, and an index are provided.

The strength of the book is in the presentation of a number of sample forms and formats, and model cost estimates. Nonetheless, readers are advised to take care of some technical disagreements as well. For example, species such as *Swietenia macrophylla, Terminalia arjuna, Terminalia bellerica, Tectona grandis, Polyalthia longifolia, Mangifera indica* and *Dalbergia latifolia* should not be regarded as typical for arid and semi-arid tropics (see p. 195-200). Inclusion of some standard reference books in the bibliography (eg. Troup's silviculture of Indian trees - original and revised volumes) would have helped the readers to further confirm the species suitability and gather details about the species. The author's engineering skills are demonstrated through well presented sketches and layouts. The book is well-bound and has a sleek appearance, but slightly overpriced for its contents.

The Afforestation Manual : Technology and Management is probably the only one of its kind among Indian publications as it combines both forest technology and management in one publication. The book is useful for both non-specialists and specialists working with voluntary organizations, government departments as well as consultants engaged in planning and execution of afforestation programmes. It will also be useful for the policy makers, planners and administrators concerned with the field of natural resource conservation and sustainable development.

K.C. Chacko
Silviculture Division

Research Highlights

Teak logs to be dearer

Using the price data of teak wood available from 1941-1994 (53 years), the price of teak logs has been predicted up to the year 2015-16. The price of a teak log in girth class 1 could be anywhere between Rs. 45,000 and Rs. 1,35,000 per cubic meter in the year 2015-16. The price of other girth classes have been also predicted in a report (KFRI Research Report No.160) published by KFRI. Mr. C.N. Krishnankutty, who conducted this study has examined the long-term trend in prices obtained in timber auctions in the Kerala Forest Department depots. Apart from teak, he has also examined a number of other timbers which include *Artocarpus hirsutus, Xylia xylocarpa, Terminalia paniculata, Pterocarpus marsupium*, etc. It is interesting to note that the overall trend of increasing prices was more or less similar for all timbers.

Are the grasslands climaxes?

An attempt to resolve the controversy whether the grasslands *in the hills of southern India* are climaxes has been made by Dr K. Swarupanandan (Ecology Division), Dr M. Balagopalan (Soil Science Division) and Dr S. Chand Basha (ex-Director) with funding from the Ministry of Environment and Forests, Government of India. They approached the problem by studying the vegetal dynamics, soil and climate in the grasslands of Silent Valley and Eravikulam National Parks in Kerala. Their study has concluded that the grassland vegetation along the south Indian hills do not represent any 'climatic climax', instead they are 'edaphic climax'. They have identified that the slow pace of succession of grasslands to wooded communities is due to the paucity of invasion of diaspore populations of the right kind of species. The study also comments on the afforestation of grasslands with plantation species. More details on this study are available in KFRI Research Report No.154.

Tree species density highest in the sholas

Establishment and inventory of permanent plots in forests can provide a window on species diversity and allow characterisation of forest, finally helping in conservation strategies. With funding from the World Wide Fund for Nature - India (WWF - India), five scientists from KFRI, Dr U.M. Chandrashekara, Dr A.R.R. Menon, Dr K.K.N. Nair, Dr N. Sasidharan and Dr K. Swarupanandan have established and studied permanent plots in tropical montane forest (sholas), tropical evergreen forest, moist deciduous forest and dry deciduous forest. They found that the tree species density was highest (76 species ha^{-1}) in the sholas, followed by evergreen forest (41 species ha^{-1}), dry deciduous forest (41 species ha^{-1}) and moist deciduous forest (37 species ha^{-1}). It is expected that all the above plots will be used in future for further studies on ecological aspects. The details of the study are published in KFRI Research Report No.156.

Early selection possible in rattan

Conservation of any organism requires understanding of its genetic diversity, reproductive biology and cytology among other aspects. The situation is not different for rattan which grow mostly wild and not in plantations. In a study sponsored by IPGRI, Rome, the above aspects were studied in three species of rattan, namely, *Calamus thwaitesii, C. andamanicus* and *C. palustris* (KFRI Research Report No. 157). Dr C. Renuka, Mrs. E.P. Indira and Dr E.M. Muralidharan, who conducted the study, observed notable variations in phenotypic characters in populations of *C. thwaitesii* and *C. andamanicus* while in *C. palustris*, it was minimal. Provenances vary significantly in seedling height and the heritability of the trait was high. This suggests that early selection will be possible at least in some species of rattan. Insects, especially bees are the main pollinators of rattans.

Origin of the Sholas

The shola forests of the south Indian hills have always remained a mystery for the ecologists. Scientists from KFRI, Dr K. Swarupanandan, Dr N. Sasidharan, Mr. K.C. Chacko and Dr S. Chand Basha have completed a detailed study (KFRI Research Report No. 158) on the sholas with funding from the Wildlife Wing of the KFD. The most interesting point about the sholas is their tropical location comprising subtropical hill forests and the montane temperate forests inhabiting over 1500 m above msl. The present study was restricted to

Mabuya allapallensis and *Aspideretes leithi* were recorded for the first time from Kerala. The amphibians, *Anosonia rubigina, Micrixalus thampii* and the reptile *Uraeoptyphlus menonii* were documented from new areas. *Anosonia rubigina* was recorded from Wayanad and the other two from Nilambur. Species diversity was high in deciduous forests. Amphibians were most abundant in plantations surrounded by natural forests and reptiles in deciduous forests. Leaf litter was found to be the most preferred microhabitat of amphibians, and tree trunk for reptiles. A detailed report (KFRI Research Report No. 147) on this study carried out by Dr. P.S. Easa from the Wildlife Biology Division has been submitted to the Ministry of Environment & Forests.

