

**INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY  
BANGALORE**

The Institute of Wood Science and Technology (IWST), Bangalore, established in the year 1988, is mandated to conduct research on wood science and technology as its National objective and focuses its research to important forestry research needs of the States of Karnataka, Andhra Pradesh and Goa at regional level.

**OLD PROJECTS CONTINUED DURING THE YEAR 2000-2001**

**Project 1: Study of anatomical, physical and mechanical properties of plantation grown timber *Acacia mangium*, *A. auriculaeformis* and *Tecomella undulata*. (IWST-OG 1/WPU/2000-01/1)**

**Objectives :** (a) To evaluate anatomical variation and its correlation with specific gravity with respect to different ages – 8,10 and 13 from the material obtained from Sirsi area of Karnataka. (b) To evaluate physical and mechanical properties with respect to different ages - 8,10 and 13. (c) To evaluate properties using non-destructive testing methods and correlate with data obtained from destructive testing and determine end uses.

**Achievements:** Studies on anatomical variation in respect of vessel morphology, fibre morphology, tissue proportions, specific gravity in *Tecomella undulata* completed. The correct description of the wood structure is made for the first time. The wood quality of 8 years old *Tecomella undulata* has been evaluated by assessing the physical and mechanical properties, and recommended for furniture, doors, window shutters and frames, tool handles, agricultural implements, pallets etc. Studies carried out on 20 trees of plantation grown *Acacia auriculaeformis*.

**Project 2: Computer assisted wood identification. (IWST-OG 2/WPU/2000-01/2)**

**Objectives :** (a) To develop a software for timber identification. (b) To develop card key features based on macroscopy. (c) To create database of Indian timbers for identification from Indian Woods Vol. IV and V. (d) To apply software for identification. (e) To upgrade additional information from the new publications. (f) To provide technical consultancy to user agencies.

**Achievements:** Codification of card key features of Indian Woods Vol. IV and V for the development of software program for identification of wood, is under progress for 63 species.

**Project 3: Development of software for calculating the properties – CALPRO. (IWST-OG 5/WPU/2000-01/4)**

**Objectives :** (a) To provide information on utilization of timber in shortest possible time with least amount of expertise. Enhance the capability of a scientist working in the field. (b) The programme has potential of earning revenue by way of sale of package to user industries.

**Achievements:** A database, proto-type demo software was developed by incorporating data of 25 species with the information on physical and mechanical properties.

**Project 4: Modifications in existing design of solar drying kiln to improve energy efficiency. (IWST-OG 3/WSP/2000-01/1)**

**Objective :** (a) To improve the efficiency of existing green house type solar kilns by modification in design. (b) To reduce drying time of timber. (c) To provide cheaper timber drying kiln design to small scale rural saw millers. (d) To popularize the environmental friendly alternative source of energy for drying timbers.

**Achievements:** Experimental work was carried out on prototype models in order to improve efficiency. Modifications on the design were suggested.

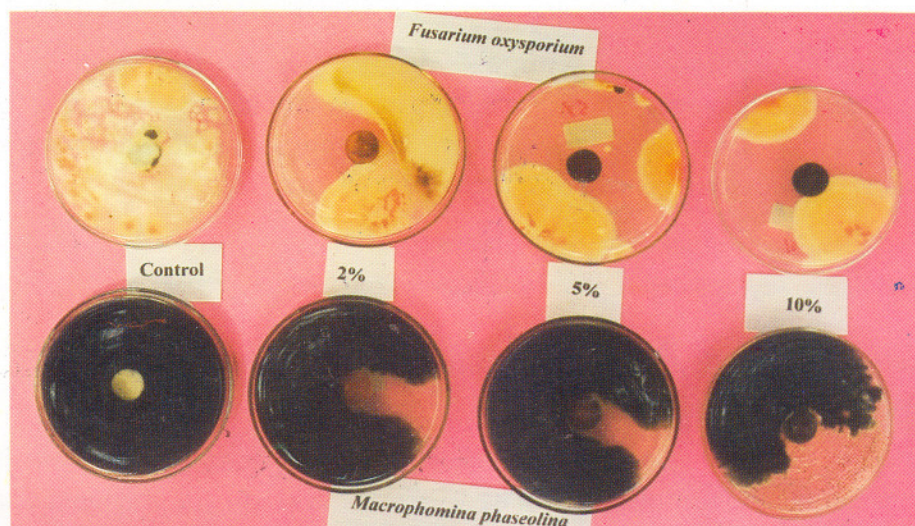
**Project 5: Studies on the permeability of hardwood species grown in regions of Karnataka, Goa and Andhra Pradesh. (IWST-OG 6/WSP/2000-01/2)**

