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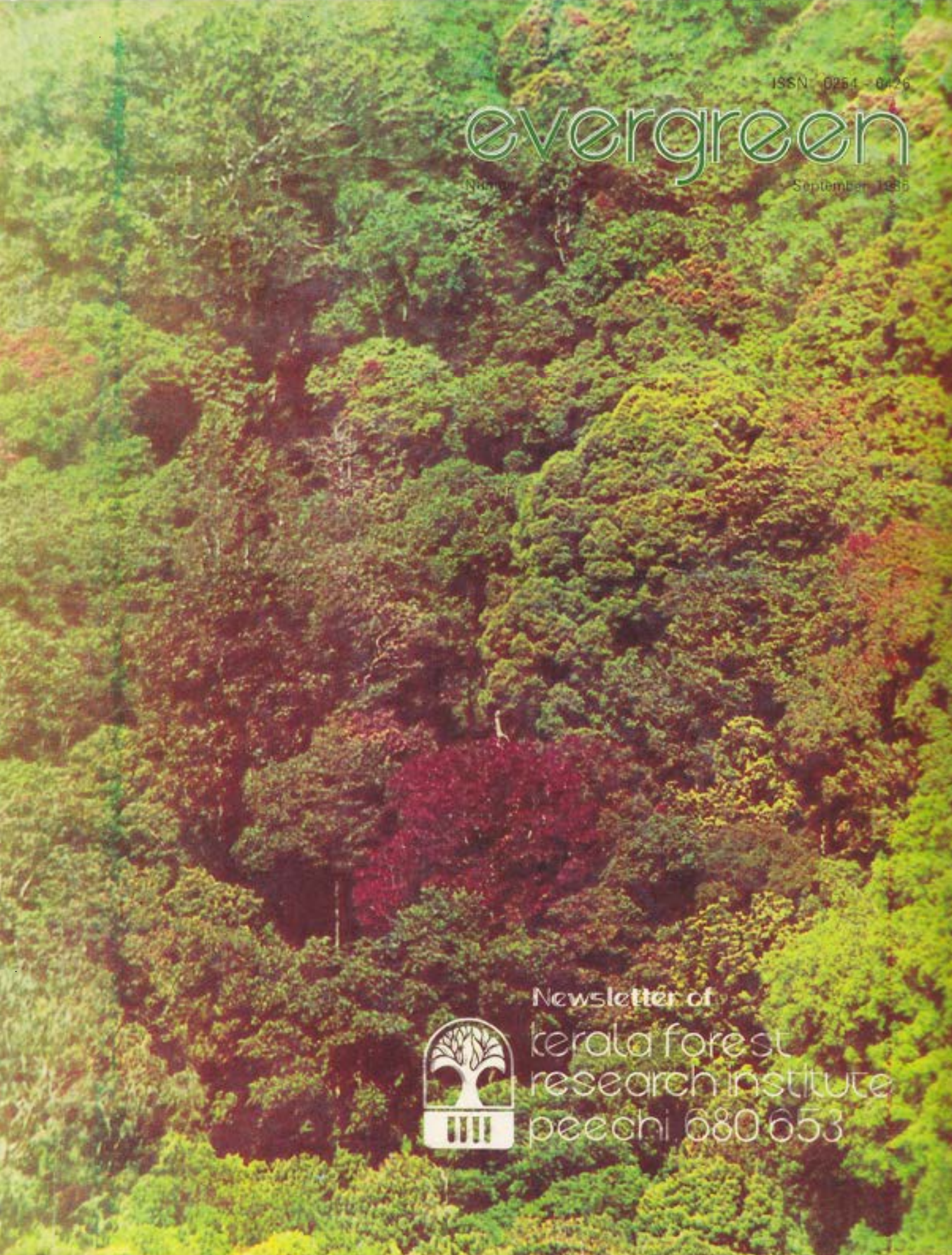

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kerala forest research institute

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Editor's column

Wasteland Development

Land degradation is not a new phenomenon. Civilizations, one after another, have left behind vast areas of wastelands. Land has been damaged due to mismanagement of the resources when the ability of the same to support humans and animals has been surpassed. Lack of integrated development policies and over exploitation of the resource base through compartmentalised development programmes have resulted in socio-economic and cultural conflicts which have left deep scars on the people as well as on the land.

The poorest sections of the society depend for their subsistence needs on the common lands, the uncultivated half of India. Over the years, these lands - forest lands, grazing lands and other common lands have become highly degraded. This situation has resulted not only in the reduced availability of fodder, fuelwood, timber etc. for the poor, but also in accentuation of floods, soil erosion etc. which adversely affected the productivity of agricultural lands. Of the 329 million hectares land area in the country about 175 million hectares are degraded.

Taking into account these facts, a massive programme for wasteland development has been launched in the country to green over 75 million hectares of land available in both the private and public sectors within a time span of 15 years. The immediate aim of the programme is to as quickly as possible revegetate the degraded areas to prevent further detericration and generate employment for the rural poor during the non-peak agricultural season. The long-term benefits will be climatic amelioration, improvement in land productivity, sustainable supply of fuelwood, fodder and timber and betterment in the quality of life of the rural poor.

To convert the wasteland development programme into a people's programme, a departure from existing strategies and formulation of new policies, new alternatives and new structures are necessary. Vital issues need to be solved in a short time regarding the choice of agencies for implementation, species for planting, meeting the day to day needs of the population and ecologically stable restoration of degraded lands.

The Forest Departments of various states have been identified as nodal agencies in the implementation of the programme, but, unfortunately, they are not geared up technically and organisationally to carry out such people-oriented work. They do have a tragic history of dealing with the people in the past and even with the social forestry projects being implemented for the last few years, the performance is not laudable. Forest Departments concentrate mainly on seedling production and distribution while planting and after-care are left unattended. Species selection is guided by factors other than the needs of the population and sustainability of the objectives of the programme. This has been the case with the ongoing social forestry projects and waste-land development as preceived today as a giant social forestry project may not deviate much from this trend.

Although the role of non governmental organisations and voluntary agencies has been highlighted quite often in paper, their actual participation in the programme will be restricted only to planting operation without a say on what and where to plant and how to distribute benefits therefrom.

As the revegetation of the private wastelands is going to be launched with support from banking institutions (NABARD etc.), permanent and sustainable tree cropping and forestry will not be an outcome. Because loans have to be repaid within a fixed time frame fast growing, single end use species like eucalypt will be preferred against traditional trees with a variety of uses. The afforestation package will be market oriented, vitiating the high sounding goals and objectives of the programme. The rural poor, who have been identified as the target group in this programme cannot receive much benefit, while most of it will flow into the coffers of big industries and large farmers, the former capable of

Endemic Trees of Western Ghats

Humboldtia unijuga Bedd. (Caesalpiniaceae)

A medium sized tree reaching 20 m height with blackish bark and pale pinkish blaze, ***Humboldtia unijuga*** is found restricted to the evergreen forests of south Travancore-Tinnelveli mountains at an altitude of about 1500 m. The leaves with a single pair of subsessile, lanceolate and acuminate leaflets, have a broad gland at base. The flowers are bright red, borne on short cauliflorous racemes. The oblique, compressed and acuminate pods (10 x 3 cm) are 2 to 3 seeded.

The species is found in abundance towards the base of Agastyar Peak, a phenomenon rather rare among our endemic trees. Though said to yield a very hard and durable timber no studies are available on the wood properties of this interesting tree. The 'Kani' tribals (dominant hill tribe of South Travancore region) call the species 'Palakan' which literally means Protector, and the species do protect the soils in the steep slopes where it is found to grow.

N. G. Nair
Division of Botany

(a) Twig (b) Flower

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consuming industrial raw material and the latter producing it in large quantities.

One objection being raised repeatedly at various official circles to the inclusion of a variety of traditional indigenous species in the afforestation programme is the lack of information on them for raising on a large scale. Unless indepth research on these lines is initiated, the programme will end up with a few million hectares of plantations tuned to supply industrial raw material. Management of such areas will be aimed at timber production rather than for creating ecological and economic stability in rural areas which is the prime objective of the programme. Such a situation will further degrade our lands, deplete our soil resource and worsen the condition of the rural poor.

Another important issue related to wasteland development is that what appears to be degraded and barren land may be providing the needed resources to individuals, often the poorest members of the society. Planting such lands with commercial crops will directly affect their livelihood. More vital, given the power structure in society, these deprived individuals may not stand to benefit in the long run from the development of wastelands.

Rather than formulating and implementing narrow market oriented projects, the efforts should be directed towards reestablishing a long-lost relationship that will permit sustainable use of soil, water, vegetation etc. A rethinking, is necessary at this juncture on the various issues and compartmentalised approach to problem solving should be discarded. The wasteland development programme has to form a part of the integrated development plan of basic resources like soil, water, forests, etc. □

Divisional Highlights - 8

Silviculture

Silviculture occupies a pivotal position in forestry somewhat analogous to that of agronomy in agriculture. Like forestry itself, Silviculture is an applied science which rests ultimately upon the fundamental natural and social sciences. The subject Silvicultural practice consists of various treatments of forest stands that may be applied to maintain an enhanced productivity. In a forest research institute with various disciplines the Silviculture Division forms the link between theory and practice

The Division, established about ten years ago, has been concentrating its activities on techniques of afforestation, management of plantations, raising of nurseries and establishment of live collections.

The forests of Kerala are sprinkled with grasslands which have to be brought under productive use. With this in view, a project on afforestation of grasslands was taken up at Chandanathode of Wynad Forest Division (Fig. 1). These grasslands (at 800 meters elevation) bordered by evergreen forests are at an arrested stage of succession due to to repeated fires. The experiment carried over five years revealed that ***Eucalyptus grandis, Casuarina equisetifolia*** and ***Grevillea robusta*** can be successfully used in afforestation of such grasslands (Fig. 2), provided adequate fire protection is ensured.

Fig. 1. Grass lands of Wynad

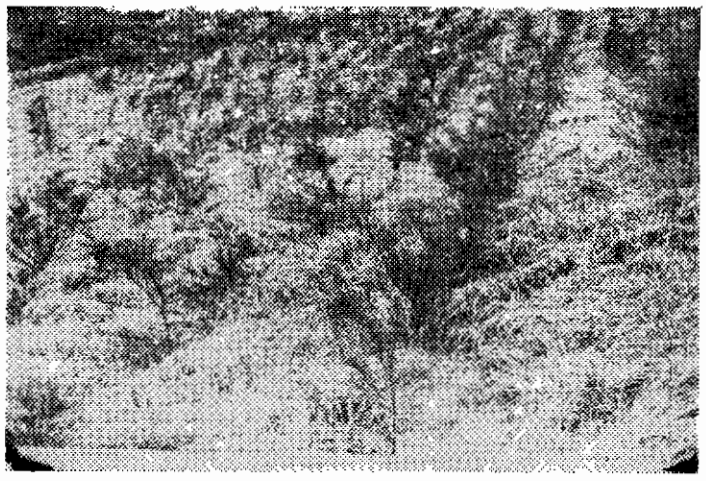

Fig. 2. ***Casuarina equisetifolia*** -
The best for afforestation.
The photograph was taken after weeding the area.

Studies have also been made on the possibilities of using stump as a planting material in the case of ***Eucalyptus tereticornis.*** As per the present indication though stumps can be produced with adequate roots and shoots, the establishment rate after outplanting is rather low.

Yet another project taken up, was to investigate the effects of the common practice of slash burning on tree growth and soil properties. The experiment was carried out at Nilambur in a teak final felling area. Preliminary indications are that better teak growth was observed in unburnt areas.

Another experiment was taken up for raising seedlings in polyurethane foam as against the conventional soil medium. Very successful establishment of ***Eucalyptus tereticornis, E. grandis,***

Anthocephalus chinensis and bamboos have been achieved. (Figs. 3 and 4) This may ultimately lead to a heavy reduction of costs in nursery practices.

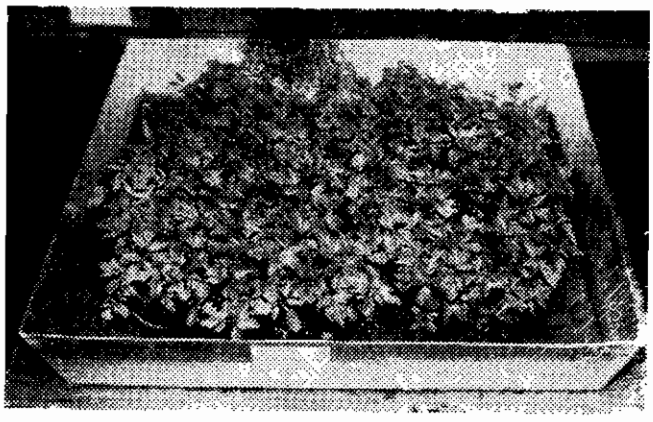

Fig. 3. Seedlings of *Anthocephalus chinensis.*

Twentyone species of bamboos from various parts of India have been introduced and the live collection maintained at the bambooteaux in Nilambur. Addition to these will be made.

Working of the evergreen forests in the past, not not always adhering to the prescriptions of working plans, has led to disturbance of the regeneration. Damages due to fire and excessive grazing have also affected their recouperance. Sporadic attempts at an artificial regeneration, have not been successful. A current technique followed elsewhere, of planting tall nursery seedlings (1 year old) may help in the sustainable management of evergreens. Tall seedlings have an advantage of not being smothered by the heavy incidence of quick growing heliophytes which appear once the canopy is opened up. Planting tall seedlings over the height of these pioneers will obviate atleast this constraint.

The Kerala Forest Department is taking up a massive and highly ambitious programme of under planting the teak plantations with bamboo - a resource that is getting rapidly depleted due to heavy indents from the ever increasing demand of the pulp units in the state. The Division has rendered technical expertise to the department on this issue and trials in the Trichur Forest Division are promising. Besides, the Division maintains a close liaison with the Department and its day to day problems are tackled. The thrust areas of the Division for the future include developing suitable techniques for raising monoculture and mixed stands of indigenous species like *Hopea, Dipterocarpus,* Reed, Canes, *Terminalias*, etc.

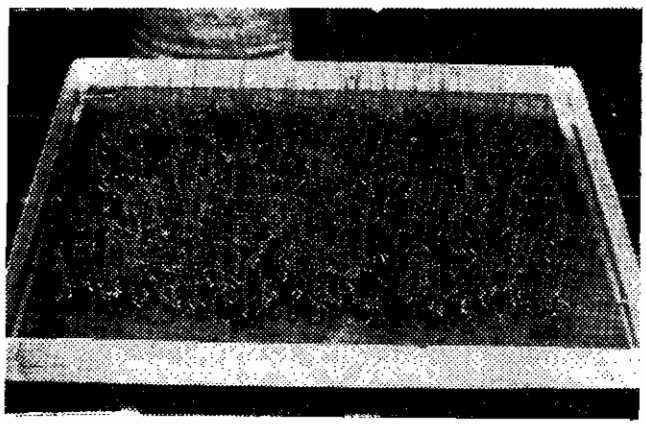

Fig. 4. Seedlings of *Eucalyptus tereticornis.*

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Interview

Wasteland Development Programme

— Prospects and Problems

Sri A. L. Rao, IFS (Retired) is a Forestry consultant and coordinator for model wasteland development projects preparation for South India. The Evergreen interviewed him in May 1986.

Evergreen: What are the factors that have led to the sudden realisation of developing wastelands, which have been existing for quite a long time?