PTR has Half of Kerala's Flowering Plants

The Periyar Tiger Reserve (PTR), which has an area of 777 km² is located in the Western Ghats of Kerala. Dr. N. Sasidharan recorded 1965 taxa from the PTR in a floristic study. Among the 1272 species that are considered endemic to the Southern Western Ghats, 515 species were collected from the PTR. It is heartening to note that, 150 species that have been placed under various threat categories could be collected. They include 17 species categorised as 'possibly extinct'. The occurrence of 1965 species in an area of 777 km² indicates the richness and diversity of the flora of PTR. Nowhere in the subcontinent has such a large number of taxa been reported from an area comparable to that of PTR. The highest estimated number of species is 2000 for the Agasthymala region of Western Ghats, but it has an area of 2000 km². The 1965 species in the PTR is more than 50 per cent of the estimated flowering plants of Kerala! The study report (KFRI Research Report No. 150) has been submitted to the Kerala Forest Department (Wildlife Wing), who funded the project.

New Thinning Schedule for Teak Mooted

Mensuration combined with computer simulation has suggested a re-examination of the present thinning schedule followed for teak plantations in the State. The results of the simulation study conducted by Dr K. Jayaraman (Statistics Division) indicated that out of the four silvicultural thinning practiced after 10 years currently, there was no need for the first and second. Even when the two thinnings were avoided, diameter growth remained unaffected. The larger sized trees when harvested in later stages, resulted in increased overall volume. The results of the simulation studies will need to be tested in the field. A detailed project report (KFRI Research Report No. 141) has been submitted to the Kerala Forest Department who funded this project.

More Accuracy in Wildlife Census

The relative efficiency of some of the feasible methods of estimating the abundance of herbivores in the forests of Kerala has been subjected to statistical evaluation by a team of scientists, Dr K. Jayaraman, Dr P.S. Easa and Dr E.A. Jayson. This study has shown that total count is unsuitable for estimation of animal abundance as it leads to heavy undercounting. Line transect sampling has a firm theoretical footing but suffers from low number of sightings arising from low density of animals or poor detection percentage. Calibration of detection functions using random parameter models shall go a long way in making localized prediction of animal density and hence future works should attempt to develop generalized prediction models based on random parameter models. The methods based on indirect evidences also hold promise for the future and works can be undertaken to convert indirect evidences to animal numbers. Indices of abundance based on indirect evidences would serve most of the practical purposes in wildlife management. A report (KFRI Research Report No. 142) has been submitted to the Kerala Forest Department (Wildlife Wing) who sponsored this work.

Choosing a Data Analysis Method

Data arising from repeated measurements of experimental units occur on many occasions in forestry and related fields. Very often such data are analyzed without considering their several peculiarities, like correlation between successive measurements and heterogeneity of variances, which may lead to erroneous conclusions. Three different methods of analysing repeated measures *viz.*, two way analysis of variance, univariate mixed model analysis of variance and multivariate analysis of variance were evaluated with respect to their suitability in different contexts such as soil properties observed from multiple core samples and another study on annual yield of latex from rubber trees in three years. The study revealed that multivariate analysis

continuously in the laboratory on host larvae.

The general egg parasitoids *Trichogramma dendrolimi* and *Trichogramma embryophagum* parasitised *H. puera* eggs. Both the species preferred fresh eggs for parasitisation and the percentage parasitism on one-day old eggs was significantly lower. This indicated that successful parasitisation is dependant on timely release of parasitoids. The report (KFRI Research Report No. 129) submitted to the Kerala Forest Department concludes that practical biological control programme depends on our ability to predict the pest incidence so that inundative release of parasitoids in the field can be suitably timed.

A promising eucalypt

Eucalypts have always been criticised by environmentalists for high water consumption. However, the water consumption need not be very alarming if *Eucalyptus urophylla* is used in plantations. This is the finding of Dr. Jose Kallarackal and Dr. C.K. Somen, scientists from the Plant Physiology Division (KFRI) in a report (KFRI Research Report No.136) submitted to the Ministry of Environment and Forests, Govt. of India who sponsored a study on the water relations and rooting depth of selected eucalypt species. Out of the six eucalypt species, namely *E. tereticornis, E. urophylla, E. camaldulensis, E. deglupta, E. brassiana* and *E. pellita, E. urophylla* showed good ecophysiological features which help to conserve water by reducing excessive transpiration.

It may be noted that *E. urophylla* is one of the two eucalypt species reported to be a native outside Australia. This species is a native of Timor. The above study also revealed that *E. tereticornis*, presently planted in Kerala can have a rooting depth of 9.3 metres, which was the water table depth of the locality. This need not cause alarm, as wider spacing is reported to result in a reduced water consumption and in shallow rooting.