**Objective:** To assess the permeability measurements in three directions (axial, radial and tangential).

**Achievements:** Permeability measurements of *Acacia nilotica* in axial, radial and tangential directions were carried out after conditioning over saturated salt solution of different chemicals. Samples of plantation grown *Tectona grandis* and *Acacia auriculaeformis* were prepared and kept for conditioning saturated salt solutions to attain 9% moisture content.

**Project 6: Control of biodeterioration of wood with the help of eco-friendly preservatives and bioactive substances on staining and decay fungi under terrestrial conditions. (IWST-28/WBD/2000-01/8)**

**Objectives:** (a) To collect the wood and plant extractives and other bioactive substances for testing the bioefficacy. (b) To treat perishable wood and laboratory evaluation of treated material. (c) To test the commercial wood preservatives to find out the efficacy of preservative on biodeterioration of wood. (d) To find out cost effective and ecofriendly preservative substitutes for enhancing durability of non durable timbers.



Antagonism of *Machilus macrantha* extract against plant pathogens

**Achievements:** Pure culture of wood rotters, staining and pathogenic fungi are maintained in laboratory for bioassay studies. Antagonism studies were conducted by using different concentrations of *Machilus macrantha* plant extract against *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophonina phaseolina*. Bioassay studies of lantana dye was carried out against plant pathogenic fungi. Double coating of test preservative has given protection against test organisms.

**Project 7: Studies on the diversity of Aleyrodid fauna of South Western Ghats. (IWST-36/WBD/2000-01/16)**

**Objectives:** (a) To survey aleyrodid fauna of south Western Ghats. (b) To revise the taxonomy of the family Aleyrodidae occurring in Western Ghats and describe any new genera and species. (c) To describe the intraspecific variation within the species of aleyrodids. (d) To prepare a key to the Indian genera of the family Aleyrodidae, with keys to species of each genera. (e) To record the host range for the species known from India and (f) To prepare a checklist of aleyrodid of southern Western Ghats.

**Achievements:** Survey was conducted covering all the States included in the Project viz., Tamil Nadu, Kerala, Karnataka and Goa. Whitefly specimens were collected from a total of 645 infested plants.

**Project 8 : Studies on termite problems on trees and timber and development of termite testing facilities. (IWST-36/WBD/2000-01/14)**

**Objectives :** (a) To study the occurrence, distribution and systematics of termites infesting timber tree species. (b) To develop facilities for maintaining the culture of termites and testing against termites. (c) To maintain the culture of timber destroying termite species. (d) To gather information on the performance of endogenous and exotic tree species against termites in the field condition. (e) To evaluate the potential on newer insecticides / termiticides and botanical species against wood destroying termites.

**Achievements :** Bioefficacy experiments against termite using rubber stakes and bamboo stakes with many insecticides were started in the field condition. Experiments to assess the natural durability of *Bamboo* spp., and timber was started in the field condition. At termite test yard *Odontotermes horni* and *Microtermes obesi* has been identified as major wood eating termites.

**Project 9 : Investigations on the potential of medicinal and Aromatic plants as source of botanical insecticides. (IWST-20/WBD/2000-01/5)**

**Objectives :** (a) To identify the medicinal and aromatic plants which possess insecticidal principles. (b) To evaluate extracts of plants which possess insecticidal principle against target insect pests. (c) To study the compatibility of extracts of different plants which possess pesticidal properties. (d) To study the effect of additives on the efficacy of phyto-pesticidal extracts.

**Achievement :** Methanol extract of *Chromolaena odorata*, Chloroform and Ethyl alcohol extracts of *Lantana camara* were tested against ash weevil *Myloccerus* sp., *Spodoptera litura* and *Eutectona machaeralis*. The extracts were found not effective against *Myloccerus* sp., but effective against lepidopteran pests.

## NEW PROJECTS TAKEN UP DURING THE YEAR 2000-2001

**Project 1: Wood quality parameters for improving planting stock of *B. arundanacea* and *Pseudooxytenanthera stocksii*. (IWST-5/WPU/2000-01/5)**

**Objectives :** (a) To assess the quality of *Bambusa arundanacea*, *Dendrocalamus strictus* and *Pseudooxytenanthera stocksii* with respect to anatomical as well as strength parameters. (b) To create data base and recommend various uses as alternate to wood.