Rao: It is not that there has been a sudden realisation about the existence of wastelands. For the past several years the idea of wasteland development was being discussed at all levels. About five years ago a paper entitled "The Uncultivated Half of India" was published based on the study made by U. S.- Aid, while trying to implement a Ford Foundation project in Madhya Pradesh. For the first time it highlighted the existence of extensive wastelands both within the reserved forests and outside. Later "Society for the Promotion of Wasteland Development" was set up in New Delhi with a number of senior officials and others as members with Smt. Kamala Chowdhury at Executive Secretary and Dr. M. S. Swaminathan as Chairman. The Society attempted to quantify the available wastelands and undertook an extensive survey. The area of wastelands available in the country was estimated to be about 90 million ha by Mr. Vohra, a staunch conservationist. He stressed the need for developing this large extent of wastelands which are remaining unproductive or underproductive, in his thought provoking paper entitled "Greening of India" which appeared sometime in 1983. Subsequently the National Wasteland Development Board was created by G. O. I. with Dr. Kamala Chowdhury as Chair person and the Prime Minister announced a massive annual wasteland development programme of about 5 million hectares annually to revegetate about 75 million ha. of critical area within a time span of 15 years. Thus a lot of spade work was done during the past five to six years, which finally resulted in the present situation with awareness on the need and magnitude of wasteland development programme seeking to all levels in all spheres.

THUS A LOT OF SPADE WORK WAS DONE DURING THE PAST FIVE TO SIX YEARS, WHICH FINALLY RESULTED IN THE PRESENT SITUATION WITH AWARENESS ON THE NEED AND MAGNITUDE OF WASTELAND DEVELOPMENT PROGRAMME SEEKING TO ALL LEVELS IN ALL SPHERES.

Evergreen: What are the short-term and long-term goals of the programme?

Rao: The immediate aim is to, as quickly as possible, bring back to productivity extensive wastelands so that further degradation is stopped atleast. Wasteland development is intimately connected with control of floods, soil erosion etc. This programme will also generate a lot of employment in rural areas particularly during the non peak agricultural season. Longterm benefits, of course, will be climatic amelioration, setting right the ecological balance and improvement in the supply of fuel wood, fodder and timber mainly for the rural population and that too for the weaker sections.

Evergreen: What is a wasteland?

Rao: There is no unanimous definition yet for the term wasteland. Several agencies gave different interpretations, but, I think the one which is commonly accepted is "that any land which is either unproductive or underproductive and which is getting further degraded due to non use or misuse". Such a definition covers both the economic and ecological aspects of wastelands.

Evergreen: Will the degraded areas within the reserved forests be classified as wastelands?

Rao: There is lot of debate regarding this issue. Most foresters are against the inclusion of degraded reserved forests in the category of wastelands, as they fear, on the basis of past experience, that such a situation may throw open forest areas to the people, and even if only tree pattas are granted such forest land may be lost once for all, and finally brought under agriculture. I, however, foresee that in the near future, degraded forest areas will also be thrown open to landless poor for afforestation on tree patta scheme with suitable safeguards as the Forest Department will not be geared to the task of afforesting the extensive degraded forest lands on its own within a reasonable time.

I, HOWEVER, FORESEE THAT IN THE NEAR FUTURE, DEGRADED FOREST AREAS WILL ALSO BE THROWN OPEN TO LANDLESS POOR FOR AFFORESTATION ON TREE PATTA SCHEME WITH SUITABLE SAFEGUARDS AS THE FOREST DEPARTMENT WILL NOT BE GEARED TO THE TASK OF AFFORESTING THE EXTENSIVE DEGRADED FOREST LANDS ON ITS OWN WITHIN A REASONABLE TIME.

Evergreen: What is the difference between the wasteland development programme as perceived today and the Social Forestry projects in vogue at present?

Rao: I do not think there is much difference. Wasteland development is a new name given to the Social Forestry programme being implemented in the country. Most Social Forestry programmes are concentrated on degraded and vacant lands owned by various government departments, including the Forest Department. It has also a component called 'Farm Forestry' aimed at tree growing in private lands. But emphasis has never been laid on large scale planting up of marginal and submarginal private lands. Thus, the wasteland programme, for the first time, focussed on the fact that there is another category of unused or underused land available in a big way which is estimated to be nearly 40 million hectares. The programme encompasses and lays stress on developing such lands by bringing them under tree cover for a combination of uses, and to prevent further degradation.

Evergreen: What will be the approximate cost of the wasteland development programme?

Rao: Out of an estimated wastelands of nearly 120 million hectares in the country, about 75 million hectares are proposed to be covered under this progamme at a total cost of about Rs. 10,000 crores, with an annual investment of Rs. 700-800 crores, over a 15 years period. G. O. I. does not foresee any difficulty in providing this much of funds annually for this programme, by bringing together the money already available from the Bilateral Social Forestry Projects (World Bank, SIDA, U. S. Aid, CIDA etc.) and the NREP, DPAP, RLEGP, DRDA, Desert Development Programmes etc. But the real problem is whether we are geared up for this much activity and whether adequate machinery is available to make full use of these funds, to produce lasting results. As you know, the Prime Minister has fixed an annual target for this programme at 5

BUT THE REAL PROBLEM IS WHETHER WE ARE GEARED UP FOR THIS MUCH ACTIVITY AND WHETHER ADEQUATE MACHINERY IS AVAILABLE TO MAKE FULL USE OF THESE FUNDS, TO PRODUCE LASTING RESULTS.

million ha. At the National Wasteland Development Board meeting held early this year, the target for 1986-87 was brought down to 3.5 million ha. I understand that from that latest estimates as worked out for 86-87 the maximum that can be achieved during 1986-87 will be around 2.5 million hectares only. This would mean that the money available for 1986-87 will not be fully utilised. Yet there is another aspect of wasteland development. For the 40 million ha. of wastelands available in the private sector, development funding is going to be from institutions like banks. NABARD is going to play a big role in this by arranging refinancing and NABARD management has indicated that there will not be any hesitance on their part in financing wasteland development projects. Guidelines have already been prepared and circulated to all the scheduled banks on financing of wasteland development projects.

Evergreen: What are the agencies identified for implementing this programme?

Rao: This programme is to be implemented with involvement of people at all stages in a big way. The Forest Departments of various states have so far been identified as nodal agencies for implementing these programmes, as, these are the only organizations with adequate infrastructure, man power, and technical competence at present to take up such a massive programme without delay and without any difficulty. But there is some apprehension in certain circles, considering the past performance of the Forest Departments in dealing with people, that the Forest Departments cannot involve people in this programme effectively, and to really work with the people.

Involving Non-Government agencies in a big way is being considered to tackle this problem. Although these agencies have an excellent record of effective work with the masses covering various aspects of rural development, their total coverage on a national scale is very small at present, and it is to be seen as to what extent the N. G. As will gear themselves up for effective implementation of this programme in the areas of their operation and beyond. An alternative is to use these Non-Governmental Organisations as the nuclei for the programme implementation, hoping to create the required momentum for the programme.

Evergreen: Will the attitudes of the Forest Departments change over time while dealing with such a peoples' programme?

Rao: They will have to change. You see, when Social Forestry Projects were taken up, it was assumed that the Forest Departments will adapt to the new environment, and train a set of extension staff who have the capacity to work with the people and are well versed in extension activities. But unfortunately we have not been able to, by and large, develop such an expertise so far in the Social Forestry sector in any state. This is mainly due to the preoccupation of the Forest Departments implementing Social Forestry programmes, in chasing large targets, targets which are too heavy for an organisation which is not geared up to execute such work and without adequate infrastructure. Further a lot of changes are required in the procedures and rules of the Forest Departments, so that they can be transformed into extension agents in the field. Unfortunately very little has been done to liberate the Forest Departments from the rigid sets of rules and regulations. There lies the problem, and the earlier steps are taken to change the system, the better. If this happens, I am sure, the Forest Departments will be able to adapt themselves to the new environment and function much better.

Evergreen: Is tree planting going to be a major or the only component in wasteland development?

Rao: I do not think that tree planting is going to be the only component, but it is going to be a major component. Emphasis is ceriainly going to be on raising tree species with multiple enduses like, fuelwood, small timber, fruits fodder etc. But there could be and I stress there should be, substantial components of other types of vegetation adapted to the soil and agroclimatic conditions of the given area.Thus even agricultural crops (annuals) are not going to be ruled out at all, with Agroforestry coming into play in several

situations. A rational mix up of trees and agricultural crops to prevent further degradation of the land, and also at a later stage to enhance productivity will be ideal. Intercropping with Subabul *(Leucaena leucocephala - ed.)* is an example. Shrubby vegetation, legumes and grasses, will also have an important role to play in wasteland development. No single species should dominate, especially in the development of the wastelands in the private sector.

EMPHASIS IS CERTAINLY GOING TO BE ON RAISING TREE SPECIES WITH MULTIPLE ENDUSES LIKE, FUELWOOD, SMALL TIMBER, FRUITS, FODDER ETC BUT THERE COULD BE AND I STRESS THERE SHOULD BE, SUBSTANTIAL COMPONENTS OF OTHER TYPES OF VEGETATION ADAPTED TO THE SOIL AND AGROCLIMATIC CONDITIONS OF THE GIVEN AREA.

Evergreen: Will the choice of species depend mainly on the bankability especially when private wastelands are being proposed to be developed with institutional financing?

Rao: With loan financing from bank, short rotation fast growing crops will be preferred in the private sector. The existing guidelines of NABARD are that repayment of loan should be completed within a maximum of 15 years. There is hardly any indigenous species that grows fast enough to be harvested in 8-10 years time and adequate returns also realised so that repayment with interest is ensured within this stipulated period. So, naturally, the emphasis has been and will be on species like ***Eucalyptus***, ***Casuarina,*** Subabul, Bamboo, Teak etc. in tree farming in the private sector. There are, of course, many indigenous species, like Neem, Tamarind, Mahua etc. which can be considered, but we should not forget the time frame in which these can be grown to harvestable size even for the fruit production of adequate quantity. The returns should be compatible with the NABARD guidelines for economic viability of project and repayment of loans. In the interest of encouraging multiple use and long gestation indigenous species in waste land development, GOI will have to seriously examine the need and take every action by issuing directives to the banks and other financial institutions to increase the time frame for loan repayment and also to reduce substantially the existing rates of interest charges on such programmes.

IN THE INTERESTS OF ENCOURAGING MULTIPLE USE AND LONG GESTATION INDIGENOUS SPECIES IN WASTELAND DEVELOPMENT, GOI WILL HAVE TO SERIOUSLY EXAMINE THE NEED AND TAKE EVERY ACTION BY ISSUING DIRECTIVES TO THE BANKS AND OTHER FINANCIAL INSTITUTIONS TO INCREASE THE TIME FRAME FOR LOAN REPAYMENT.

Although the interest rates of 10.25 to 12.2% as now being charged by the NABARD, for small farmers and others, the burden of repayment will be substantial. Therefore there must be drastic reduction in the interest rates on loans given to categories of farmers and particularly to landless, marginal and small farmers involved in this programme.

Another important issue is providing adequate subsidies and grants for land development before actual tree planting, to make the enterprise economically viable. There exist subsidies as part of rural development programmes, for live stock improvement, cash crop development etc. and tree growing effort as part of waste development should also receive subsidies from IRDP etc.

Evergreen: Entry of financial institutions into forestry projects involving the people, is a novel thing in India. How best can this programme be implemented?

Rao: My opinion is that we should adopt the single window approach like in the case of small scale industries. There, you have one person, one organization, which helps in identifying the project, preparation of the project report, assist in getting funds and even in implementation. Can we not develop such a mechanism for our wasteland development programme too? I believe, that unless such a type of organization is developed and especially when we are dealing with small farmers and other socially backward sections of the society, then the large targets set

before us in wasteland development can never be achieved, when a multiplicity of agencies or organizations assume responsibility for different aspects of wasteland development.

> THERE YOU HAVE ONE PERSON ONE ORGANIZATION, WHICH HELPS IN IDENTIFYING THE PROJECT, PREPARATION OF THE PROJECT REPORT, ASSIST IN GETTING FUNDS AND EVEN IN IMPLEMENTATION. CAN WE NOT DEVELOP SUCH A MECHANISM FOR OUR WASTELAND DEVELOPMENT PROGRAMME TOO?

We must also have a single window approach with an agency, which can tell the farmer where, how and what to plant and also arrange for them on getting subsidies and loans good quality seeds in time to required extent, and also educate them on the techniques of raising, managing, harvesting of the tree crops, and finally see that the produce is gainfully marketed.

Evergreen: What are the tree species identified for use in the programme?

Rao: There is no limit to the number of species. You see the ecologists and environmentalists prefer mostly indigenous species,. like neem, tamarind, mahua, babul, sissoo, karajn, etc. As already mentioned the problem is how these species will fit into the time frame when bank loans will have to be repaid at current rates of interest, for such projects. The choice of species to be compatible with banking norms will have to be worked out. May be a few species of long gestation like tamarind, neem, etc, as minor forest produce yielding trees can be combined with quick growing species like eucalypts, subabul etc. Another aspect of this problem is that where indigenous species are concerned, we hardly know anything about their silviculture and management, rate of growth, yield, etc. Similarly no work has been done so far in selecting the best varieties, and genetically improving these species.

> MAY BE A FEW SPECIES OF LONG GESTATION LIKE TAMARIND, NEEM, ETC. AS MINOR FOREST PRODUCE YIELDING TREES CAN BE COMBINED WITH QUICK GROWING SPECIES LIKE EUCALYPTS, SUBABUL, ETC.

I believe the present day foresters will have to play a very important role, as it will be their responsibility to collect and supply proper seed material, raise healthy seedlings and distribute them. You can imagine, for a 5 million hectare tree planting target per annum, even the quantity of seeds required will run into thousands of tonnes.

Evergreen: Is the National Wasteland Development Board planning to organise research activities on these lines?

Rao: Research on above should be one of the components, and funding will not be a problem. I think there is enough money already available in the bilateral Social Forestry Projects for research. What is lacking really is an agency for effective implementation of even those, due to lack of adequate appreciation of the need for same, or constraints in manpower because of constant chasing of huge unachievable physical target. Thus research, extension, etc. have always been relegated to the background. Even after 4 to 5 years of implementing bilateral Social Forestry Project, where provision for research is available, very little was done so far in this field, which is very unfortunate. Of late, certain agricultural universities have taken to providing Forestry education and also conducting research on agroforestry problems mainly, and this may improve the situation to some extent.

Evergreen: So, as things stand is it that mostly the old techniques of tree planting of already familiar species like eucalyptus, subabul, etc. may be tried In this programme also?

Rao: It is not a matter concerning the species or the techniques alone. I think wasteland development is not as much a technical problem as a sociological and institutional problem. Species can be the same. But what do we know really about even the so called familiar species? We do not have any information on rates of growth, productivity, etc. except for a few species and that too under one or two agroclimatic conditions. Let us take the case of eucalypts with which we are dabbling for about the past 25

WE DO NOT HAVE ANY INFORMATION ON RATES OF GROWTH, PRODUCTIVITY, ETC. EXCEPT FOR A FEW SPECIES AND THAT TOO UNDER ONE OR TWO AGRO-CLIMATIC CONDITIONS. LET US TAKE THE CASE OF EUCALYPTS WITH WHICH WE ARE DABBLING FOR ABOUT THE PAST 25 YEARS.

years. If a farmer comes and asks any of us about this species, how to plant, at what spacing, how many irrigations to be given and at what intervals, dosages of fertilizers to be applied and when and given a set of conditions what will be the expected yield at different ages, etc, we have no exact answers. When we know so little even about eucalypts what about all other species? In wasteland development we will have to deal with a large number of species, and also in mixtures, multiple end uses. Most of our answers to the farmers on questions relating to them will have to be arbitrary at present, and I think if any two foresters are asked individually the same question, they may give two somewhat different replies. Such is our ignorance at present about most of our traditional species and their management with high inputs, as is likely in the private sector.