Juvenile wood is not inferior

Compared to mature wood, the juvenile wood in teak is characterized by wide growth rings, short fibres, high percentage of cell wall, wide microfibrillar angle, small diameter and low percentage of vessels and low or similar mechanical properties. Because all mechanical properties did not differ consistently between juvenile and mature wood, the former is not always inferior in timber strength to mature wood. This will be a good news for planters who manage short-rotation plantations of teak. The above finding was made by Dr. K.M. Bhat, scientist in the Wood Science Division while studying the cambial activity and juvenile wood formation in teak. The above results were submitted as a report (KFRI Research Report No.137) to the Department of Science and Technology, Government of India who sponsored this study.

A Sanctuary for Ferns

The Kerala Forest Department has implemented the Sylvan Valley Fern Sanctuary scheme with the help of KFRI. Dr Muktesh Kumar from the Botany Division collected and identified 159 species of ferns from different parts of Kerala. All these specimens are maintained in a fern house set up at Sylvan Valley. It is reported that there are 236 species of ferns and fern allies in the Western Ghats. This means that the collection in Sylvan Valley Fern Sanctuary is a good representation of the entire

Figure shows the ferns growing in the fern house at Sylvan Valley

Ghats. A detailed report (KFRI Research Report No. 145) on the work done by KFRI in this project has been submitted to the Kerala Forest Department who funded this. It is hoped that the nature lovers visiting Munnar will have another beautiful spot to visit in Sylvan Valley, which is located 12 km east of Munnar town in Idukki district of Kerala.

Wild Boars damage Crops most

A survey(KFRI Research Report No. 140) in the peripheral human settlements of the Peppara Wildlife Sanctuary has shown that wild boar causes the maximum damage to crops, compared to all other wild animals including elephants. Of the 30 species of larger mammals recorded from the sanctuary, five species were destructive to 17 crop species. Dr E.A. Jayson from the Wildlife Division who undertook this survey, in his report to the Kerala Forest Department (Wildlife Wing) has recommended the control of wild boar population also among other recommendations. He observed that solar powered electric fence can protect crops from elephants, sambar and gaur.

NEWS AND VIEWS

World Environment Day Celebrated

KFRI celebrated the World Environment Day by organising programmes for students of selected local schools in the Pananchery Panchayath. For seven days during June 15 -22, 1998 everyday 60 students each were brought to KFRI. They were given lectures on environmental conservation with the help of audiovisual aids. The students accompanied by their teachers also visited various Divisions of the Institute. Feed-back indicates that the students and teachers immensely enjoyed and benefitted from the programme. Dr P.S.Easa, Dr N. Sasidharan and Dr George Mathew led the programme with the help of the research fellows.

Training for PCKL Staff

KFRI organized a training programme on "Nursery and Plantation Practices of Forestry Species" for officials of the Plantation Corporation of Kerala Ltd. on 10-11 June 1998 and 11-13 August 1998 respectively. Mr. K.C. Chacko (Silviculture Division) co-ordinated both the training programmes. Additionally, another three-months training was organised for the JRFs of the PCKL on "Questionnaire-cum-field study on home gardens". This was co-ordinated by Dr P.K. Muraleedharan (Economics Division).

Costa Rican Team visits KFRI

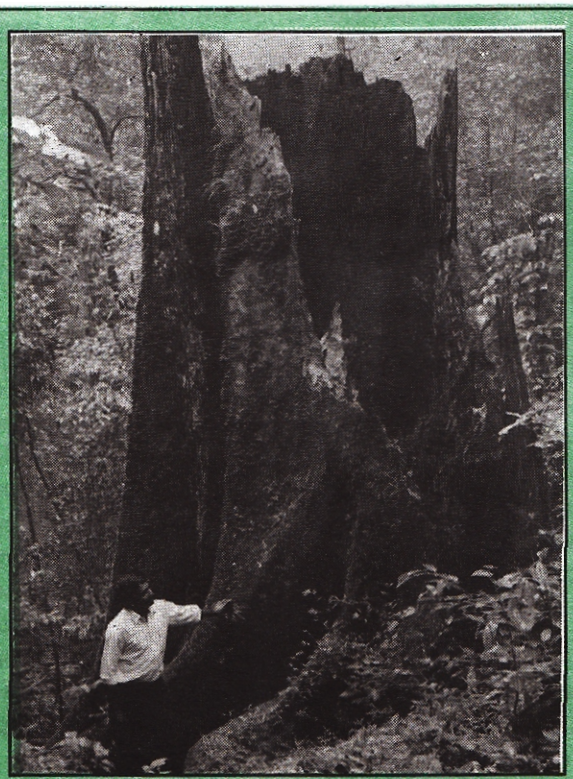
A team of forestry professionals interested in teak planting from Costa Rica visited KFRI during 11-12 August 1998. A training programme on the cultivation, management and protection of teak plantations was arranged for them at KFRI. The programme was coordinated by Dr K.M. Bhat (Wood Science Dn).

Low-cost Micropropagation

The State Committee on Science, Technology and Environment has sponsored a training course in "Low-cost micropropagation techniques" in KFRI as part of an ongoing research project. The training was held from March 16-21, 1998 in the Genetics Division. Farmers and housewives attended the training programme. The training was coordinated by Dr E.M. Muraleedharan (Genetics Division) and Dr U.M. Chandrashekara (Agroforestry Division).