**Progress made :** Nine culms of *P. stocksii* were studied for specific gravity, moisture content and compression parallel test to find culm to culm variation in respect of culm wall thickness.

**Project 2: Production of reconstituted wood products / wood composite - Laminated Veneer Lumber (LVL), Parallel Splint Lumber (PSL) from different plantation grown timber species and to study their different physical and mechanical properties. (IWST-23/WPU/2000-01/6)**

**Objectives :** (a) To optimize the processing parameters for the manufacturing of glue laminated wood products like parallel splint lumber (PSL) and laminated veneer lumber (LVL). (b) To study the influence of the combination of different specific gravity timber species on the preparation of reconstituted wood products (composites) and its effect on physical and mechanical properties, gluing properties as well as their economic analysis.

**Progress made :** Preliminary experiments on the production of LVL using available veneers of three different timber species namely mango, gurjan and dido.

**Project 3: Wood quality parameters for improving planting stock of *Gmelina arborea*. (IWST-25/WPU/2000-01/7)**

**Objectives :** (a) To assess the wood quality of *Gmelina arborea* with respect to anatomical as well as strength properties, create the data base and recommending for its rational utilization. (b) To study variation of strength properties with respect to within tree, between tree, age and site to use it for tree improvement programme.

**Progress made :** The project was taken up on the suggestion of Andhra Pradesh Forest Department, who promised to supply the material. As the procurement of the material as promised by Andhra Pradesh Forest Department could not materialize, RAG is being requested to defer the project for 1 year.

**Project 4: Relationship of the wood properties of coppice plantation grown *Eucalyptus* species. (IWST-37/WPU/2000-01/8)**

**Objectives :** (a) To study the quality of wood of the coppice sprout and compare with that of the tree which was coppiced (b) To study the structural changes which in turn influence the properties. (c) To make use of second grown or third grown stumps, which are available after first and second felling for recommending it for various end uses.

**Progress made:** Initial survey of different plantations ( first and second generation) has been carried out near Hoskote area and data were collected on girth, height and age of the trees to be studied. The Project has been identified by NABARD for possible funding. The same has been formulated for submission to NABARD.

**Project 5 : Studies on influence of (i) Microfibril angle and (ii) Spiral grains in wood on the strength properties of plantation grown timbers (*Eucalyptus* spp). (IWST-38/WPU/2000-01/9)**

**Objectives :** (a) To find the effect of variation in microfibril angle and spiral grain on the shrinkage and strength properties of plantation grown timbers (*Eucalyptus* spp.). (b) To study the influence of microfibril angle and spiral grain on physical and strength properties.

**Progress made:** A large number of samples have been tried and the technique has been standardized. The technique is now being applied for the measurement of microfibril angle of two CPTs of *Eucalyptus tereticornis* in radial direction from pith to periphery.

**Project 6: Development of seasoning and preservation techniques for bamboo and rattans. (IWST-03/WSP/2000-01/3)**

**Objectives :** To evolve appropriate technology for the better utilization of bamboo through seasoning and preservation techniques for the control of decay.

**Progress made:** The ammonia pre treatment did not help much in the treatment of *Dendrocalamus* by CCB, as control specimens also gave better absorption and penetration. Drying rates were compared between CCB treated and untreated samples of bamboos. Treated samples were found to dry slower as compared to untreated samples. No appreciable drying degrades were observed even after 120 days of air-drying.

**Project 7: Developments of composites from wood waste and non wood lignocellulosic materials. (IWST-07/WSP/2000-01/4)**

**Objectives :** (a) To synthesise and characterization of TMI grafted Polypropylene. (b) To study the effect of various parameters on grafting yields. (c) To improve compatibility between natural fibers and thermoplastics.

**Progress made:** Compatibilisers were synthesized by grafting. Cellulosic fibres (Bleached pulp of *Eucalyptus*) were surface modified with polypropylene- m-isopropenyl-a, a-dimethylbenzyl- isocyanate graft-copolymer by immersing the fibres in 5% solution of copolymer in hot toluene. Treated fibres were totally hydrophobic. Soxhlet extraction of treated fibres confirmed that the modifying agent (graft-copolymer) is attached to the fibres by covalent bond. FTIR studies showed that the product of this reaction is a stable carbamate ester bond.