Evergreen: So, will we be again chasing time to achieve the set targets, rather than doing some reassessment of the present know how and do how, before starting off?

Rao: I do not expect that the forest departments are going to continue in the same way, as they have been doing before. There is realization everywhere on the need for a change. I think

I THINK IT IS HIGHTIME TO UNDERTAKE SERIOUS AND INDEPTH RESEARCH ON SEVERAL OF THESE ISSUES. THE AMOUNT OF MONEY AND EFFORTS THAT IS LIKELY TO BE PUT IN WASTELAND DEVELOPMENT WILL NOT YIELD THE DESIRED RESULTS, UNLESS WE HAVE ADEQUATE INFORMATION ON THE SEVERAL SPECIES, HOW TO GROW THEM IN MIXTURES, PLANTATION TECHNIQUES AND MANAGEMENT PRACTICES.

it is hightime to undertake serious and indepth research on several of these issues. The amount of money and efforts that is likely to be put in wasteland development will not yield the desired results, unless we have adequate information on the several species, how to grow them in mixtures, plantation techniques and management practices. So we will have to build up an adequate research base. We can no longer relegate research to the background and give it secondary importance. Every one at the decision making level should be made to understand about this situation, and that we cannot compromise any longer on this issue.

Evergreen: With the implementation of the Wasteland Development Programme, we are going to experience an enormous flow of wood into the market in the years ahead. Has any consideration been given to the aspects of pricing or fixing remunerative prices to the producer?

Rao: This is a very important issue. Although there has been something on these lines, there are no clear cut decision on this yet. Everyone is aware on the need for creating adequate infrastructure to see that the farmers who grow trees will get adequate returns for the wood etc. How to ensure this is the problem.

Take the case of agriculture, where we have the Agricultural Prices Commission, and the support price system, etc. Even then the farmers are not satisfied with the prices they get for their produce, even when there is a regulated market for agricultural products. I do not know what will be the situation when new products like wood in large quantities produced by weaker section farmer flows into the market. I believe that, it is extremely desirable to have a minimum support price fixed for the wood and other products arising from wasteland development.

If you announce a support price, then there must be a back up marketing arrangement through an institution. Can we develop an organisation like the F. C. I. for this purpose? Funds will not be a problem, but wood being a bulky commodity, its procurement, transport and distribution is going to be very difficult. So this raises more problems than it solves.

One practical way is to divert the wood flowing from farmers' lands to the wood using industries.

That is a good idea, as we can also reduce the pressure on natural forests, which are gradually getting degraded. But the pricing mechanisms will have to be changed. Wood industries in India for various reasons have always been getting wood raw material in bulk at a lower price than the market price. But farmers will not be willing to part with their produce at such subsidised rates to wood using industries. The Government at the Centre in consultation with those in the States, should find a solution to this problem. If it does not, then the entire Wasteland Development Programme implemented for and through the weaker sections of the society and even other farmers will receive a set back.

BUT THE PRICING MECHANISMS WILL HAVE TO BE CHANGED. WOOD INDUSTRIES IN INDIA FOR VARIOUS REASONS HAVE ALWAYS BEEN GETTING WOOD RAW MATERIAL IN BULK AT A LOWER PRICE THAN THE MARKET PRICE. BUT FARMERS WILL NOT BE WILLING TO PART WITH THEIR PRODUCE AT SUCH SUBSIDISED RATES TO WOOD USING INDUSTRIES. THE GOVERNMENT AT THE CENTRE IN CONSULTATION WITH THOSE IN THE STATES, SHOULD FIND A SOLUTION TO THIS PROBLEM.

Evergreen: There is a claim from certain organisations that by classifying certain lands as unproductive (marginal) there will be a diversion of arable land for tree cropping, which will in future undermine the agricultural production?

Rao: This is a very difficult question to answer. One cannot clearly draw a line to distinguish which is a marginal land (wasteland) and which is not. There is certainly going to be a certain amount of diversion of arable land for tree cropping, because of various reasons. Already in Gujarat and Several other States, thousands of hectares of dry lands which were under various agricultural crops was brought under eucalypts, because the owner farmers felt that tree farming is more economical than annual agriculture on such lands due to high labour wages, low prices for agricultural produce, etc. In India we have no law to regulate areas brought under different

THERE IS CERTAINLY GOING TO BE A CERTAIN AMOUNT OF DIVERSION OF ARABLE LAND FOR TREE CROPPING, BECAUSE OF VARIOUS REASONS. ALREADY IN GUJRAT AND SEVERAL OTHER STATES, THOUSANDS OF HECTARES OF DRY LANDS WHICH WHERE UNDER VARIOUS AGRICULTURAL CROPS WAS BROUGHT UNDER EUCALYPTUS, BECAUSE THE OWNER FARMERS FELT THAT TREE FARMING IS MORE ECONOMICAL THAN ANNUAL AGRICULTURE ON SUCH LANDS DUE TO HIGH LABOUR WAGES, LOW PRICES FOR AGRICULTURAL PRODUCE, ETC.

crops. The lands under cotton, tobacco jute, etc. vary from year to year depending on their profitability. But I am of the opinion that in the long run, the market mechanism will take care, to limit the area under tree crops also as in the case of other cash crops mentioned above, as the farmers will realise that remunerative prices cannot be realised for wood due to over production. But the time lag is going to be critical because the produce from tree crops will come to the market only six or seven years after actual planting. Big farmers may not be affected by the glut of wood in the market and subsequent fall in prices, as badly as the marginal and small farmers who may be facing disaster. Big farmers always take up the idea of tree planting first because of their financial status and ability to take to new ideas quickly and risk taking capacity. By the time the small farmers and marginal farmers get inspired by the example set by the bigger farmers and divert their little bit of land for tree cropping, the market would likely to get saturated. Thus people who are going to be hurt will belong to this category, whose upliftment is also one of the objectives of this programme. To my knowledge, there are no precise estimates yet of how much fairly productive wasteland is available, and how much of that can be brought under this scheme economically, and how much of wood and other produce can be grown with regard to any individual State. There are problems and problems allround, and all these are to be solved at the earliest, if wasteland development is to proceed at the desired speed, and achieve the national goals set for us already. □

Pooyamkutty Hydroelectric Project - An approach to generate baseline information

Large dams have an enormous impact on the environment, both directly by flooding valleys upstream and indirectly by altering the productive riparian, estuarine and coastal ecosystems, hundreds of kilometers downstream. Dams also have the power to change the social life of a country destroying indigenous, traditional cultures and accelerating the change to a cash economy centred on cities (Williams. 1986). Under Indian conditions indepth studies have been very rarely carried out to assess the status of the area together with the people involved to which will be subjected, serious changes before the implementation of river valley projects. Often one witnesses sweeping statements triggering uproars in all circles on the loss of forests, wildlife, cultivable lands, resettlement of people, etc. The multipurpose river valley project at Idukki is a classic example, where the environmental impact assessment was attempted only *post facto*.

With this in view a team of scientists from the Kerala Forest Research Institute drawn from disciplines of Ecology, Botany, Soil Science, Wildlife Biology and Forest Economics is attempting to generate information on the present status of a a proposed hydel project area. The project sponsored by the Department of Environment, Govt. of India aims to conduct detailed ecological and environmental studies pertaining to Pooyamkutty Hydroelectric Scheme.

Located in the Western Ghats of Kerala, between 10°0' to 10°15'N latitude and 76°40' to 77°10'E longitude in Idukki district the proposed Pooyamkutty Hydroelectric project is intended to generate electricity to the tune of 750 MW. The project envisages the construction of 6 dams at upper Idamalayar, Anamala-Manali, Kudal, Mankulam and Pooyamkutty proper all in the Periyar River Basin. The catchment

Pooyamkutty River Gauge.

Pooyamkutty Dam site Evergreen vegetation.

covers 456 sq kilometers and extends from 100 m to 1600 m elevation.

The existing landuse pattern, vegetational and wildlife status and the human impact on the ecosystem will be investigated. It is proposed to assess the floral wealth of the area with particular reference to endemic and endangered taxa and also species of economic importance. The existing vegetational types laying emphasis on species diversity, regeneration status of important tree species will also be looked into. The crucial aspect of this study is the estimation of loss in vegetation due to submersion. A comprehensive landuse map of the area is also under preparation.

From the wildlife point of view the study envisages to assess the population density, distribution, habitat utilization and movement pattern of different animals. The avifauna of the area too will be studied.

Important soil characteristics will be studied at numerous sampling points for detecting soil changes over time. Rate of silt load in streams and soil erosion will be monitored. Together with this an assessment of the current level of human activtties in the area will be made.

At present, the team is concentrating its efforts in the submergible and catchment area of the proposed Pooyamkutty dam, which is approachable from Thattekkad by road (Pl. I). The catchment of the Pooyamkutty river abodes mainly moist deciduous forests which are replaced by evergreens in the upper reaches (Pl. II). The riverine vegetation of the area is extremely luxuriant and unique harbouring Podostemums, Lycopodiums and an array of orchids. The area sustains vast stretches of reed which is the prime source of raw material for traditional matweeving and modern pulp and paper industries. Certain pockets are inhabited by tribals especially the Muthuvas.

This multidisciplinary investigation is expected throw light on the various facets of environmental changes connected with the construction of large hydroelectric projects in a forest environment.

Reference

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Division of Ecology

Elephant Damage in Teak Plantations

Introduction

Teak accounts for about 50 % area of the forest plantations in Kerala. Among the various constraints in raising successful teak plantations the damages caused by different organisms is a significant factor. Apart from insects which seriously affect teak plantations, considerable damage is also caused by larger vertebrates like elephants. Earlier working plans indicated elephant damage as one of the major problem in establishing new plantations, but recent working plans show that elephant damage has decreased considerably as the number of elephants also decreased due to various reasons. But, in places where elephant population is high damage to teak plantations is still prevalant.

In spite of extensive researches on the ecology of African and Asian elephants the interaction between elephants and agriculture has received very little attention. In Sri Lanka and Malaysia crop raiding by elephants has received some attention. Economic implications of crop damage especially in oil palm and rubber plantations have been reported from Malaysia. Crop damage by elephants in agricultural fields has also received attention in Northern India. By casual observation, eventhough we can detect some destroyed plants in the plantations, we are not able to assess the damages unless detailed studies are conducted.

Modes of damage:

Damages done by elephants in teak plantations can he classified into four categories.

1. Breaking of branches.
2. Breaking of main stem
3. Complete damage
4. Uprooting of trees

Among the four types of damages, breaking the main stem is common in younger plantations upto 20 years (Fig. 1). Here, the elephants break the main stem with their trunk and then peel off the bark which they consume. Another method of destruction is uprooting plants as such and extract the bark from the fallen tree. This is seen mostly in three to five year old plantations throughout.

In young teak plantations elephants do considerable damage They usually visit the plantations in herds of 3 to 10 individuals for consuming the bark. Bark is eaten and other parts are left out in the process. It was observed that a single herd moves around the whole day in the young plantations as seen at Parambikulam (Fig. 2). Along with elephants, herbivores such as gaur, sambar, spotted deer and wild boar also do considerable damage in young plantations.

In plantations where teak has attained pole size, elephants usually peel the bark and eat. In the case of old plantations which are mature enough for clear felling, this is seldom seen. As the trees are considerably large, elephants cannot resort be breaking the trees or uprooting. At this age, plantations are rather safe from the point of elephant damage.

In natural forests, eventhough some signs of feeding are observed, damage is rather limited. In such cases, as most of the trees are fully grown,

Fig. 1. A 20 years old teak tree, completely damaged by elephants while debarking.

Fig. 2. An elephant herd during their visit in teak plantation.

elephants are unable to inflict severe damage. However, occasional debarking of teak and other trees was recorded in such areas also. Breaking the tree top or uprooting are not usual here.

Discussion

Elephants feeding on tree-bark were already recorded in Africa and India. For eating bark they often visit natural forests and adjoining plantations and in the process younger plantations suffer much due to their tenderness, but old trees withstand the pressure. Heavy damage of teak plants in younger plantations below the age of 20 years may be attributed to this factor.

Among the four types of damages mentioned earlier, bark damage does not lead to permanent loss to the trees because the injury will heal after some time. However, it may lead to stem rot with the passage of time. In the second type of damage, trees of which the main stem is broken will produce new shoots in the next season (Fig. 3). Severely damaged and uprooted plants are permanently lost because the whole plant is destroyed and it is obvious that no chance of survival is left

Preventive measures like high voltage electric fencing of young plantations can be adopted after careful assessment of its economic implications in the elephant-prone plantations. In addition to this biological methods like keeping all indigenous, vegetative communities both age-wise and species-wise and in perpetuity may also be tried. Fodder species of elephants such as bamboos and other selected trees can be planted along with teak or in the periphery of the plantations so that damage to the plantations can be reduced to an acceptable level. Before improvising such methods like electric fencing we should also keep in mind that elephants adopt methods like breaking the high voltage electric fences using their non-conducting tusks.

Fig. 3. A 3 year old teak plant partially broken by elephants for debarking.

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Hunting with a Camera

Shooting with a camera can be as exciting and challenging as using lethal weapons. Photography can bring immortal images of landscapes and animals and knowledge on some of them may be available to the next generation only through this media.

The tropical sun, clouds, mist, luxuriant vegetation, rugged mountains cascading streams open before us an infinite choice for landscape photography. The beauty of flowers and insects come to life with the aid of close-up photography. If it is the risk involved in photographing larger mammals, that appeal to many, it is the technical skill and patience in bird photography that attract others.

We are lucky to be in an age when image recording devices have been perfected to a level which brings them down to the domain of the unskilled at an affordable cost. Large cameras, slow black and white films, laborious print making are all things of the past. Computerised machines provide colour prints within an hour of submitting for processing. We are on the verge of another revolution in image recording, wherein magnetic media and digital processing are going to bring about a total change.

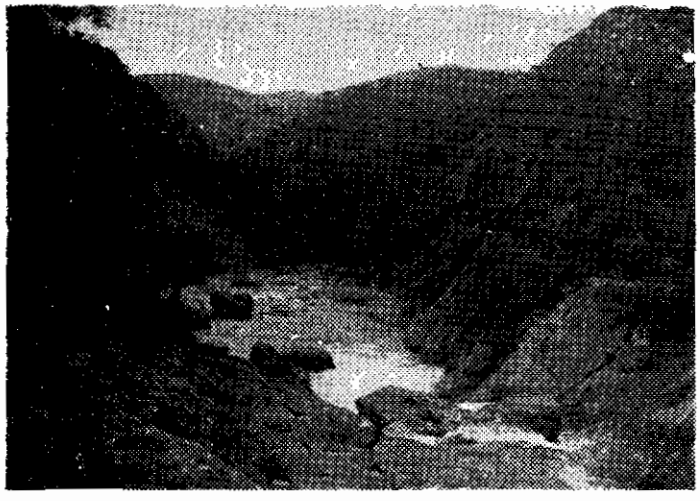

Plate 1. Silent Valley Dam site.