The fall of a giant tree

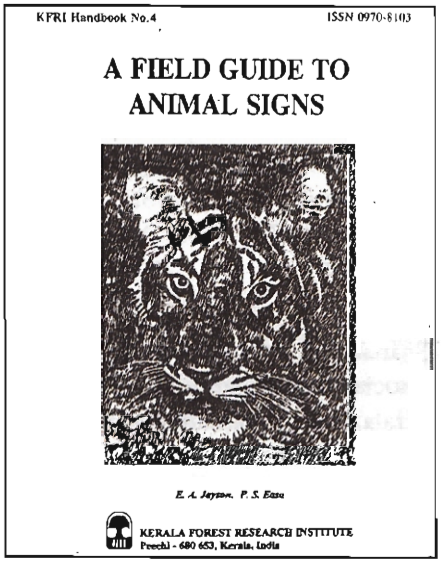
The giant hollow tree of the Silent Valley National Park that attracted the attention of many visitors is no more. Its giant size (height 40 m and GBH 13 m) and the hollow bole from base to top had attracted many visitors. The identity of the tree was a matter of dispute till Dr N. Sasidharan (NWFP Division) collected flowering twigs of this tree in 1989. Further studies by him and Dr K. Swarupanandan (Ecology Division) proved it to be an undescribed species. Later, this species was located at Punnamala, Sairanthry, Arvambara and a few other spots in the National Park. The species was named as *Cassine kedarnathii* Sasi & Swarup. (Fam: Celastraceae) (Reinwardtia, 11(1): 29-32) in honour of Dr S. Kedarnath, geneticist and former Director of KFRI who took keen interest in determining the taxonomic identity of this giant hollow tree. This species has not yet been reported outside the Silent Valley NP. Conservationists would be pleased to know that there is a good population of this species in the National Park.



Broken stump of Cassine kedarnathii photographed a week after its fall.

A Field Guide to Animal Signs

Most of the wild mammals are nocturnal and their direct sighting is difficult. But many of them declare their presence by way of indirect evidences or signs. Such evidences are used for many scientific studies on wild animals. Several census methods are also based on indirect evidences. A field guide published by KFRI describes twenty seven species of mammals based on



indirect evidences left by them. A key is also provided for identification of species based on indirect signs. Indirect evidences examined for this work include tracks, foot prints, droppings, gnawings on the bark of the trees, scratches on trees, rubbings and burrows. The field guide is illustrated with drawings and colour plates. It is hoped that this field guide will be useful to researchers, wildlife enthusiasts, foresters and volunteers who help in wildlife census. This guide is authored by Dr E.A. Jayson and Dr P.S. Easa, both from Wildlife Biology Division.

Familiarization Workshop on Bamboo

To acquaint the officers of Indo-German Reservoir Development Project, Malampuzha with the species diversity, cultivation and management of bamboo, a one day workshop was organized on 4 August 1998. Twenty five officials benefitted from this training. Dr S. Sankar (Agroforestry Division) coordinated the training.

Environment Awareness Campaign

A one-day National Environment Awareness Campaign Workshop was organized on 27 June 1998. KFRI conducetd this workshop at Gandhi Smarak Nidhi School, Vadakkanchery, Palakkad District. Dr S. Sankar (Agroforestry Division) organised the workshop.

An Initiation Workshop

A project initiation workshop on "Improving and maintaining productivity of eucalypt plantations in India and Australia" reviewed the researches on eucalypts done in India and Australia. The Australian group was represented by Dr. A.M. O'Connell, Prof. R.J. Gilkes and Dr. T.S. Grove. The KFRI team was led by Dr K. V. Sankaran (Plant Pathology Dn.). The interaction helped scientists from both sides to get a clear understanding of the productivity problems in both countries and to proceed with the right kind of research methodology.

Volunteer training for biodiversity register

Mr. E. M. Sreedharan, Member, Planning Board inaugurated the training of volunteers for the preparation of a Biodiversity Register for the Panacherry Panchayat on 9 May 1998. This is in connection with a project sponsored by the STEC and implemented by KFRI with peoples participation. The Panchayat President Mr. C. M. Damodaran, Professor T. P. Sreedharan and Professor M. K. Prasad served as Resource Persons for the training, in addition to several scientists from KFRI.

Forest Secretary visits KFRI

Mrs. Lissy Jacob IAS, Secretary of Forests to the Government of Kerala visited KFRI on 28 September 1998. She showed keen interest in the ongoing research work at KFRI and visited all Divisions and held discussion with scientists. Later, she visited Kottappara, near Kothamangalam accompanied by Dr. K.S.S. Nair, Director, Dr. J.K. Sharma, Research Coordinator and scientists of the Plan Pathology Division to see the tree improvement work on Eucalypts in progress. As a follow-up measure, she convened a meeting of the senior officials of the Kerala Forest Department and KFRI in Thiruvananthapuram to discuss ways to better utilise the services of KFRI and facilitate greater interaction with the Department.

Photograph shows Mrs. Lissy Jacob IAS along with the director Dr. K.S.S. Nair, Dr. J.K. Sharma and Mr. K.C. Chacko visiting the field experiments at Kottappara.

Recent Publications

Books/Chapters in Books

Balasundaran, M. and Gnanaharan, R. 1997. Timber defects of plantation grown teak and their implication on wood quality. In: *Teak* (Eds. S. Chand Basha, C. Mohanan & S. Sankar) Kerala Forest Department and Kerala Forest Research Institute. pp. 129-134.