**Project 8 : Performance evaluation of wood coating system. (IWST-08/WSP/2000-01/5)**

**Objectives :** To develop pre-treatment for wood surface for enhancing life of paint coats.

**Progress made :** Based on experiments, three chemical solutions have been screened for pretreatment.

**Project 9 : Studies on lignin filled thermoplastic composites. (IWST-12/WSP/2000-01/6)**

**Objectives :** (a) To assess the effective utilisation of abundantly available waste material (lignin). (b) To study the reaction mechanism between lignin and compatibilising agents. (c) To characterize the product.

**Progress made:** Compatibilisers were synthesized by grafting Polypropylene with maleic anhydride and unsaturated aliphatic isocyanate. Lignin was modified by reacting with these compatibiliser. The nature of adhesion was studied by FTIR. It was found that the surface modifying agent is covalently bonded to the lignin through esterification.

**Project 10 : Evolving kiln-drying schedules of timbers from plantations. (IWST-14/WSP/2000-01/7)**

**Objectives :** To evolve kiln drying schedules for fast grown timber species from plantations.

**Progress made:** The equipment /facilities are being procured under World Bank grant.

**Project 11 : Investigation on the effect of growth stresses in processing of timbers from plantations. (IWST-19/WSP/2000-01/8)**

**Objectives :** (a) To improve measurement technique for measurement in growth stresses in trees and timber. (b) To study the growth stresses distribution in trees and logs of *Eucalyptus tereticornis* and *Acacia auriculaeformis* from two locations. (c) To establish relationship between growth stresses and physical and chemical properties. (d) Mechanism of generation of growth stresses in trees.

**Progress made:** Growth strain was measured in *Eucalyptus tereticornis* logs using hole-drilling method in which holes of 30 mm diameter are generally made on the surface of logs. It was observed that growth strain value with 30 mm diameter hole was 2.7 to 2.8 times that of 6 mm diameter hole. Average strain in logs of 10 years old trees was more as compared to 12 years. Average strain values observed in this study are higher than the *Eucalyptus tereticornis* obtained from Bangalore region.



Furniture made from *Acacia auriculaeformis*

**Project 12 : Developing techniques for surface thermoplasticisation of wood. (IWST-26/WSP/2000-01/9)**

**Objectives :** (a) To develop suitable techniques of surface thermoplasticisation of wood for improvement in surface properties. (b) To develop new products like hot-melted- self bonded wood boards utilising Industrial woodwaste like sawdust.

**Progress made:** Effect of different reaction parameters have found to play a significant role in benzylation of wood surface. A significant change in chemical structure of wood was observed by benzylation. Absorption bands at 1950-1810, 1600, 740 and 700  $\text{cm}^{-1}$  increased indicating presence of benzene rings of benzyl groups. Benzylated wood particles have exhibited hydrophobic nature.

**Project 13 : Efficacy of preservative in enhancing durability of timber (Development of alternative preservatives of more economic value and schedules for their incorporation in wood). (IWST-27/WSP/2000-01/10)**

**Objectives :** To study different plant extractives by incorporating them with less toxic chemicals to develop wood preservative which are eco-friendly and cost effective.

**Progress made :** Copper ions were incorporated in CNSL liquid to obtain different gradation of concentration of copper in the CNSL wood preservative. This will be used for further investigation for treatment of wood.

**Project 14 : Analysis of wood and its constituents by fluorescence and FTIR spectroscopic techniques – a non destructive tool for rapid characterization of wood. (IWST-34/WSP/2000-01/11)**

**Objectives :** (a) To investigate feasibility of fluorescence and FTIR spectroscopic technique for the analysis of biodegradation of wood. (b) To assess the usefulness of fluorescence characteristics of some of the wood species for separating closely related

**Progress made :** Correlation of FTIR measurements was made with lignin content determined by acetyl bromide method. Analysis of the changes in the microscopic and chemical structure in wood samples of a soft wood and a hardwood decayed by a brown-rot (*Coniophora Puteana*) and a white-rot (*Trametes versicolor*) fungi was carried out. Accelerated weathering of cellulose sheets show no degradation of cellulose up to 200 hours of UV radiation, whereas a significant delignification in wood surfaces within few hours of exposure was noticed. Pre-treatment of wood surfaces with chromium trioxide and ferric chloride significantly restricted weathering deterioration and microbial colonization, whereas chromic nitrate and ferric nitrate gave partial protection from weathering and microbial colonization. Acetylation also prevented delignification and fungal staining.