Plate 2. Tribal boy fishing from forest pond

Before considering different aspects of nature photography a survey of material and facilities available in our country is essential. Subjecting films to heat during transport, storage and while in camera will drastically lower the quality of pictures obtained. Prompt processing by reputed laboratories is also essential to get good results. Small scale photo-studios damaging films by negligence and laying the blame on the customers is a common feature in our country. Attempts at manufacturing good quality 35 mm cameras locally by and large has not been very successful. With the restriction on import of cameras there is still difficulty in getting proper equipment at reasonable prices.

Except in very bright light, manual judging of light condition is not possible. One cannot expect good quality result from wrongly exposed pictures. This is especially true for colour film where precise exposure is required. Almost any type of camera will give satisfactory results while photographing landscapes like mountains, rivers etc. (Plate 1). Many frames may require wide angle lenses that would

Plate 3. Kuruba drummer during Sivarathri festival. Medium telephoto lens.

bring in a wider coverage. A yellow or orange filter will show the clouds clearly in black and white photography. A polarising filter will increase the intensity of the blue sky in colour photos and slides. Artistic composition, framing, choice of subject, angle, lighting etc., play a crucial role in obtaining good photographs. Including trees, branches etc., as border for landscape is a common technique. Reflections also make very good images (Plate 2).

The tribal people and their life styles also provide material for good pictures (Plate 3). Photography is the only way of preserving an orginal account of these people who are under heavy onslaught by urbanisation and inevitable change by contact with other cultures.

Photographing other subjects usually calls for more specialised equipment. For instance, close-up photography demands magnifying lenses and a flash while, tele lenses are required to get pictures of small, shy or dangerous animals.

Most of the larger animals are photographed with tele lenses. Tele lenses compress the distance and bring in enlarged images in the film. But there are many problems while using these lenses. Larger animals usually will be moving; thus requiring a fast shutter speed to arrest the movement. Heavy tele

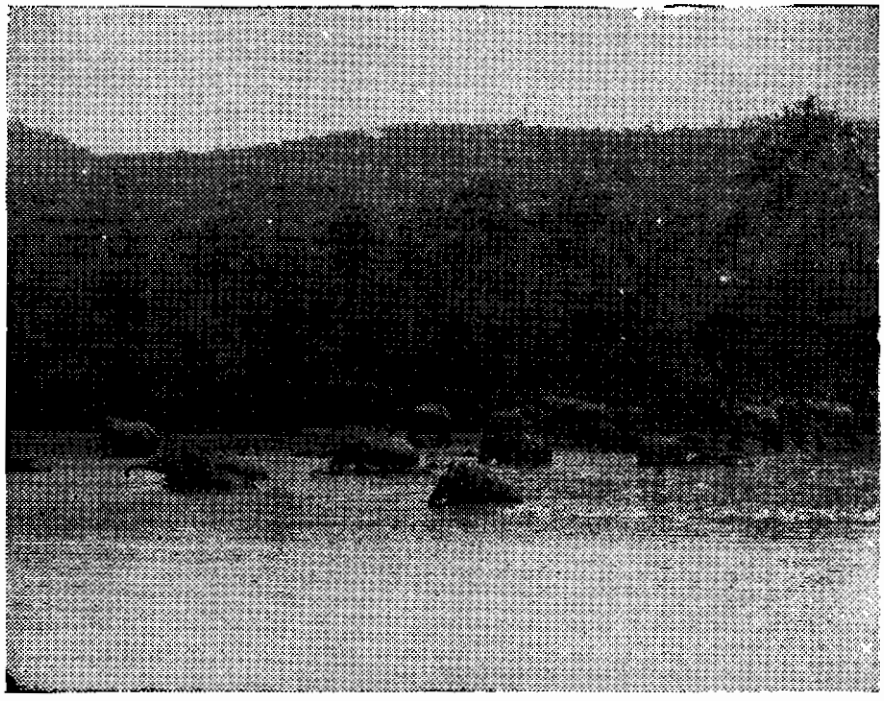

Plate 4. A large herd of elephants at a pond in Bandipur National Park. Taken from the tank bund.

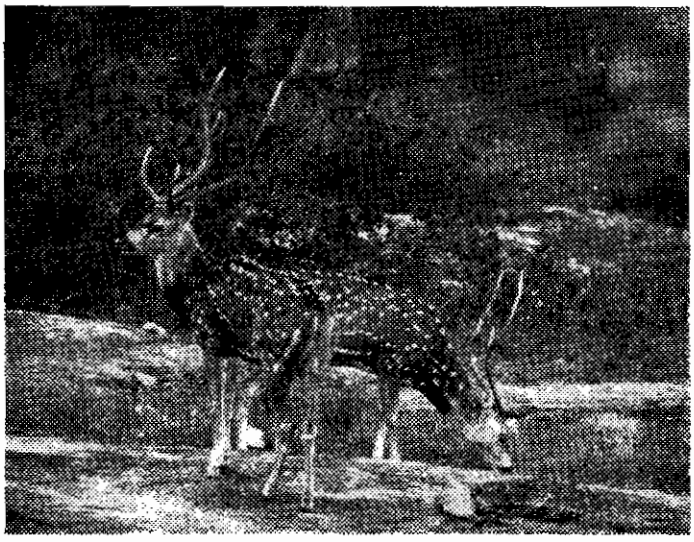

Plate 5. Spotted deer stags at Bandipur. Taken from a jeep with a 300 mm lens.

lenses also demand high shutter speed. As it is almost impossible to get sharp pictures from moving vehicles, one has to stop the vehicle, switch off the engine and take the picture. Another method is to wait patiently near places frequented by animals. Tele lenses also let in only less light. Thus, demands for high shutter speed and good light preclude their use in dim light. The accompanying photograph (Plate 4) of elephants was taken by a telephoto lens fixed on a tripod on a tank bund. It may be possible to photograph animals like bonnet macaque with a medium telephoto lens while a jumping langur would call for a tele lens and fast shutter speed. In many wildlife sanctuaries where animals are used to being approached closely it may be possible to take relative close ups (Plate 5).

Birds can be photographed at their nest or stalking. In any case long tele lenses and fast shutter speeds are a must as birds are extremely active. Even a fast camera may not be abie to freeze the wing beats of a small bird. Stalking is not feasible except with very common birds. To snap the magpie robin

Plate 6. **Magpie robin photographed by stalking with a 400 mm lens and closeup attachment.**

Plate 7. Green bee eater taken by the cores of a wall. 300 mm lens on tripod.

(Plate 6) it required a 400 mm telelens with close up attachment. The bee eater also required such elaborate equipment on a tripod (Plate 7). Birds can be approached fairly closely near their nests, once they start feeding their young ones regularly. Hasty steps and insufficient habituation may lead to the bird abandoning the clutch. The barbet (Plate 8) was taken through a 300 mm lens on a tripod and the camera clicked from about 20 m. Many birds can be photographed from the cover of a ridge. Birds nesting in colonies can be approached fairly close and photographed with medium tele photo lenses.

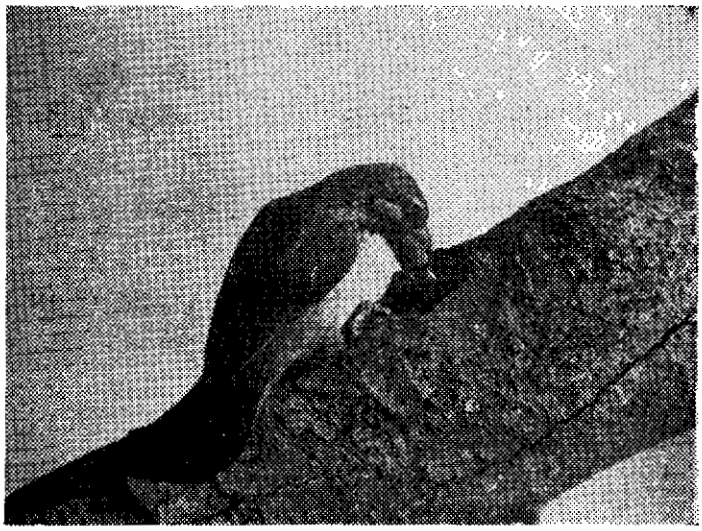

Plate 8. Small green barbet feeding young ones with fruits. 300 mm. lens on tripod.

Flowers and insects acquire a new dimension when photographed with close up equipment. Close up lenses for a specific work must be chosen in such away as to allow 25 to 50 cm working distance from the object. Focussing is often a problem because close up lenses let in only less light. Since any shake, of either object or camera also gets magnified it becomes essential to use high shutter speeds. In such situations using artificial light may become necessary.

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"Before leaving this subject ***(Natural Production)*** His Excellency the Governor in Council thinks on it advisable to point out that it is not the wish of the Government that attempts should be made to grow high forests are the whole of the reserves and reserve lands. Many of them are primarily needed as pasture grounds, and in the case of such areas grazing requirements must not be sacrificed to the necessities of natural regeneration."

— From Annual Administration report of the Forest Department (Southern and Northern Circles). Madras Presidency for the year 1887—1888.

Cartography: Some General Principles and Facts

The preparation of maps are based on certain generally accepted principles, notions and facts. Some of the common principles are cited here.

Contour

Datum plane for survey is the Mean Sea Level (MSL) The most common contour interval on the 1:62, 500 topographic sheet (approx. 1" = 1 mile) is 20 ft.: in high mountain area it is occasionally 50 ft. On the 1 ; 1,25,000 map they are usually 50 ft. apart. As a general rule, in regions of medial relief, a contour interval in ft. equals 25 times than miles-per-inch scale of the map; in rugged region the interval is larger, in flat region it is smaller. The contours are placed closer at lower elevations. The intervals chosen are 100, 200, 300, 400, 500, 700, 1000, 1500, 2000, 2500, 3000, 3500 and 4000 m. On small scale maps the usual intervals are 500, 1000, 2000, 3000, 5000, 7000, 10,000 and 15,000 ft. Every 5th contour line is made heavier thus making the map easier to follow.

Contour lines should be labelled frequently with figures of elevation which, if possible should be placed on the southern slopes so as to read upward, To facilitate finding contour figures they are placed, if possible, in a row one above the other.

Contour profiles (vertical exaggerations)

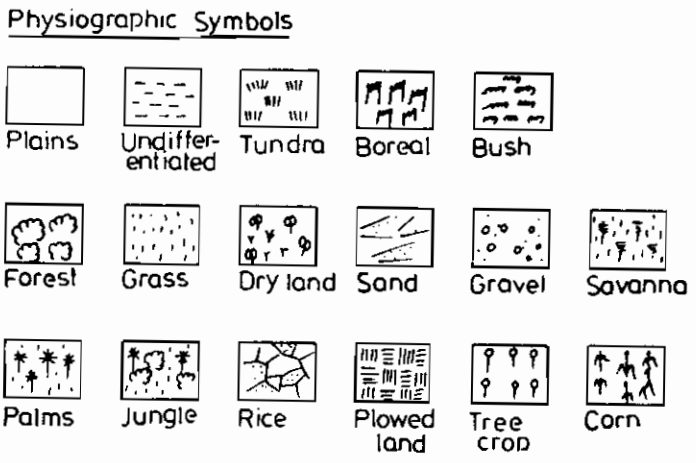
As a rough rule, for an average hilly country the following figures apply.

Scale	Vertical exaggeration*
1 mile/inch	2 times
2 miles/inch	3 times
4 miles/inch	4 times
8 miles/inch	6 times
16 miles/inch	8 times
64 miles/inch	16 times

*vertical exaggeration = $2\sqrt{\text{mile/inch}}$

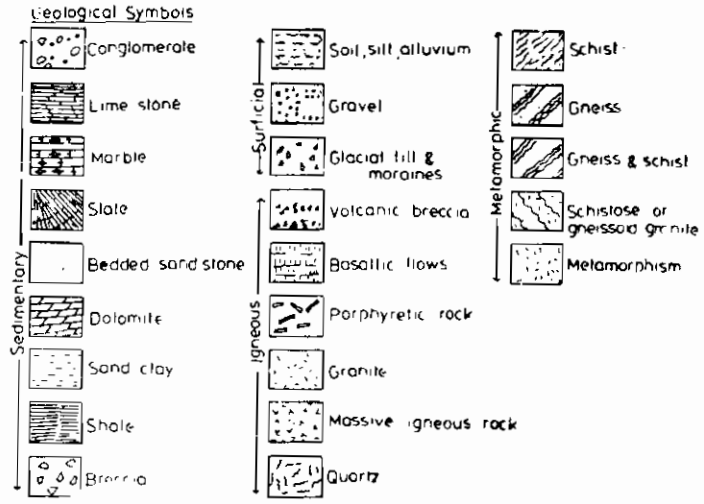
Physiographic symbols

The commonly accepted physiographic symbols are given below.



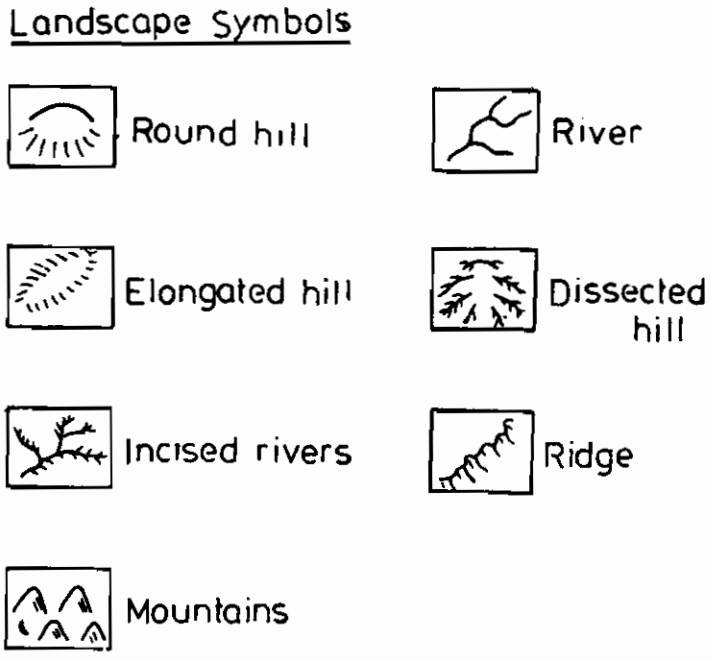
Geological symbols

The following are the main geological symbols used.



Landscape symbols

The landscape symbols used are as follows



Lettering

Standard rule when one type lettering is used
Name of natural features-vertical lettering
Name of water features and man-made cultural features-slanting letters

Countries, States, Townships, Capitals and principal cities-All capital letters (straight higher case letters) Town and villages-with capital initials; (straight small letters) Oceans, gulfs, harbours, bays, large rivers, large lakes-all capital (slanting capitals, higher case).

Small rivers, branches creeks, springs, small bays, small lakes, ponds, swamps, marshes, falls, inlets etc.-small letters, slanting lower case with capital nitials.

Mountain ramps, plateau, lines of cliffs, large valley, national parks, bench marks, game or bird refuges, primitive areas, national forest names, townships, range and section numbers (all capitals)-straight, capital letters, lower case.

Small valleys, prairies, meadows, peaks, criaters, hills, caves, islands, flats, ravines, points, basins, ridges, beaches, plateaux, passes, gaps, peninsulars, base lines, meridians and paralles-small, straight letters, lower case with capital initials.