Bhat, K.M. 1997. Timbers. In: *The Natural Resources of Kerala* (Eds. K. Balachandran Thampi, M.M. Nayar and C.S. Nair). WWF-India, Trivandrum. pp. 441-453.

Gnanaharan, R. and Balasundaran, M. 1997. Effect of mistletoe attack on teak wood. In: *Teak* (Eds. S. Chand Basha, C. Mohanan & S. Sankar) Kerala Forest Department & Kerala Forest Research Institute. pp. 122-123.

Indira E.P. 1997. Genetic improvement of teak in Kerala: Present status and future strategy. In: *Teak* (Eds. S. Chand Basha, C. Mohanan & S. Sankar) Kerala Forest Department & Kerala Forest Research Institute. pp. 154-156.

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No. 130. A.R.R. Menon 1998. Vegetation mapping and analysis of Eravikulam National Park using remote sensing techniques.

No. 140. E.A. Jayson 1998. Studies on the man-wildlife conflict in Peppara Wildlife Sanctuary and adjacent areas.

No. 141. K. Jayaraman 1998. Structural dynamics of teak stands in Kerala.

No. 142. K. Jayaraman, P.S. Easa & E.A. Jayson 1998. Evaluation of methods for estimating the abundance of herbivores in the forests of Kerala

No. 143. K.K. Ramachandran 1998. Ecology and population dynamics of the endangered primates in Silent Valley National Park.

No. 144. Mammen Chundamannil 1998. Teak Plantations in Nilambur : An economic review.

No. 145. M.S. Muktesh Kumar 1998. Studies on the fern flora of Kerala with special reference to Sylvan Valley, Munnar.

No. 146. George Mathew 1998. Mass rearing of selected butterflies for possible reintroduction in the conservation programme.

No. 147. K.S.S. Nair, V.V. Sudheendrakumar, R.V.Varma & K. Mohanadas 1998. Tracing the epicentres of teak defoliator outbreaks in Kerala.

No. 148. P.S. Easa 1998. A survey of reptiles and amphibians in Kerala part of Nilgiri Biosphere Reserve.

No. 149. P. Rugmini and K. Jayaraman 1998. Analysis of data from long term trials.

No. 150. N. Sasidharan 1998. Studies on the Flora of Periyar Tiger Reserve.

No. 151. K.S.S. Nair, R.V.Varma, V.V. Sudheendrakumar & K. Mohanadas 1998. Management of the teak defoliator (*Hyblaea puera*) using Nuclear Polyhedrosis Virus (NPV).

No. 152. U.M. Chandrashekara and S. Sankar 1998. Ecological and social importance of conservation of sacred groves in Kerala.

Campus News

New Research Projects

KFRI 295/98 : Raising planting stock of *Eucalyptus* clones for the Kerala Forest Department.

Investigators: Dr J.K. Sharma, Dr M. Balasundaran and Dr E.J. Maria Florence (Plant Pathology Division)

Objectives: 1) To raise planting stock of selected clones of *Eucalyptus* identified by KFRI and 2) to supply the clonal planting stock for establishing Clonal Multiplication Areas at Palode and Nilambur.

Funding source: KFD Forest Development Fund

Duartion: 6 months (Jan.-Jun.1998)

KFRI 296/98 : Fungal pathogens as a potential threat to tropical acacias - Phase II.

Investigators: Dr J.K. Sharma and Dr E.J. Maria Florence (Plant Pathology Division)

Objectives: 1) Identification of newly recorded pathogens of acacias in India, and further assessment of their potential for damage, 2) taxonomic investigations of existing collections and 3) preparation of manual of diseases of tropical acacias aimed at plantation managers and forest health officers.

Funding source: Centre for International Forestry Research (CIFOR), Indonesia

Duration: One year (Jan. 1998 - Dec. 1998)

KFRI 297/98 : Insect fauna of the shola forests of Munnar and Wayanad.

Investigators: Dr George Mathew and Dr K. Mohanadas (Entomology Division)

Objectives: 1) To determine the insect fauna (major groups) in the grassland-shola forests of Eravikulam and 2) to study the diversity and distribution of major groups in different biocoenoses in the grassland-shola forests.

Funding source: KFD Forest Development Fund

Duration: 2 years (Apr. 1998 - Mar. 2000)

KFRI 298/98 : Inventory of macro-invertebrate fauna of the shola forests of Kerala.

Investigator: Dr K.K.Ramachandran (Wildlife Biology Division)

Objectives: 1)To document the macro invertebrate fauna of the shola forests based on field collections. 2) To document the abundance of the major organisms within the shola forests. 3) To derive elevational specificity of the organisms based on the collections.

Funding source: KFD Forest Development Fund

Duration: 2 years (Apr. 1998 - Mar. 2000)

KFRI 299/98: Generation of basic data on variability of rubber wood in Kerala and formulation of grading rules.

Investigator : Dr R. Gnanaharan (Wood Science Division)

Objectives : 1) To generate data which are missing but are essential for effective utilization of rubber wood. 2) To formulate grading rules.

Funding source: Science, Technology & Environment Committee (STEC), Kerala.

Duration : 2 years (Apr. 1998 - Mar. 2000)

KFRI 300/98: Preparation of Biodiversity Register - A model study in Pananchery Panchayat, Thrissur District, Kerala.