**Project 15 : Thermodynamics of moisture adsorption and desorption in wood. (IWST-39/WSP/2000-01/12)**

**Objectives :** (a) To determine the thermodynamic parameters for wood water system. (b) Analysis of the enthalpy-entropy compensation effect.

**Progress made :** Changes in free energy enthalpy and entropy were determined for adsorption of water in wood. Studies on enthalpy-entropy compensation effect were made and a linear relationship was found to exist between enthalpy and entropy for adsorption of water in wood. This phenomenon was used to characterize wood.

**Project 16 : The role of biofertiliser in ecorestoration of problematic site like mine reject soil in Goa. (IWST-13/WBD/2000-01/3)**

**Objectives :** (a) To study the efficacy of ecofriendly and economically viable biofertiliser (by use of VAM fungi and Nitrogen fixing bacteria) on different forestry seedlings used for mine dump and degraded soil at Goa. (b) To achieve better growth and survival in afforestation programme in problematic sites at Goa.

**Progress made :** Multiplication of composite VAM spore and nitrogen fixing bacteria were carried out under controlled conditions. Efficacy of VAM fungi and nitrogen fixing bacteria have been evaluated for *Wrightia tinctoria*, *Bombax ceiba*, *Dendrocalamus strictus* and *Eucalyptus* species at nursery level.

Techniques of multiplication of biofertiliser and inoculation to the nursery plants were demonstrated to Goa Forest Department officials.

**Project 17 : Eco restoration of degraded mangrove habitat along the Goa coast. (IWST-2/WBD/2000-01/1)**

**Objectives :** (a) To assess the eco restoration / afforestation of degraded mangrove habitat. (b) To study ecology, phenology and distribution of mangroves. (c) To develop nursery of seedling to be used for afforestation programme (d) Succession and zonation of mangrove.

**Progress made :** Various mangrove habitats were surveyed. Degraded mangrove area were selected, phenological data on the adjoining mangrove habitat, chorao were recorded. Flowering and fruiting pattern, seed formation etc. were noted. Various marine organisms like the foulers, borers, crabs and other crustaceans, fishes and marine algae were recorded. Number of mangrove plants from this area were recorded.

**Project 18 : Effect of industrial effluents on the biology of some mangrove plants. (IWST-9/WBD/2000-01/2)**

**Objectives :** (a) To compare the characteristics of mangrove vegetation thriving in a polluted environment with that of relatively less polluted environment. (b) To study the capacity of mangroves to store / detoxify / eliminate different toxicants. (c) To understand the role of mangroves in water quality improvement and habitat enrichment.

**Progress made :** Mangrove areas in a "Severely Polluted Zone" of the Visakhapatnam harbour area and unpolluted area near Bangarammapalayem fishing village were surveyed. Water and soil samples collected were analysed for different hydrographical, nutrient parameters and heavy metals.

**Project 19 : Species, provenance and clonal test trials of *Casuarina* spp. in North Andhra coast. (IWST-18/WBD/2000-01/4)**

**Objectives :** (a) To identify the best suitable species of *Casuarina* for plantation along the coastal areas of North Andhra Pradesh. (b) To identify CPTs from the provenance trials. (c) Clonal testing of CPT from known source.

**Progress made :** The sites for *Casuarina* plantations in the North Andhra coast were selected in consultation with Andhra Pradesh Forest Department. Different species are being planted to study the survival, growth, salt tolerance and effect on coastal stabilization.

**Project 20: Impact of disturbances on canopy insect biodiversity: An assessment of forest health. (IWST-22/WBD/2000-01/6)**

**Objectives :** (a) To assess the insect diversity of sites using quantitative sampling methods. (b) To standardize the sampling methodology. (c) To develop inventory of the important indicator species in different study sites. (d) To map spatial variation of insect diversity in different landscape elements.

**Progress made :** Survey was conducted in the Western Ghats and low and medium elevation forests. A new composite flight interception trap has been designed to obtain unbiased samples from the canopies.



**Project 21 : Studies on entomofauna of mangroves of Karnataka, Goa and Andhra Pradesh. (IWST-24/WBD/2000-01/7)**

**Objectives :** (a) To study the diversity of insects in the mangrove forests. (b) To study the pest problems of the mangrove flora. (c) To study the parasite-predator complex of the mangrove forests.