Telephone lines, radio stations, lookouts, triangulation stations, rail roads, tunnels, bridges, ferries, camps, roads, trails, dams, reservoirs, canals, wells, ditches, mills, mines, schools, houses, cabins, boundary, monuments, administrative sites, power houses, water works, water tanks, light houses, docks, air ports, landings, yaging stations, fish hatchery, forest nursery, marginal notes etc,-as a rule use all capital letters; slanting capitals, lower case.

Placing of letters

The placing of letter is one of the major difficulties. As a general rule the name should unmistakably refer to the feature it designates. It should be clearly readable without overcrowding. The direction of letters indicates the trend of the feature. The name of mountain range should follow its trend The name of a river should be parallel to the river course.

If the lettering refers to a point or if there is no special trend, the lettering should be horizontal (horizontal means, parallel to the parallels in the map).

In large polar maps, all lettering may have its top towards the pole. The spacing of lettering should express the extent of the area.

All lettering, designating an area and placed inside the area should be spread from one end to the other, usually one unit distance is left on the two ends and the letters are evenly placed.

City names are preferably centred below the symbols; second choice is to right or above. If it has to go on left, it should be slightly above or below the symbol.

In the case of river names, if the name is inside the river it should be used if the name has to go outside. River names are not spread while writing. The names of rivers should follow their courses. It is better to place the lettering on the northern side of the river. When the river happens to be exactly north-south, it is advisable to letter it on the western side.

The names of lakes, swamps etc. should be either entirely inside or entirely outside. The same rule applies to islands and peninsulars.

Mountain peaks are difficult to name. It is a good practice to name mountain peaks on a circulare arc above each peak and altitude of the mountain be marked underneath. The letters should be heave and narrow.

Abbreviations

Abbreviations commonly used are as follows.

Ave	—	Avenue
Bdy	—	Boundary
Br	—	Bridge, Branch
C	—	Cape
Cem	—	Cemetery
Ch	—	Church
Co	—	Country
Cr	—	Creek
Dist	—	District
E	—	East
El	—	Elevated, Electric
F, Fr	—	Forest
Ft	—	Fort
Hbr	—	Harbour
Hy	—	Highway
H	—	House
Ind	—	Indian
Is	—	Island
Junc	—	Junction
L	—	Lake
LH	—	Light house
Mid	—	Middle
Mi	—	Mile
Mil	—	Military
Mon	—	Monument
Mt	—	Mount
Mts	—	Mountains
N, Nat. Natl	—	National
N	—	North
Pk	—	Peak
Pen	—	Peninsula
Pd	—	Pond
PO	—	Post Office
PH	—	Power house
RR	—	Rail road
R	—	River, Range
Res	—	Reservoir
Rd	—	Road
Rk	—	Rock
Sch	—	School
S	—	South
Sta	—	Station
Str	—	Stream
St	—	Street
Val	—	Valley
W	—	West, Water

Composition and drafting maps

Title

The title of the map designate the name of the land represented, the type of map, possibly its author, the scale, the year of preparation, pertinent remarks etc.

Legend

It is not necessary to include in the legend obvious features that will be clearly understood by prospective users of map; thus the road, railroad etc., rarely need to be explained. It is not necessary to list the standard abbreviations.

Border

A double line, at least $\frac{1}{8}$ inch wide, makes a good frame; between the two lines the numbers for parallels and meridians may be placed. In order to save the space it is customary to interrupt the inner borders for projecting corners of the land. The outermost line of border should not be interrupted.

Parallels and meridians

The drawing of parallels and meridians is necessary only when they promote a better understanding of the map. In simple maps they can often be omitted and designated only on the borders. Parrallels and meridians are fine hairlines drawn with smallest pen. They are drawn from intersection to intersection along a straight or curved ruler.

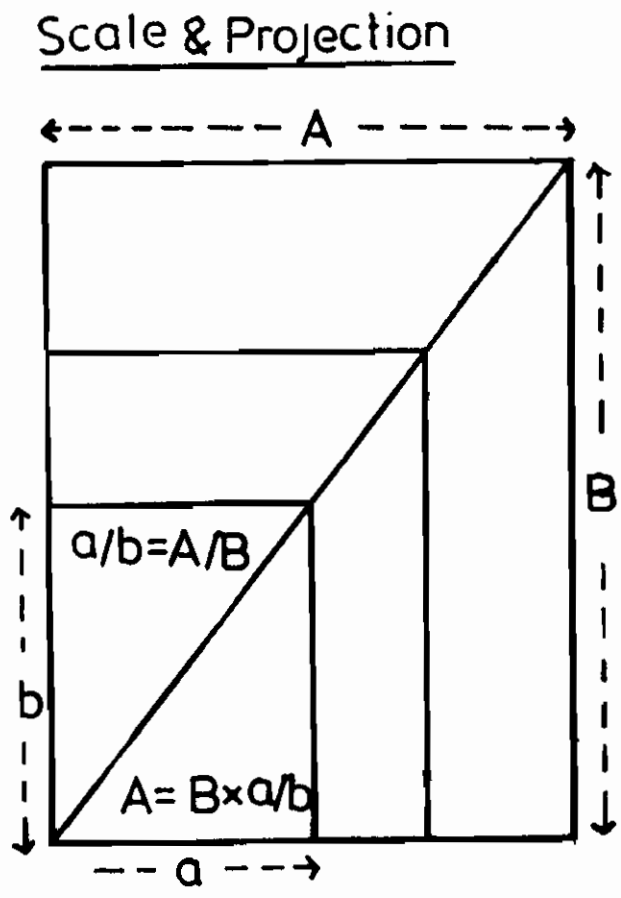
Compass roses

A compass rose or any indication of the North direction is necessary only when the map is oriented other than the north and when the parallels and meridians are not drawn. On large scale maps it is usual to indicate the true north by a star and the magnetic north by a half arrow and to a state the exact amount of magnetic declination.

Insets

The empty spaces on the maps are used for insets. One inset may show a significant portion of the main map on a larger scale or it may be a small scale general map showing the location of the main map. The inset should be regarded as an independent separate map; it should have its own central meridian, border, title etc. An exception to this rule is made when the inset map shows a peripheral portion of the main map that was chopped off to save

space. Such inset should have the same scale and the parallels, and meridians should be in the same direction as on the main map.



Scale and projection

The portion of enlarged drawing can be figured either by a diagonal or by calculation with the help of a slide rule.

Method of Drawing

In the actual process of drawing, the projection is constructed first on a separate paper and then parallels and meridians are transferred. It is advisable to use a hard pencil. Next hydrography is drawn- the shore lines, rivers and lakes. Shore lines are drawn with great exactness. The same accuracy is important in the drawing of rivers, lakes etc., because they are the major reference lines for locating cities, mountains, etc. With the help of shore lines, river and a few boundary lines it is usually possible to ascertain the exact extent of the map, so the frame can be laid out. The sides of the frame should be parallel to the central meridian. Next the boundaries, roads, rail roads and cities are drawn. Next comes the mountains (also contours). The final step is the lay-out of lettering and the make up. Names of countries, mountains and large political divisions are lettered first, because they are most difficult to place. Names of cities come next as there is some choice to place them. Last comes the names of rivers, which can be placed anywhere along their courses, except the small streams. Lettering is first done lightly with pencil (especially large letters). Title, scale, insets, legends and other accessories complete the pencil work.

Inking

Inking is the last step in the preparation of maps. First the map is rolled over with erasor in order to remove superfluous markings. The map is erased until the lines are faint, but still clearly visible. The inking is usually done on the reverse sequence of the pencil work. Lettering is inked in first, then the symbols, content of the map and finally the parallels and meridians, borders and accessories. This order is important because the lettering has the right of way over everything else, and the parallels meridians and border have to be interrupted where any symbols require the space. After inking the remaining traces of pencil lines are erased. A final checking, touching up with ink or painting out with white ink is always necessary. The map is then trimmed and mounted.

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Statistical Techniques in Mensuration

Mensuration is concerned with measurements in forestry. Measurements arise in terms of billets stacked or otherwise, individual trees or whole stands and the features measured will quite often be length, area or volume and weight in a few cases. Obviously certain features are easily measured and some with difficulty. The prediction of those attributes which are difficult to measure directly in terms of easily measurable characteristics is the crux of mensuration problems. Since the prediction is probabilistic in nature the science of statistics plays a major role in this field.

Over the years this subject field has given rise to quite a few concepts which are of direct use to the practicing foresters. An attempt is made here to review the statistical techniques associated with these concepts. The references are well selected and not exhaustive.

Site quality

Site quality is supposed to be a measure of the productive capacity of a designated land area as measured from the existing condition of a stand growing there. Naturally it is a post planting concept and is highly related to the planting material and the associated environment including management. The concept is useful in the estimation of growing stock in even-aged stands and also in deciding the kind of treatment to be given to a stand based on its current status.

Site quality estimation is usually based on stand top height which is found to be less affected by inter-tree competition. If a complete quality class mapping of an area is intended, then top height is to be determined for every square chain plot in that area. Top height is obtained as the average height of 10 tallest trees in a square chain plot. Like d.b.h. this is also a standard adopted in India which can not be changed. If height measurements are not possible then the height corresponding the average diameter of dominant trees can be read out from a height diameter curve (Chathurvedi and Khanna, 1982). It is also found that very often stock mapping is done based on a partial enumeration to save time and effort.

It is incorrect to say that the top height is the average height of 100 tallest trees in an acre or 250 tallest trees in a hectare because if 10 tallest trees in every square chain plot in an acre are considered and their average height is taken, it may not coincide with the height of 100 tallest trees in that area.

Franz and Rawat (1979) described the statistical basis of site index curves and proposed a new system of harmonised curves. The method specifies that the mean values of the conditional distributions of top height for different ages are to be connected to get a guiding curve. Then the distributions are partitioned based on percentiles to delimit the site quality classes. Site index curves are fitted after gathering the points belonging to each site quality. The parameters of these curves are then related to the site indices to get a family of site index curves.

Yield table

Yield table is a tabular statement which summarises all the essential data relating to the development of fully stocked and regularly thinned, even aged crop at periodic intervals covering greater part of its useful life. Yield tables have multiple uses in management such as estimating growing stock, fixing rotation age, assessing site quality and suggesting thinning levels.

The standard regression techniques have gained wide acceptance for the construction of yield equations. The set of regression equations underlying a yield table is termed a stand model.

Stand models are mainly of three forms: (i) whole stand models (ii) diameter distribution models (iii) models based on individual trees. Whole stand models are based on stand features like total volume, crop diameter, crop height, stand density etc. expressed as functions of age. Model based on Richard's function considered by Franz and Rawat (1979) belong to this category. Diameter distribution models on the other hand approximate an observed

diameter distribution of a stand with some theoretical frequency distributions and establish age-dependent relations with parameters of such distributions. The predicted diameter distributions are then condensed to stand volume figures by appropriate functions later. For instance, Burkhart and Strub (1979) have proposed models based on beta distribution. Individual tree models are described by Arney (1979). They essentially describe the development of individual trees in relation to the competition stress the trees suffer, and later sum up individual volume to whole stand levels. Of late, models based on multivariate allometric relations have been introduced by Garcia (1984). There are also cases where yield tables are established through generalized least squares (Ferguson and Beech, 1978).

Volume table

Volume table is essentially the output of a regression function with tree volume as the dependent variable and diameter and/or height as independent variables. In practice the best suited function out of a set of polynomial or exponential models is selected based on some goodness of fit criterion. Adjusted coefficient of multiple determination (Draper and Smith, 1981) is the most widely used one. But when the form of dependent variable is different in different equations Furnival Index (Furnival, 1961) may be used for comparison. Recent research indicates the use of data splitting techniques involving PRESS statistic (Montgomerry, 1982) for model selection. With unequal error variances, either weighted least squares (Cunia, 1964) or power transformation suggested by Box and Cox (1964) are of use.

While using a volume table, care has to be made not to extrapolate the results. Moreover cumulative error in a large number of predictions is usually much lesser than that occurs with an individual case.

Taper functions

Taper is the decrease in diameter of a tree stem or a log from base upwards and the rate of taper is termed form. Taper varies not only between but also within trees. The segments of a tree bole approximate to various geometrical frustrums. The volumes of individual segments of a tree can be calculated from taper tables which exist for different diameter and height or form classes. Max and Burkhart (1976) have presented the method and application of segmented polynomial regression models to describe the tree taper. Husch *et al.* (1972) suggest that three regression models are required to describe taper; one model each for the lower, middle and upper segments. A number of other authors also have proposed various types of models useful in describing stem taper. All these models, like that of volume and yield table models, use regression equations in various forms.

Growing stock

The total amount of forest crop growing in a given area expressed in terms of volume or number of stems constitutes the growing stock and its accurate estimation is of use in production planning, silvicultural and ecological research.

For even-eged stands growing stock estimation proceeds through the use of variable density yield table. For any specified age, site quality and stand density the total volume can be read out from such tables. Stand density can be estimated from plots laid out systematically or through point sampling. Point sampling relies on counts made through wedge prism or angle guage from a series of points distributed uniformly or randomly over the area covered. From the number of trees tallied by the instrument and diameters of the tallied trees, stand density can be arrived at. If the height of the tallied trees is also known, then volume estimation is possible through point sampling. The trees would get tallied by the instrument depending on their diameters and the distances from the observation point. Thus a selection occurs at the time of observation which is comparable to the PPS (Probability Proportional to Size) sampling scheme.

In the case of mixed stands also one of these techniques can be utilized. Because of poor accessibility, the sampling is predominantly systematic, carried out in regularly spaced strips. The sampling intensity varies from 5 to 50 percent depending upon the forest types. For large areas, stratification based on natural boundaries or compartment would be useful. Volume prediction utilizes the volume tables established for individual species. Some other sampling schemes applicable to growing stock estimation in mixed stands are discussed by Chacko (1965). Stand yield tables for mixed stands are very rare (Chathurvedi and Khanna, 1982).

Biomass estimation

Biomass refers to the total mass of living material in a location and its estimation has assumed

considerable importance in recent times. Foresters are mostly concerned with tree biomass and the common procedure of estimation is through the use of regression equations and stand tables. A few stems are destructively sampled and weight of each component is determined and related by regression to some dimensions of the standing tree. A stand table which classifies stems per unit area by units of the dimension used in the regression (usually diameter) is then expanded to an estimate of biomass by multiplying the number of stems in each dimension class by weight. In the literature on biomass estimation in forestry many of the theoretical refinements in regression, viz., generalized least squares, stepwise regression, nonlinear regression etc. are found used extensively.

Continuous Forest Inventory (CFI)

Successive inventories are required in forestry for assessing the effectiveness of management and silvicultural practices and for studying the subtle changes over time in a forest ecosystem Permanent sample plots to some extent serve the above purposes. But, of late, more efficient techniques have been proposed which involve sampling with partial replacement (SPR). The applicability of this method is commonly limited to sampling in two successive occasions. Two different sets of plots are observed in the two successive inventories keeping a few plots common. But estimates can be developed for all the plots in both the instances by employing regression techniques. This procedure has been found better than taking fresh set of plots every time or observing the same set of plots both the times. Cunia and Chevrou (1969) extended the theory of SPR from two to three or more occasions and showed how it could be applied to CFI. Since then a number of works followed these developments covering different aspects of the method. One notable extension is the one achieved by Cunia and Kyaw (1985), which deals with a transformation of the sample values to make SPR formulae applicable to varying size, shape and structure of sampling units in successive inventories.