Investigators: Dr K.S.S. Nair (Director)and Dr P.S. Easa (Wildlife Biology Division)

Objectives: To carry out a model study for documenting the people's knowledge about biodiversity conservation through people's Biodiversity Register at Pananchery Panchayat.

Funding source: State Committee on Science, Technology and Environment

Duration: 3 years (Apr. 1998 - Mar. 2000).

KFRI 301/98 : Floristic studies in Parambikulam Wildlife Sanctuary.

Investigator: Dr N. Sasidharan (NWFP Division)

Objectives: 1) To prepare an inventory of the plants of the Sanctuary. 2) To carry out floristic analysis with emphasis on dominant plant groups, endemic, rare and threatened species. 3) To find out areas with respect to species richness.

Funding source : KFD Wildlife Wing

Duration: 3 years (May 1998 - Apr. 2001)

KFRI 302/98 : Survey on the commercial exploitation of medicinal plants in the drug industry of northern Kerala.

Investigators: Dr N. Sasidharan

(NWFP Division) and Dr P.K. Muraleedharan (Economics Division)

Objectives : 1) To find out the source of supply of the medicinal plants. 2) To estimate the extent of medicinal plants from the forests. 3) To enlist the medicinal plants extracted from the forests and recommend species which needed urgent protection and conservation.

Funding source: KFD Wildlife Wing

Duration : 1 year and 6 months (May 1998 - Oct. 1999)

KFRI 303/98: Ecology of wetland birds in the kole lands of Kerala.

Investigator: Dr E.A. Jayson (Wildlife Biology Division)

Objectives: 1) To determine the status and distribution of wetland birds in Thrissur kole region, 2) to assess the seasonal fluctuation of wetland bird population, 3) food and feeding habits with special reference to cultivation damage and 4) identify and rate the conservation problems.

Funding source: KFD Wildlife Wing

Duration: 3 years (May 1998 - Apr. 2001)

KFRI 304/98: Documentation of vertebrate fauna in Mangalavanam Mangrove area.

Investigators: Dr E.A. Jayson and Dr P.S. Easa (Wildlife Biology Division)

Objectives: To document the fauna of the Mangalavanam mangrove, threat to the mangrove ecosystem and to suggest possible management strategies.

Funding source: KFD (Social Forestry Wing)

Duration: 1 year (May 1998 - Apr. 1999)

KFRI 305/98: Transfer of some wood processing technologies developed by ICFRE to wood using industries in Kerala.

Investigators : Dr R. Gnanaharan and Dr T.K. Dhamodaran (Wood Science Division)

Objectives : 1) To set up a solar kiln as a demonstration unit. 2) To demonstrate the techniques of plasticization of wood and bending. 3) To demonstrate colouring and ammonia fumigation of wood. 4) To promote simple preservative treatments in rural areas.

Funding source: ICFRE, Dehra Dun

Duration : Aug. 1998 - Dec. 1999

KFRI 306/98: Mass multiplication of selected bamboos by macro-propagation.

Investigator: Dr K.K. Seethalakshmi (Plant Physiology Division)

Objectives: 1)Testing simple techniques of macro-proliferation for *B. bambos* and *D. strictus* 2) production of planting stock in bulk and distribution, 3)preparation of brochure on simple techniques for bamboo propagation, 4) organization of a training on bamboo propagation.

Funding source: ICFRE

Duration: Aug. 1998 - Oct. 1999.

Participation in Seminars, Symposia and Workshops

Dr. K.M. Bhat (Wood Science) participated in the National Conference on teak during 25-26 May 1998 in Jabalpur and presented an invited paper on "Tree breeding for improved wood quality of teak." He also participated in National Seminar on processing and utilisation of plantation grown timbers and bamboo during 23-24 July 1998 in Bangalore and presented paper on " Properties and utilisation of small timber resource of teak plantations". Also he attended the INBAR meeting held on 25 July 1998 at IPIRTI, Bangalore.

Mr. K.C. Chacko (Silviculture) and **Dr U.M. Chandrashekara** (Agroforestry) attended the Workshop on "Setting Research Priorities for ICFRE in Forestry Research in Kerala" from 4-6 May 1998 at Thiruvananthapuram. Mr. Chacko attended the Seminar on "Role of Forest Education in Conservation of Natural Resources" on 22 May 1998 in Coimbatore. He also participated in the Launch Workshop of Kerala Forestry Project at Thiruvananthapuram during August 1998.

Dr P.S. Easa (Wildlife Biology) attended the Annual Symposium of International Society for Conservation Biology held at Macquarie University, Sydney, Australia during 13-16 July, 1998. Presented a paper on Man-Wildlife conflict in Wayanad Wildlife Sanctuary". He also attended the National seminar on Wildlife Conservation, Research and Managment from 10-13 August, 1998 organized by Wildlife Institute of India, Dehra Dun.

Dr E.J.M. Florence (Plant Pathology) participated in the 29th International Research Group on Wood Preservation Annual Meeting in the Netherlands during 14-19 June 1998 and presented two papers entitled "Sapstain fungi associated with softwood species in Kerala, India" by E.J.M. Florence, J.K. Sharma and R. Gnanaharan and "Temperature tolerance of *Botryodiplodia theobromae* causing sapstain in rubber wood" by E.J. Maria Florence, J.K. Sharma and

R. Gnanaharan. She also participated in the National Seminar on Processing and Utilisation of Plantation Timbers and Bamboo at IPIRTI, Bangalore during 23-24 July 1998 and presented a paper on "Strength properties of rubber wood affected by sapstain" by E.J. Maria Florence and J.K. Sharma.