The above review would indicate that the subject field of mensuration has a strong footing on the theory of regression and sampling. Hence any theoretical refinements happening in these areas will be of direct relevance to mensurationists. The review also brings out the fact that there is no dearth of methods and proper application of them is important.

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Seed Storage of Tree Species for Longer Viability

When the best period for collection of seeds does not coincide with the appropriate time of sowing, storage of seeds without loss of their viability becomes essential. The best date of sowing for any species depends on the anticipated date of planting and also the time required in the nursery to develop into a good planting stock. Storage of seeds may be required for varying periods depending upon the purpose. If the species is one which produces seeds annually, storage may be required only upto one year, i. e., from the date of collection to the best date of sowing. But if the seeds are available at longer intervals storage methods for more than a year have to be adopted. Further, prolonged storage for decades will be reqired for conservation of genetic resources.

Seeds are also subject to aging and death as in other living systems. The term 'physiological aging' is commonly used to describe the degree of deterioration of seeds, measured by their reduced capacity for germination. A number of physiological changes are associated with aging of seeds. These changes are:

(1) Loss of food reserves caused by respiration, resulting in an increase in reducing sugars and free fatty acids, 2) accumulation of toxic or growth-inhibiting byproducts due to respiration, 3) inactivation of enzymes, 4) detèrioration of membranes, 5) lipid peroxidation leading to formation of free radicals which react with and damage other components in the cell and 6) alteration in DNA leading to mutation.

Whether these changes are the causes or symptoms of seed deterioration is not clearly understood. However, the loss of seed viability is considerably affected by the rate of respiration. Measures which reduce the rate of respiration without damaging the seeds are effective for prolonging viability. With a proper control of oxygen, moisture content and temperature it is possible to control the rate of respiration.

Depending on the ability of seeds to withstand reduction in moisture content they are classified into orthodox and recalcitrant types. Orthodox seeds can be dried to a low moisture content (around 5%) and successfully stored at low or subfreezing temperature. They include both hard-coated seeds such as those of ***Leucaena leucocephala, Cassia bicapsularis, Albizia julibrissin*** and many species of ***Acacia*** and seeds without hard seed coats such as ***Pinus*** and ***Eucalyptus***. Recalcitrant seeds cannot survive drying below a relatively high moisture content (20 to 50% on wet basis) and cannot be stored for longer periods. Most of the short lived recalcitrant tropical trees, for example; species of ***Swietenia, Terminalia, Shorea*** and ***Dipterocarpus***, are constituents of moist tropical forests where conditions are favourable for immediate germination.

Natural longivity of seeds varies from species to species considerably. Besides, the seed viability is influenced by the quality of seeds, treatment received from the time of collection to the time of storage and methods of storage.

Collection of seeds

For obtaining maximum seed viability the following precautions need to be taken while collecting seeds for storage.

1. Collection of only mature and fully ripened seeds ensures retention of viability longer than immature seeds. Immature seeds may lack some biochemical substances required for preserving viability or the embryo may be underdeveloped thus making them unsuitable. 2. Collection of seeds from a high yielding mother tree during a good crop year-the percentage of sound seeds in a high yielding mother tree will be higer than one with a poor crop. Similarly number of healthy seeds in a good crop year will be more than that of a poor crop year. 3. Avoiding mechanical damage to seeds during extraction and cleaning since mechanical damage will cause deterioration easily. 4: Collection of seeds which are free from insect and fungal attack. The affected seeds will loose their viability soon and the pathogens will be carried on to other healthy seeds also under storage.

5. Selection of seeds which have high initial germination percentage preferably more than 80% in initial viability check. Seeds having low germination percentage will loose their viability faster when compared to seed lots with high germinability.

Methods of storage

The method of storage depends upon the type of seeds. For orthodox seeds, generally, dry storage is adopted. After bringing down the moisture content to a tolerable level (4 to 8%) the seeds are stored in sealed containers. The containers should be made of a moisture proof material like tin, aluminium, glass or plastic. This method is suitable for a range of species including those of ***Pinus*** and ***Eucalyptus***. Dry storage at low temperature gives better response for some orthodox species such as ***Fagus***, ***Abies*** and ***Populus***. After drying to critical moisture level seeds are stored at low temperature (0.5°C). in sealed containers. A combination of 4 to 8% moisture content and 0.5°C temperature is suitable for many species. This can be done in ordinary refrigerators for small seed lots. When storage is required for large quantity of seeds special cold rooms are needed. Seeds of ***Gmelina arborea*** can be stored at 5°C with a moisture content of 6 to 10% for more than two years. The seeds of ***Tectona grandis*** can be stored in piles or sacks at ambient temperature and humidity giving shelter against rain. By this simple method viability can be maintained for more than six months. The best method of dry storage for long-term gene conservation involves storing at - 18°C. Deep freezers can be used for small seed lots. Use of liquid nitrogen is another possibility for long term storage.

In the case of recalcitrant seeds, as the dry storage methods are not suitable, conditions of moist storage are provided. As compared to orthodox seeds, storage of recalcitrant seeds is more difficlult. Seeds may be stored in heaps on the ground, in shallow pits in well drained soils or in layers in well ventilated sheds, often covered with leaves, moist sand or peat which have to be moistened regularly. This nethod can be used for temperate species ***(Quercus, Castanea*** and ***Aesculus)*** and may be unsuitable for tropical species because of the relatively high ambient temperature. When moist storage under low temperture is requried the seeds are mixed with a moist media such as sand, peat or a mixture of both to retain the moisture content and packed in containers which allow oxygen and carbondioxide exchange with air outside. Lightly sealed polyethylene bags are suitable. The temperature is maintained above freezing point. In a dipterocarp ***Hopea helferi***, storing at 10-15°C with a moisture content of about 35% is effective for prolonging the viability from a week to about two months but long term storage is necessary since the 'seed years' vary from 3 to 6 years. For species of ***Araucaria, Agathis*** and ***Triplochiton*** longivity can be extended to few months by this method.

Some other methods are also used for seed storage but they have limited application. For example, some of the recalcitrant seeds can be stored in running water. Another promising method is to store seeds under partial vacuum. For smaller quantity of seeds desiccator can be used. The air in the desiccator is removed using exhaust pump to create vacuum. By this method the reduction in oxygen minimizes the rate of respiration which helps to prolong the viability.

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"In Nilambur, South Malabar, the largest Mahagony tree is that planted in September 1873"

This was 71 feet tall, 60 inches girth at base and 46 inches girth at five feet.

"This tree was never apparantly attacked by the borer.

The new planting amongst the teak, suffers so much from the attack of the borer, that Mr. Hadfield thinks we shall have to give up planting the mahogany with the teak."

The teak carpenterworm, *Cossus cadambae* and its status as a pest in plantations

In the previous issue of "Evergreen" (March, 1986) an account was given on the carpenterworms that attack various trees and their role as pests in forest plantations. In the present article an attempt is made to highlight the economic importance of a carpenterworm pest of teak in southern India viz., ***Cossus cadambae.***

C. cadambae was first reported in India from Calcutta (Hampson, 1892). Beeson (1941) reported it as a minor pest of teak trees in southern India. Very few studies were made on this insect since it was never found to cause any serious problem for teak cultivation in India. However, recently, this insect has assumed major pest status in several teak plantations in the state of Kerala, Tamil Nadu and Karnataka. Hence detailed studies were undertaken to get a better understanding on its biology and ecology in order to evolve suitable management strategies. Some details of the above aspects are discussed below:-

Life cycle

The eggs are light brownish in colour and are laid in groups on the bark of trees. As many as 600 eggs are laid by a single female which hatch in 17-19 days (Fig. 1). The newly emerged larvae are light reddish in colour and measure about 2 mm in length. After some initial exploratory movements, they settle in small crevices in the bark, usually in the axillary region of side shoots, in callus growth around wounds or in some sheltered situations. The larvae start feeding on the bark in concealment under the cover of accumulated frass and excreta. In about 2-3 months they attain a length of 3-4cm and by then commence boring into the wood. Fully mature larvae measure about 6 cm in length and are light reddish in colour (Fig. 2). The larval tunnels are about 1 cm in diameter and reach as far as the centre of the bole. Larval period lasts for about 8 months. Infestation may not be distinguishable in the initial stages. But since the affected portions are prone to further attack, this area subsequently becomes more and more debarked and riddled with numerous holes leaving the characteristic beeholed appearance on the trunk (Fig. 3).

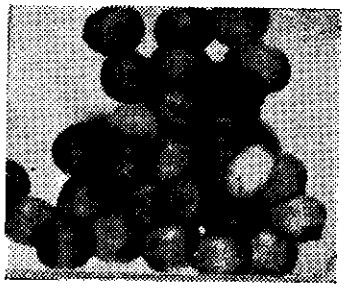

Fig. 1. Eggs.

Fig. 2. Larva.

In most of the wood boring lepidoptera, pupation occurs within the larval tunnel. However in ***C. cadambae***, prior to pupation, the larvae descend to the soil and undergo pupation, a few cms below the top soil in a cocoon made of silken fibres and soil particles webbed together (Fig. 4). Pupal period lasts for about 10 days. When the moth is ready for emergence the pupa frees itself from the cocoon

Fig. 3. Bee holed appearance.

by cutting open the cephalic end of the pupal bag and wriggling its way upto the soil surface. Certain spiny processes present on the pupal cuticle (Fig. 5). as well as the mobility of the abdominal segments help in its movements. Eclosion occurs by a longitudinal split of the pupal skin at its cephalic region.

The moths are dull brownish in colour and are cryptically marked to match the bark of teak trees (Fig. 6). They measure about 4-5 cm in wing span and are devoid of well-developed mouthparts. They are short lived and their only purpose seems to be the propagation of race.

Distribution

Distribution of this pest in teak plantations in Kerala State was studied by conducting a sample survey in the various Forest Divisions. The areas so far covered include, Parambikulam Wildlife, Sanctuary Nemmara, Trichur, Chalakudy, Ranni, Konni, Thenmala and Wynad Forest Divisions. Infestation was prevalent in most of the Divisions except Wynad and Thenmala. Survey in the other Divisions is in progress.

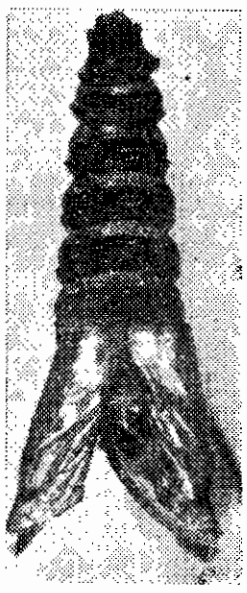

Fig. 4. Pupa.

Host range

Unlike other carpenterworms, which have a wide host range, ***C. cadambae*** is almost specific to teak except for a few instances of infestation on isolated standing trees of ***Grewia tiliifolia*** and ***Terminalia bellerica*** growing naturally in the vicinity of teak plantations.

Fig. 5. Spiny processes on the pupal cuticle.

Seasonality

Information on the seasonality of an insect pest is often very essential to evolve suitable management strategies. Studies so far conducted indicate that ***C. cadambae*** has continuous overlapping generations throughout the year with a high population intensity in the months May-November. Moths produced in each generation lead to a tremendous increase in their population which is an important factor rendering control operations rather complicated.

Natural enemies

C. cadambae has very few natural enemies, an advantage due to its concealed mode of life. However two species of birds; one, the common golden backed wood pecker and the other, a barbet, were found to feed on larvae which they extract from the borer galleries. Larvae, pupae and adults were also found to be affected by various fungal as well as bacterial pathogens, probably due to contamination from the soil, when this insect passes its stages in the soil.

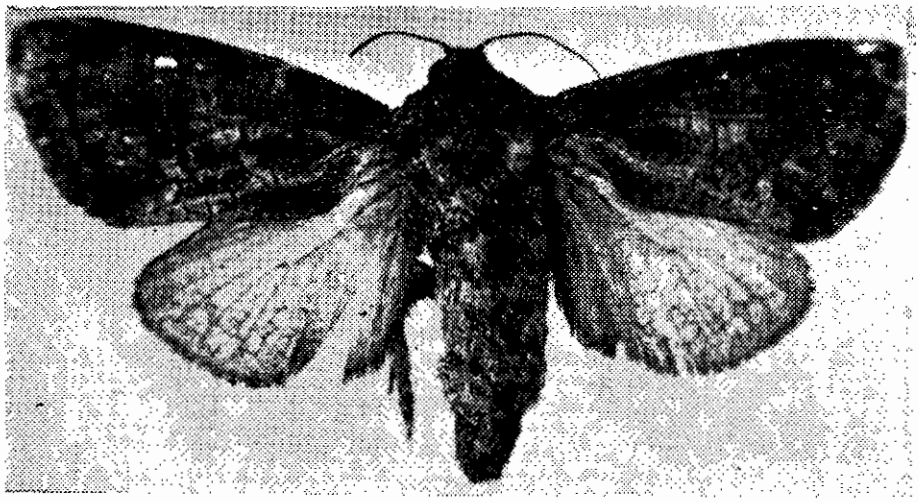

Fig. 6. Moth.

Conclusions

Information gathered so far indicates that ***C. cadambae*** is highly specialised in its biological and ecological requirements, a factor which leaves apprehensions on its successful management using the conventional pest control methods. The high fecundity of the females coupled with the larval behaviour of being confined to tunnels inside the wood and the occurrence of several overlapping generations ensure a better survival rate for this insect.

While the initial establishment of this insect in plantations is rather slow and is dependent on a variety of factors involving the site quality, age and nature of stands, mechanical injury to trees due to lopping of branches, occurrence of twiners etc., subsequent rate of establishment and spread in plantations is rather steady and in geometrical proportions. The initial stages of infestation usually go unnoticed and by the time the trees start to show symptoms of attack, the insect population might have increased considerably. Attacked trees also suffer from infestation by various fungal pathogens resulting in the decay of wood (~~Fig. 7~~). Thus, while most insect pests of teak cause indirect loss, attack by ***C. cadambae*** result in direct economic loss. Considering its present rate of spread and establishment in the various teak plantations in the State, it is quite reasonable to consider this as a major teak pest in Kerala and possibly throughout the Southern India.

Being a comparatively new insect pest of teak, no control measure has been proposed so far. Research on the management of carpenterworms in other countries has shown great promise in the application of newer pest control technologies involving pheromone trapping, insecticidal application using implants etc. Studies in these lines might prove successful in managing this insect.

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Orchid Habitats and their Conservation with Special Reference to Kerala

Introduction

Orchid habitat is governed by the influence of topographic factors, vegetation as well as microclimatic conditions prevalent in a particular region. In some species, specificity in their habitat requirements, is also seen. As a result of this, certain species of orchids are found to inhabit particular phytogeographic regions, thus contributing to endemism. The orchid habitat of Indian floristic region has been broadly included under 8 phytogeographical regions;, Peninsular India, Eastern India, North Eastern India Eastern Himalayas, Western Himalayas, Andaman & Nicobar Islands, Central India and Gangetic plains and Western India. North Eastern India and Eastern Himalayas show more number of orchids when compared to other regions. Manilal and Sathish Kumar (1985) estimated 1095 species belonging to 157 genera of orchids from India. In Peninsular India, there are about 265 species distributed in different habitat conditions at altitudes ranging from sea level to about 2500 m, all along the West Coast, Western Ghats, Nilgiris, Pulneys, Shevroy hills, Biligiriragan Hills, Parts of Eastern Ghats, and Deccan plateau (Santapau and Kapadia, 1966; Abraham and Vatsala, 1981; Joseph, 1982).

The Western Ghats of India are floristically rich and form one of the richest natural orchid growing regions. The tropical evergreen forests of Western Ghats receive both South West and North East monsoons coupled with bright sunlight throughout the year providing ideal condition for the orchids to grow, especially for the epiphytic ones. Field studies indicate that the hill forests of Idukki, Peerumade and Devicolam, Ponmudi, Thenmalai and Silent Valley, have considerable number of both terrestrial and epiphytic orchids. The commonest epiphytic orchids found on the plains of these regions are ***Acampe paraemorsa, Aerides ringens, Rhynochostylus retusa, Dendrobium macrostachyum*** and ***Pholidota pallida***. The terrestrial orchids that are found at sea level and plains are ***Eulophia epidendraea***, ***Habenaria viridiflora*** and ***Habenaria diphylla***.

Distribution and Endemism

Joseph and Vajravelu (1978) estimated about 150 species and listed 135 species of orchids to occur in Kerala. From the collections during floristic exploration of the Kerala forests and from the available literature the authors have compiled a list of 190 species that are distributed in the Kerala Forests among which 91 species are found to be endemic to South India. An enumerated list has been published elsewhere (Muktesh Kumar and Sasidharan, 1985). Manilal and Sathish Kumar (1984) recorded over 100 species of orchids from the Silent Valley, one of the reminiscent of the tropical evergreen rainforest in the Western Ghats. Sathish Kumar (1984) listed 85 species to be endemic to Western Ghats, of which 15 are found only in Kerala State, thus estimating 17.6 per cent of endemism in Kerala orchids. Hedge (1985) estimated about 113 endmic species to occur in Penninsular India. Among them nearly 25 species are considered endangered. The occurrence of Southern African, Sri Lankan and South East Asiatic elements in the orchid flora of South India is of considerably phytogeographic significance.

Though considerable work has been done in the endemism and phytogeography of the Indian floristic region, (Chatterjee, 1940; Rao, 1972, 1979; Subramanyan and Nayar, 1974; Nayar, 1977, 1980, 1982 and Nayar et al., 1984) it is felt that the status of the endemic taxa with reference to orchid species known to be endemic to South India should be re-evaluated.

The genera ***Cottonia*** and ***Sirhookera*** were considered to be exclusive to South India. But Rao (1979) excluded the genus ***Cottonia*** from the list of endemic taxa as another species was recorded from elsewhere. Similarly ***Chiloschista pusilla*** and ***Diplocentrum recurvum*** can no longer be considered endemic to Western Ghats (Subramanyan and Nayar, 1974). These two species have been reported from Sri Lanka (Jayaweera, 1981). ***Peristylus richardianus,*** considered to be endemic to Western Ghats was collected from Meghalaya (Joseph and Abbareddy, 1982). ***Oberonia longibracteata*** (Nair ***et al.,*** 1982) ***O. tenuis*** and ***O. thwaitesii*** considered to be endemic to Ceylon (Jayaweera, 1981) were recently recorded from Western Ghats (Manilal and Sathish Kumar, 1983, 1984). During the field explorations the authors collected ***Dendrobium mabelae, Liparis wrayii, Pomatocalpa manhii*** and ***Smithsonia maculata*** which were new records to Western Ghats of Kerala. ***Liparis wrayii*** was recorded previously only from Meghalaya. Recently the authors collected ***Dendrobium lawianum*** from Sholayar, which adds

yet another new record to this region. This species was so far known only from the Western Ghats of Karnataka.

Conservation

It becomes evident while comparing the floristic accounts that a large number of plants cannot be found in places from where they have been previously recorded. During the survey of orchids in the Kerala Forests, the authors observed that the areas from where Abraham and Vatsala (1981) had collected considerable number of species, are more or less barren at present, devoid of any orchids due to rapid destrucrion of the orchid habitats. There are certain intrinsic factors present within the individual species itself which are responsible for its restricted distribution. The need for protecting the areas where orchid species grow, particularly those species which are considered fast disappearing or where the only occurrence of a species in the area is known, is of great significance. It is these areas that are to be protected and made into nature reserves. The habitat of the orchids should be protected as it has its unique influence on specific ecological niche and if disturbed by any external agency, its survival is threatened and they may even become extinct. Many feel that by protecting the forests the orchids are conserved but many orchid species do occur in areas where there are no trees. The grasslands in Munnar, Ponmudi, Silent Valley and Wynad area abode considerable number of terrestrial orchids. As and when the grassland afforestation programme is implemented it is imperative that, this should be meticulously done, or else the large number of terrestrial orchids will be destroyed.

Among the orchids of Kerala, there are only a few species that are exploited in commercial scale for their ornamental value. The remaining species are inconspicuous and less attractive, but of great academic interest. Apart from indiscriminate collection of orchids from the natural habitat by the commercial growers, the scientists and academicians also cause threat to these as they too, remove the species from the wild in bulk, occasionally even by felling the tree itself.

Among the Kerala orchids that are considered presumably extinct or on the verge of extinction like *Acampe congesta* and *Taeniophyllum scaberulum* no collection record is available other than the type collections. The extremely rare and endangered species *Paphiopedilum druryii* recorded only from Agasthiamalai hills in Kerala requires urgent protection from further depletion of its natural habitat and the area should be made a nature reserve.

Conclusions

In order to preserve the orchid wealth the following suggestions are made ;

1. A through regionwise field exploration of the orchids should be undertaken.
2. Identify Scientific Areas and Nature Reserves in all the regions with special reference to the localised endemics for *in situ* conservation.
3. Maintenance of live collections of the representative specimens occurring in the respective regions

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Biological Conservation

The theme biological conservation is aimed at preserving the existing animal and plant species and representative natural communities for the benefit of posterity. To the conservationists, failure to protect life forms and their assemblages is an outright theft, since, once species and communities have been obliterated, they cannot be reconstituted. Of course, the prime objective of conservation is not to prevent changes from taking place. It is rather to ensure that nothing in the existing natural order is permitted to become permanently lost as a result of human activities unless all the forseeable consequences of the losses have been weighed and calculated. Let us examine the factors that threaten natural communities and individual species.

COMMUNITIES

It is well known that plants and animals are not sprinkled haphazardly on the surface of the earth and that they are distributed based on certain environmental determinants. For example, the tiger in India and the hippopotamus in Africa are all results of their habitat preferences. Another major factor that determines the formation of a community is the relative distribution of other species. For example, distribution of animals is greatly dependant on that of plants. Similarly dependence of animals on animals, plants on animals and plants on plants is also well known. This kind of dependence and the resulting assemblage sharing a common environment constitute the community. Similar environments may generate similar looking communities in far away places, for example, rainforest of Kerala very well resembles that of North-East India.

Before coming to the external factors that tempt to change communities, one has to account for the inherent trend of communities to change by way of succession, which is nothing but a type of metamorphosis in the process of its growth and maturation. The final stage of succession process is a climax community and in theory it will remain unchanged until some major geologic or climatic change takes place. From the point of view of conservation, the built-in-stability of such communities is sufficient to withstand small challenges to their integrity. But if its structure is drastically altered, it cannot grow back to the original state.

FACTORS THAT THREATEN THE COMMUNITIES

Population increase and technological advance

Expanding human population consumes food, other commodities and space at a rate that frightens the conservationists, and their effect on the existing fragile communities in such areas is hard to predict.

Construction of large multipurpose projects, mining activities with modern mechanical facilities like bulldozers, industrialisation, urbanisation, etc. are all factors that affect natural communities destroying them forever.

Landscape alteration

In populous countries like India and China, the for more and more arable land is a curse to the natural communities, especially in the coastal belt and in the rainforest regions. Such a situation poses serious threat to the environment, rendering many communities extinct.

Pollution

This is perhaps the best publicised of the various threats to ecosystems and natural communities. However, the ecological implications of it is the most important factor for the conservationists. Pollution may affect water, air and soil and in fact our understanding of each category decreases in the order in which it is mentioned. Following are the major types of aquatic pollution.

Natural pollution

Falling of leaves and twigs into the aquatic ecosystem is a common example of this. In case of such contaminations, even fish fauna

is found to be killed, the main reason being the lessening of oxygen content in the polluted water. One significant difference between natural and man-made pollutions is that the products the former are of all biodegradable and form part of the ecosystem.

Man.made pollution

Deoxygenation : Dumping of wastes of various kinds which by chemical or bacterial oxidation lowers the oxygen content in the aquatic system. Raw sewage and industrial effluents are common examples of this.

Poisons : Poisons directly affect the metabolic chemistry of organisms, often enter into food chains and cause an array of problems in a variety of organisms; for example, foliar application of poisons like pesticides, etc.

Radioactive wastes : This is an increasingly important type of pollution the danger of which on the ecosystems is difficult to evaluate. Nuclear explosions, accidents of atomic power and nuclea installations and wastes from a variety of research laboratories all release radioactive substances.

Thermal pollution ; Excess heat produced by nuclear power stations and other industries cause this. Temperature differences especially in water will result in threat to communities there directly and also by lessening the oxygen solubility. Temperature increase can also produce new poisonous substances in the medium.

Air pollution : This is caused by gaseous substances like hydrogen fluoride, nitrogen dioxide, etc. Carbon dioxide exit from vehicles and other systems that use fossil fuel also belong to this category.

Industrial accidents

Industrial accidents are mostly during the transport and storage of bulk chemicals. Chlorine gas from tankers, pipeline explosions and leakages, storage tank fires, oil spills, reactor accidents, etc. are common examples of this. They all contribute to pollution in the environment endangering natural biotic communities.

Introduction of exotic species

Introduction of exotic plants and animals into a balanced natural ecosystem will cause irreparable damage to it, and the success of the exotic is always at the risk of natural communities. Natural spread of *Salvinia* in our backwaters and introduction of *Eucalyptus* in the forest areas are deterimental to the indigenous species.

SPECIES

Ecosystem alteration

The principal cause of the loss of species is the alteration of the ecosystem in which they live. The Red Data Book of the IUCN lists hundreds of cases where man's alteration of the environment is causing extinction of species. Although poaching and unrestricted hunting are now the immediate threat to many mammals and birds in India, these creatures would not be in such a precarious position if there was no devastation of the Indian landscape. Even sanctuaries are no exception to this. The asiatic lion in Gir Forest, which once had an extensive distribution from Aisa Minor to India now has a dwindled habitat.

Hunting

For animal products : Eventhough the per capita demand for many animal products has decreased in the 20th century due to the availability of synthetic products, in some cases they are favoured for the same or for different purposes. For example, even though Whale oil is no more needed for lamps its meat is a pet food in Europe. The craze for feather of certain species, fine wool, reptile leather and stuffed curios like leopard; tusks of elephant, etc. all pose threat to the natural populations of the concerned species.

Game hunting : If properly regulated game hunting is primarily a conservation activity as it serves to control the population size of animals such as deer, sqirrels, rabbits, etc. But when it exceeds the limits, it will pose problems to the natural population, often rendering them endangered.

Predator control

Even though a part of the ecosystem, predators are often considered as dangerous, undesirable and unnatural elements. But man forgets the fact that predators serve a necessary function in the natural communities by way of regulating the natural size of populations. Attempts to exterminate predators is still going on in many countries based on two popular myths, i. e. they are dangerous to man (especially medium to large sized ones) and that they are a threat to domestic livestock.

CONSERVATION FOREST GENETIC RESOURCES

When we consider specifically factors that adversely affect the forest ecosystem, it can be seen that they are mainly due to the result of an increased need for forest land, products and services, and such needs result in a few major deleterious effects on forests like :

a. Loss of forest-land to shifting or permanent agriculture or plantation raising.
b. Watershed damage and desertification
c. Decreased availability and increased cost of many forest products
d. Disputes on the ownership of forest lands.

To minimise further such deleterious effects, it is essential to explore, evaluate and conserve the existing forest resources.

What to conserve ?

As natural forests, especially in tropics, contain many species whose properties are not yet known fully and plants and animals of no obvious immediate use, but whose continued existence is essential for future generations and that they provide other services such as water and soil conservation, amenity aud tourism, there is a need to conserve such ecosystems *in toto*. Many countries have thus set aside rapresentatives of their major ecosystems from any further change. Such samples will automatically conserve species diversity also. In such cases the size of the area is the determining factor. For example, mixed forests of Dipterocarps in Sarawak, some 2000 ha is considered the minimum area required to conserve 200 individuals of each species.

How to conserve ?

In situ : If protection of an ecosystem is what is needed, it can be done only *in situ* (i. e. in the natural place of origin) and the area required in such cases can be decided after proper studies on the interactions between all species and animals there. However, such studies are to be undertaken before the ecosystem is irrevocably changed. Such areas are often called Strict Nature Reserves (SNR). *In situ* conservation is also possible for individual species, provided information on their reproductive biology, pattern of distribution and ecology are available to establish the minimum area of the forest to contain daequate number for gene pool maintenance.

Ex situ : This is a more attractive method of conservation, because it can be done for individual species in areas where environmental conditions or management techniques are suitable. It is achieved in various ways like storage of pollen, seed, etc. and multiplication by tissue-culture and also by living plants. The number of individuals required for conservation is still a controversial subject and the number of trees recommended vary from 20-30 for a single population. Further, before choosing populations and species for *ex situ* conservation, it is necessary to evaluate their existing genetic variability on the basis of existing sites, management treatments and economic criteria. This include growth trials in nurseries, field, green house or growth chambers and anatomical, morphological and chemical studies in the laboratory.

Who should conserve?

National activities : Many countries have initiated *in situ* and *ex situ* conservation programmes by way of establishment of national parks, biosphere reserves, seed stands, botanic gardens, etc. Some countries are also making efforts to conserve and utilize little known species. What is required is to take steps to conserve indigenous species in each country and have collaborative efforts with other countries for species grown commonly, as co-ordinated exploration and conservation programmes.

International activities : Internationally, ICUN and UNESCO are co-ordinating national efforts for ecosystem preservation. It is FAO that has taken a more active role in the exploration, conservation and evaluation of tree species that are of major use in exotic plantations. International efforts of CSIRO, Canberra, and CFI, Oxford, for exploration evaluation, and conservation of *Eucalyptus* spp. *Gmelina* and *Tectona* also deserve mention here. For the overall success in forest conservation programme, it is essential that practising foresters, both professional and technical, be aware of the implications of genetic conservation, as we are now moving away from traditional forest management to diversified management appropriate for overall development.

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Recent Publications

Published in journals

Nair, K. K. N. 1986

Additions to Gamble's Flora of the Presidency of Madras (1915-1935) from the States of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh up to 1982.
Ind. J. Forestry 8(4): 250-261. 1985 (1986).

ABSTRACT

Gamble's Flora of the Presidency of Madras (1915-35) is an account of the flowering plants of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. Since the publication of this Flora, a number of plants have been reported from this region either as new to science or as new distributional records. This catalogue is an alphabetical assemblage of all those additions to the Flora of the Presidency of Madras with original citations for new taxa and the publication reporting in the case of new distributional records. The present paper covers the enumeration starting with A and ending E and will continue in subsequent issues of the Journal.

Nair, K. K. N. 1985 (1986 May)

Two unrecorded species of ***Dalbergia*** L. f. (Fabaceae) in Kerala.
J. Econ. & Tax. 7(3): 730-34. 1985 (1986).