Dr R. Gnanaharan (Wood Science) attended the Timber Sub-committee meetings CED 9:3 and CED 9:9 of the Bureau of Indian Standards held at FRI, Dehra Dun on 19 May 1998. Also, he attended the Timber Sectional Committee meeting CED 9 of the Bureau of Indian Standards held at Bangalore on 22 July 1998. He also attended the National Seminar on Processing & Utilisation of Plantation Timbers and Bamboo organized by IPIRTI, Bangalore during 23-24 July 1998.

Dr K.S.S. Nair (Director) and **Dr A.R.R. Menon** (Ecology) participated in the National Workshop for user Interaction on the Application of Remote Sensing Technology for the Management of Natural resources - RESEREON- KERALA-98 held at Thiruvananthapuram on 16 September 1998. Dr Menon contributed a paper on "Bamboo Resource Estimation Using Remote Sensing".

Dr K.K.N. Nair (Botany) attended a workshop of National Wasteland Development Board at Chennai during April 19-21, 1998. He also participated in another workshop on setting up Forestry Research Priorities organized by ICFRE and KFD in Thiruvananthapuram during 4-5 May 1998.

Dr S. Sankar (Agroforestry) participated in the International Project Advisory Panel meeting of CIFOR held on 24-26 March 1998 in Rome. He presented a paper on Criteria and Indicators for Sustainable Management of Teak Plantations in Kerala. He also participated in the Launching Workshop of the Kerala Forestry Project on 20-21 August 1998.

Dr J.K Sharma (RME) presented a paper entitled "Tree improvement of eucalypts for high productivity and disease resistance to *Cylindrocladium* leaf blight and pink disease in Kerala" by J.K Sharma, M. Balasundaran and E.J.M Florence in the International Symposium on Plant Pathology held at Indian Agricultural Research Institute, New Delhi during November 1997. He also attended the IUFRO International Symposium on micropropagation and spread of superior genetic material held at WWF Auditorium, New Delhi during 10-12 April 1998 and presented a paper entitled "Clonal propagation in tree improvement of eucalypts for high productivity and disease resistance" by J.K Sharma, M. Balasundaran and E.J.M. Florence.

Dr V.V. Sudheendrakumar (Entomology) attended the IUFRO workshop on "Pest management in Tropical forest plantations" organized by the IUFRO working group S7.03.09 at Bangkok, Thailand during 25-29 May 1998, and presented a paper entitled "Feasibility of using *indigenous parasitoids for biological* control of the teak defoliator".

Guest Lectures

Dr K.M. Bhat, as guest faculty, gave lectures and conducted wood anatomy practical for the ACF trainees at SFS College, Coimbatore during 16-21 March 1998. Dr Bhat also gave lectures on " Utilisation of wood and non-wood forest resources" and "Application of wood anatomy in tree breeding for wood quality" on 20 June 1998 to the participants of UGC refresher course in the Department of Applied Botany of Mangalore University, Mangalagangotri.

Mr. K.C. Chacko, took a class on General Silviculture on 19 May 1998 for the III Semester Master of Environment Management students from the School of Environmental Studies, Mahatma Gandhi University, Kottayam.

Drs R. Gnanaharan, K.K.N. Nair, R.C. Pandalai and T.K. Dhamodaran gave invited talks to the participants of the seminar on "Wood Industry - Problems & Prospects" organized by the Thrissur District Panchayat at Ollur on 25 July 1998.

Dr R.C. Pandalai, took a class on "Our neglected trees and how to grow and manage them" in connection with a one-day Environmental Awareness Camp under the auspices of the National Environment Awareness Campaign 1998 on 27 June 1998 at The Gandhi Smarak Sevakendram, Anjumoorthimangalam.

Research Visits

Dr K. Jayaraman spent 3 months at *the Finnish Forest Research Institute,* Suonenjoki, Finland during the months of March - June 1998.

Dr J.K. Sharma attended a two-week training programme on "Forestry Research Strategy Formulation, Planning and Management" during 10-22 April 1998 at Universiti Putra, Malaysia. The participation was sponsored by FORSPA, Bangkok. He also attended a five week hands-on

training in the use of biochemical and molecular markers in eucalypts at the CSIRO Division of Forestry and Forest Products, Canberra, Australia during June-July 1998.

Exhibitions

KFRI participated in the *Rajakad Fest-1998* conducted from 2nd to 6th April 1998 by providing an information stall on forestry.

KFRI Seminars

The following seminars were given in KFRI:

Mr. K.H. Hussain, KFRI Library - ISIS Personal: application of CDS/ISIS for the management of personal information system - 17 March 1998.

Dr Prem Masand, Global Hospital and Research Centre, Mt. Abu, Rajasthan - Self Management qualities - 28 April 1998.

Dr Radhika, Management Centre, Hyderabad - Leadership attitude - 28 April 1998.

Dr R. J. (Bob) Gilkes, Professor and Head, Department of Soil Science and Plant Nutrition, University of Western Australia - Properties of Lateritic Soils from South Western Australia - 30 April 1998.

Dr V. V Sreenivasan, Former Director, Institute of Wood Science and Technology, Bangalore - Wood preservation -14 July 1998.

Mr. Abdul Kareem, Puliyamkulam village, Kodon Bailur, Kanhangad led a discussion based on his experience of raising 32 acre forest - 24 July 1998.

Dr C.T.S. Nair, Senior Programme Advisor, FORSPA, FAO, Bangkok - Activities of FORSPA and funding opportunities - 7 August 1998.

Dr Mark Wilkinson, School of Biological Sciences, University of Bristol and British Natural History Museum, London, U.K. - Naked Snakes - 11 August 1998.

Dr A. P. Gore, Professor and Head, Department of Statistics, University of Pune - Forecasting weather for pests management - 18 August 1998.

Distinguished Visitors

Mr. Lionel Jayanetti and **Mr. Paul Follett** of TRADA Technology Limited, High Wycombe, U.K. visited the Institute on 27 July 1998.

Ms. Tuyen Pham, Chemical Analyst, CSIRO, Division of Forestry and Forest Products was a visitor at the Soil Science Division for two weeks in March 1998.

Mr. K. N. Kurup, Secretary Planning visited the Institute on 22 May 1998.

Dr Harsh Gupta, Director, National Geophysical Institute, Hyderabad visited KFRI on 23 June 1998.

Professor K.R. Shivanna, Professor of Botany, University of Delhi visited KFRI on 18 August 1998.

Professor R.J. Gilkes, Professor of Soil Science, University of Western Australia was in KFRI during 18-30 April 1998.

Ph.D. Awarded

Mr. Mammen Chundamannil has been awarded Ph.D. degree in Social Sciences by the Cochin University of Science and Technology for his thesis entitled "Teak plantations in Kerala: An analysis of productivity and profitability". He was guided by Prof. K.K. George, Director, School of Management Studies, CUSAT.

Mr. T.K. Dhamodaran has been awarded the Ph.D. degree by the Cochin University of Science and Technology for his thesis, "Preservative treatment and chemical modification of rubber wood". He was guided by Dr R. Gnanaharan, Wood Science Division.

Mr. B. Jayasankar has been awarded Ph.D. degree by the FRI Deemed University, Dehradun for his thesis entitled "Economic analysis of Forest Resource Management: A study of Bamboos in Kerala". He was guided by Dr P.K. Muraleedharan, Economics Division.

Mr. P. Jeyakumar was awarded Ph.D. degree in Forestry by the FRI Deemed University, Dehradun for his thesis entitled "Physiological investigations on the performance of oil palm (*Elaeis guineensis* Jacq.) introduced into India from different sources". He was guided by Dr Jose Kallarackal, Plant Physiology Division.

Mr. A.O. Varghese was awarded Ph.D. Degree in Botany from FRI Deemed University Dehradun for his thesis entitled "Ecological studies of the forests of Peppara Wildlife Sanctuary using remote sensing techniques". He was guided by Dr A.R.R. Menon, Ecology Division.

Nominated

Dr. K.M. Bhat has been nominated as a member of the Technical Foundation Committee of TEAK 2000, operated from Ireland.

Dr. C. Renuka and **Dr. M.S. Muktesh Kumar** were nominated as members of the organising committee for the National Seminar on Biodiversity Conservation at Kozhikkode.

Evergreen

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KFRI Publications (priced)

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1.	Ecodevelopment of Western Ghats	30.00	200.00
2.	Rattans of Western Ghats	10.00	100.00
3.	Structure and Properties of South Indian Rattans	08.00	75.00
4.	Tropical Forest Ecosystem Conservation and Development in South-East Asia	30.00	200.00
5.	Rattan Management and Utilization	35.00	300.00
6.	Litter Dynamics, Microbial association and Soil Studies in *Acacia auriculiformis* Plantations in Kerala	08.00	75.00
7.	Socio-economic Research in Forestry	40.00	350.00
8.	History of Forest management in Kerala	15.00	150.00
9.	Teak (Information Bulletin)	05.00	15.00
10.	Upgradation of rubber wood	08.00	75.00
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16.	Forest Trees of Kerala	10.00	30.00
17.	A Field Guide to Animal Signs	10.00	40.00
	Educational Videos (VHS)		
1.	The Teak Defoliator	50.00	500.00
2.	Bamboo - A Crop	50.00	500.00

Prices are inclusive of inland and surface-mail postal charges. Those who wish to receive by air-mail may please ask for an invoice.

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FOREST TREE SEEDLINGS AVAILABLE FOR DISTRIBUTION.

KFRI has in stock seedlings of a number of tree species meant for distribution. They include:

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5. *Thespesia populnea* (Poovarasu)
6. *Aegle marmelos* (Koovalam)
7. *Castanospermum australe*
8. *Cassia fistula* (Kani konna)
9. *Artocarpus hirsuta* (Anjili)
10. *Santalum album* (Chandanam)
11. *Wrightia tinctoria* (Danda pala)
12. *Bambusa vulgaris* (Yellow bamboo)

Advance order can be placed for seedlings of species not mentioned above. Details of supply are available from the Silviculturist, KFRI, Peechi 680 653, Kerala. Ph: (0487) 782037.