ABSTRACT :

While studying the herbarium materials of the genus ***Dalbergia*** L.f. from Kerala State represented in Madras Herbarium (MH), Coimbatore and Herbarium of the University College, Trivandrum, few specimens belonging to the species ***D. acaciifolia*** Dab. and ***D. pseudo-sissoo*** Miq. were located. In literature these two species are not so far recorded from Kerala. Descriptions and illustrations of the two taxa are provided in the paper to facilitate their future collections and identification.

Bhat, K. V., Surendran, T. and Swarupanandan, K. 1986.

Anatomy of branch abscission in ***Lagerstroemia microcarpa*** Wight. New Phytol. 103: 177-183.

ABSTRACT

Some anatomical details of branch abscission in ***Lagerstroemia microcarpa*** Wight (Lythraceae) are discussed. Repeated abscission of numerous annual branchlets and subsequent healing of their scars produce irregular growth of the subjacent branch portions to give gall-like structures. In the abscission zone, secondary xylem fibres are thin walled and poorly lignified with dense protoplasmic contents and closely spaced septa Disintegration of pith parenchyma cells and shrinkage of bark and wood tissues contribute towards weakening of abscission zone. The protective zone situated proximal to the abscission zone is strongly lignified and rich in extractives. Detachment occurs immediately above the protective zone leaving the encircling dormant buds intact. Abscission scars are healed centripetally by the usual method of callus formation from the cambial tissue. It appears that branch abscission in *L. microcarpa* is a mechanism to withstand drought by reducing the transpiring surface.

Seminars, Congresses, Lectures

Sri T. K. Dhamodaran attended the Second Forest Products Conference held at Forest Research Institute, Dehra Dun on 26 and 27th May 1986 and presented two papers entitled 'Some promising tropical hardwood species for cement-bonded wood wool board' by T. K. Dhamodaran and R. Gnanaharan, and 'Tropical hardwood branches as raw material for reconstituted wood products' by K. M. Bhat, K. V. Bhat and T. K. Dhamodaran.

Dr. T. G. Alexander, Sri. Mathew, P. Koshy, Sri. C. Mohanan. Sri. N. Sasidharan, Dr. C. T. S. Nair and Dr. R. V. Varma attended the State-level workshop on 'Agro/Social forestry practices' held at the Directorate of Extension, Kerala Agricultural University on 12, 13 August 1986.

Campus News

Joined KFRI recently

Sri A. Nandakumar	28-5-1986
Sri A. T. Devassy	8-7-1986
Sri K. Nanu	12-6-1986

KFRI Research Reports

Venkatesh, C. S., Koshy M. P., Chacko, K. C. and Indira, E. P. Genetic improvement of teak *(Tectona grandis L.f.)* in Kerala. KFRI Research Report No: 13. Final Report of the Project Genet 01/1979. July 1986, 21 pp.

ABSTRACT

Though teak plantation programme in Kerala commenced in 1841, attempts to genetically improve the planting stock were initiated in 1961 only when a few plus trees were selected. As no further work continued since then, this project was initiated with the objectives of selection of seed stands and plus trees and establishment of pilot seed orchards. Plantations superior in vigour and growth compared to adjoining areas were selected and converted to seed production areas after removal of inferior trees. Fifty trees, outstanding in growth and stem form designated as plus trees have been selected in different teak growing areas in Kerala using check method. Bud grafts of the plus trees were prepared using scion from upper one third part of the tree crown and stock prepared from 1-to 2-year-old teak stumps collected from Forest Department nurseries. Grafts raised in polypots during February-April were outplanted in the orchard site by the onset of monsoon in June. For planting, 8 m quinquincial espacement was adopted, using a poly cross design. Altogether three pilot seed orchards were established at three representative locations. They were Nilambur in the Northern, Palappiily in the Central and Arippa in the Southern Forest Circles of Kerala. Fifteen, twenty and twentyfive clones are represented in these orchards respectively. Having begun the basic work.in the genetic improvement programme, future scheme of work is also suggested.

Varma, R. V.: Seasonal incidence and possible control of important insect pests in plantations of *Ailanthus triphysa.* KFRI Research Report No: 39. Final Report of Ihe project Entom 09/1983. April 1986. 42 pp.

ABSTRACT

Ailanthus triphysa is one of the fast growing tree species grown in plantations in Kerala. The two major pests noticed were *Atteva fabriciella* (Lepidoptera: Yponomeutidae) *Eligma narcissus* (Lepidoptera : Noctuidae). The seasonal occurrence, damage intensity, natural enemy complex and possible control of these pests were investigated.

E. narcissus feeds on all the leaves at times of pest outbreaks whereas attack by *A. fabriciella* is confined to the terminal portion of the plants. After a heavy attack by *E. narcissus* new foliage appears in about two weeks. Repeated attacks can result in completed defoliation and may affect the growth of the plants. Damage by *A. fabriciella* can result in the formation of epicormic branches or partial or even complete death of the terminal buds, thus causing loss in height growth.

The two pests were commonly distributed throughout Kerala, wherever *Ailanthus* is grown. Seasonal incidence of pest was studied in a 2-year old *A. triphysa* plantation at Pothuchadi in Peechi Range of Trichur Division over a period of $2\frac{1}{2}$ years. *A. fabriciella* was present almost throughout the year. However, the population was comparatively low during the monsoon period. In general, incidence of *A. fabriciella* was high between October and December in the study area. A peak in the population of *E. narcissus* was observed only during September to December in one year; during other periods the insects were practically absent. Based on the present data, the population trend of the two pests cannot be generalised because pest incidence was noticed in other localities at other times of the year. Pest outbreaks were noticed more often in young plantations and nurseries; older plantations were generally free from damage.

Quassia indica, a shrub which belongs to the same family as that of *Ailanthus* was found as an alternative host of *A. fabriciella*. No other alternative host plant has been reported so far for the two pests.

Many mortality factors were found to operate under field conditions against the two pests which include -- a tachnid *(Sarcophaga* sp.), a chalcid *(Brachymeria hime attevae)*, nematode *(Hexamermis* sp*)*, an ant *(Crematogaster perelegans)*, a fungus *(Paacilomyces farinosus)* and a bacterium *(Bacillus firmus)*. Of these the microbial pathogens, the fungus and the bacterium, appear to exert maximum pressure, especically to *E. narcissus*.

Selected insecticides--quinalphos (Ekalux), monocrotophos (Nuvacron) cypermethrin (Cymbush)--were screened in the laboratory against the pests and tested further under field conditions. The use of microbial pathogens in the control of the pests seems promising, but needs further studies.

Key words : *Ailanthus triphysa, Eligma narcissus, Atteva fabriciella,* seasonal incidence, natural enemies, chemical control.

Forthcoming Events

13-21 October, 1986. Ergonomics in the Tropics-Training Course. Wageningen, Netherlands.
Contact: F. J. Staudt, Vakgroep Bosboutechneik PO Box s42, NL 6700AH, Wageningen.

4-8 November, 1986. Hout '86-International Timber Machinary Fair, Rotterdam, Netherlands
Contact: Intradex BV, Strevelsweg 700/207, 3083 As Rotterdam, Netherlands

24-29 November, 1986. International MAB/IUBS Workshop on Rainforest Regeneration and Management. Caracas, Venezuela
Contact : MAB Secretariat, 7 Place de Fontenoy 75700 Paris, France.

November-December, 1986. South-East Asian Training Course on Insect and Mite Identification for Agriculture and Forestry. University Kebangsaan, Malaysia
Contact : Dr. K. M. Harris (Director), Commonwealth Institute of Entomology, 56 Queen's Gate, London SW7 5JR, England.

6-13 December, 1986. Parsitis '86 - Pest Control Exhibition and Symposium, Geneva, Switzerland.
Contact : IOMI - EXPO S. A. 5 Cours des Bastions 1205 Geneva, Switzerland.

10-13 December, 1986. International Seminar on Silviculture and Management of Tropical Rain Forests, Mysore, India
Contact : Dr. S. N. Rai, Conservator of Forests, Sandal Research Centre, 18th Cross, Malleswaram, Bangalore 560 003, India

January, 1987. Regional MAB Workshop-Man's impact on Tropical Forest Ecosystems
Percy, India
Contact : MAB National Committee,
Department of Environment, Birkaner House, Shahjahan Road, 110 011 New Delhi, India.

3-5 April, 1987. Techniques for Wildlife Management; Lancaster, England.
Contact : Institute of Chartered Foresters, 22 Walker Street, Edinburgh EH3 37 HR, England.

22-24 April, 1987. Second French National Symposium on Wood Science and Industries. Nancy, France.
Contact : Deuxiem'e Colloque national 'Sciences et Industries du Bios'. ENGREF, 14 rue Girardet, 54042 Nancy, Cedex, France

8-11 June, 1987. International MAB/IUBS Workshop on Reproductive Ecology of Tropical Forest Plants. Bangi, Malaysia
Contact : MAB Secretariat, 7 Place de Fontenoy 75700 Paris, France or Dr. Noraini Tamin, Department of Botany, Universiti Kebangsaan, Malaysia.

20-30 August, 1987. XVI Pacific Congress. Seoul, Korea.
Contact : B. Bishop, XVI PSC 1987 KPO Box 1008, Seoul 110, Korea.

11-18 September, 1987. Fourth World Wilderness Congress. Estes park, Denver, Colorado, USA
Contact : Secretariat, 4th World Wilderness Congress, Colorado State University, Fort Collins Co 80523, USA

19-22 October, 1987. Management of Water and Nutrient Relations to increase Forest Growth (IUFRO Div 1: Forest Environment and Silviculture) Canberra, Australia
Contact : Dr. Ross Squire, Von Mueller Institute C/-School of Forestry and Lang Management, Creswtck, Vic. 3363, Australia.

February, 1988. IVth International Round Table Conference on Dipterocarps. Sakaerat Biosphere Reserve, Thailand
Contact : G, Maury-Lechon, Laboratoire de Phanerogamie, Paris, France.

22-24 April 1988. Australian Bi - Centenary - Eucalypts, Casuarinas and Acacias. Albury, Australia
Contact : R. L. Newman, AFDI, PO Box 515 Launceston, Tasmania 7250.

Balasubramanyan, K. and Swarupanandan, K. : A study of the seedlings of some commercially important trees of Kerala. KFRI Research Report No: 41. Final Report of the project Ecol 03/1979. May 1986. 64 pp.

ABSTRACT

Seedlings of fifty commercially important tree species of Kerala forests were studied. Seedlings used for the study were of nursery origin, raised from the seeds of identified mother trees, or collected from natural forests. Morphology of the seedlings were studied under a stereomicroscope at low magnifications. Descriptions of the seedlings and necessary drawings, are provided so as to facilitate easy identification. Based on the study, an artificial key for the fifty species, to distinguish from one another, is also provided. □

KFRI Research Reports

No. 1* Easwarankutty, K., Sivarajan, M. and Asan, R. B. 1977. Study on wood and bark volumes of eucalypt trees in Kerala. Final Rep. Res. Proj. Stat. 03/1977, 27 pp.

No. 2 (1)* KFRI. 1977. Availability of wood raw-materials for plywood industry-Kerala-Karnataka Region. Final Rep. Res. Proj. (Sponsored by the Federation of Indian Plywood and Panel Industry) Part-1.117pp. (Mimeographed).

(2)* KFRI. 1978. Availability of wood raw-materials for plywood industry-North-Eastern Region. Final Rep. Res. Proj. (Sponsored by the Federation of Indian Plywood and Panel Industry: Part-2. 85 pp. (mimeographed).

No. 3* KFRI. 1978. Dipterocarps of South Asia. Final Rep. Res. Proj. (Sponsored by FAO). 637 pp (Typewritten).

No. 4* Alexander, T. G., Sobhana K., Balagopalan, M and Mary, M. V. 1980. Taungya in relation to soil properties, soil erosion and soil management. Final Rep Res. Proj. Soils 01/1977, 24 pp

No. 5* KFRI. 1980. Studies on changing pattern of man forest interactions and its implications on ecology and management: A case study of the Reserved and Vested Forests in Attappady, Kerala Final Rep. Res. Proj. (Sponsored by the Department of Sci. & Tech., Govt. of India) 235 pp (Mimeographed).

No. 6* Nair, K. S. S. and Varma, R. V. 1981. Termite control in eucalypt plantations. Final Rep. Res. Proj. Entom 01/1976, 48 pp.

No. 7* Alexander, T. G., Balagopalan, M., Thomas P. Thomas and Mary, M. V. 1981. Properties of soils under teak. Final Rep. Res. Proj. Soils 02/1977, 13 pp.

No. 8* Alexander, T. G., Balagopalan, M., Mary, M. V. and Thomas P. Thomas 1981. Properties of soils under eucalypts. Final Rep. Res. Proj. Soils 03/1977, 12 pp.

No. 9* Nazma, Ganapathy, P. M., Sasidharan, N., Bhat, K. M. and Gnanaharan, R. 1981. A handbook of Kerala timbers. Final Rep. Res. Proj. Wood 01/1979, 260 pp.

No. 10* Mathew George 1983. A survey of beetles damaging commercially important stored timber in Kerala. Final Rep. Res. Proj. Entom 07/1979, 92 pp.

No. 11* Varma, R. V. 1982. Investigations on the possibility of non-insecticidal control of termites. Final. Rep. Res. Proj. Entom 06/1979, 28 pp.

No. 12* Gnanaharan, R., Nair, K. S. S. and Sudheendrakumar, V. V. 1982 Protection of fibrous raw-materials in storage against deterioration by biological organisms. Final Rep. Res. Proj. Wood 04/1980, 24pp.

No. 13 Venkatesh, C. S. Koshy, M. P., Chacko, K. C. and Indira, E. P. 1986. Genetic improvement of teak *(Tectona grandis I. F.)* in Kerala. Final Res. Proj Genet 01/1979, 21 pp.

No. 14* Alexander, T. G. and Thomas P. Thomas 1982. Cultural practices for managing soil erosion in forest plantations. A state of knowledge report. Final Rep. Res. Proj. Soils 05/1981, 11 pp.

No. 15* Gnanaharan, R. and Mathew George 1982. Preservative treatment of rubber wood *(Hevea brasiliensis)*. Final Rep. Res. Proj. Wood 03/1977. 16 pp.

No. 16* Nair K. S. S. 1983. Seasonal incidence, host range and control of the teak sapling borer *Sahyadrassus malabaricus*. Final Rep. Res. Proj. Entom 08/1979, 36 pp.

No. 17* Alexander, T. G., Mary, M. V., Thomas P. Thomas and Balagopalan, M. 1983. Influence of site factors in *Bombax* plantations. Final Rep. Res. Proj. Soils 04/1979, 19 pp.

No. 18* Nair C. T. S. and Muraleedharan P. K. 1983. Rural institution for development of appropriate forestry enterprises: A case study of the traditional reed industry in Kerala State, India. Final Rep. Res. Proj. Econ 03/1982, 150 pp.

No. 19* Nair, K. S. S. Mathew George, Varma, R. V. and Gnanaharan R. 1983. Preliminary investigations, on the biology and control of beetles damaging stored reed. Final Rep. Res. Proj. Entom 04/1979 33 pp.

No. 20* Balagopalan, M. and Alexander, T. G. 1983. Organic matter dynamics in teak and eucalypt plantations. Final Rep. Res. Proj. Soils 06/1981, 21 pp.

No. 21* Ghosh, S.K., Balasundaran, M. and Mohamed Ali, M. I. 1984. Studies on host-parasite relationship of phanerogamic parasite(s) on teak and their possible control. Final Rep. Res. Proj. Pathol (NF) 01/1979, 39 pp.

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