**Progress made :** Mangroves at Coondapur, Karwar and Goa in the West coast and Visakhapatnam in the East coast were surveyed at regular intervals and more than fifty species of insects were collected from mangrove trees. From the 7 major orders, insects from 32 families were recorded and catalogued. The most serious pests were leaf galls on *Sonneratia* sp. and microlepidopterous defoliator on *Avicennia* sp. and *Pteroma plagiophleps* on *Rhizophora* sp.

**Project 22 : Application of pheromone technology for the management of teak heartwood borer, *Alcterogystia cadambae* Moore. (IWST-29/WBD/2000-01/9)**

**Objectives :** (a) To study the distribution, seasonal occurrence and population dynamics of the pest and the extent of economic loss caused due to the attack. (b) To study the pre-disposing factors leading to infestation. (c) To study the behavior and ecological features of the insect. (d) To develop an integrated pest management strategy with major thrust on the application of pheromone technology.

**Progress made :** The teak growing areas of North Canara circle were surveyed for heartwood borer, *Alcterogystia cadambae*. Infested trees were graded (A to D) depending on the number of holes to study the annual progression rate. Bio-ecological studies on the pest has been taken up.

**Project 23 : Studies on durability of selected Indian secondary timbers against marine wood biodeteriorating agents in the marine environment along Karwar coast (Karnataka). (IWST-30/WBD/2000-01/10)**

**Objectives :** (a) To assess natural durability of different species of Indian timbers. (b) To screen out suitable timber species for marine crafts and structures. (c) To assess efficacy of wood preservatives in enhancing durability of timbers. (d) Observations on the fluctuations in occurrence, distribution, biology of the organisms responsible for wood biodegradation.

**Progress made :** Selection, procurement and treatment of timber species done. Five timber species, namely *Toona ciliata*, *Erythrina indica*, *Tetrameles nudiflora*, *Bombax ceiba* and *Melia dubia* and one bamboo species, *Dendrocalamus strictus* were pressure treated with CCA preservative. Pressure treatment as well as prophylactic coating treatment with the Cashew nut shell oil was given to *B. ceiba* for studying the efficacy of this crude preservative against the borer attack. Five timber species and one bamboo species, both treated and control, are exposed to the marine environment of Karwar.

**Project 24 : Investigations on pest problems of wood in packing cases and handicraft industries. (IWST-31/WBD/2000-01/11)**

**Objectives :** (a) to identify the insect pests adversely affecting the wood used in packing and handicraft industries. (b) To study the bio-ecology, seasonal occurrence, extent of damage and natural enemies of major pests. (c) To study and evolve appropriate prophylactic and other control methods.

**Progress made :** The packing and handicraft industries in Chennaptnam, Mysore and Bangalore were surveyed. Sapwood of timbers used for handicraft and packing purposes were found attacked in varying degrees by Coleopteran borers belonging to Bostrychidae and Lyctidae. The major species were identified as *Sinoxylon anale* and *Heterobostrychus* spp.

**Project 25 : Development of protocol for rearing woodborer larvae: response of wood boring molluscs to (wood preservative) chemical stress. (IWST-31/WBD/2000-01/12)**

**Objectives :** (a) To develop optimum laboratory conditions for larval development and settlement. (b) To maintain generations of organisms and larval cultures as subject specimens for various experiments. (c) To find out (preservative) chemical tolerance limits of adult molluscan borers. (d) To probe into the mechanisms that help the animals to adapt to the chemical stress. (e) To investigate the effect of chemical stress on the physiological processes and reproduction.



Plywood bottom wall attacked by Lycidae

**Progress made :** Three generations of adult woodborers are being maintained in the laboratory by inducing settlement of borers on fresh test coupons. Experiments to study the recruitment patterns of woodborer larvae on coupons treated with CCA, CCB, Protecto and Cleistanthin were conducted. Test coupons treated with 6 different loading of CCA exposed in the laboratory for observations on recruitment patterns of woodborer larvae are in progress. Tolerance of copper and arsenic by adult woodborers was evaluated.

**Project 26 : Evaluation of buoyancy, specific gravity and water absorption characteristics of alternate timber for Catamarans. (IWST-35/WBD/2000-01/13)**

**Objectives :** (a) To evaluate buoyancy, specific gravity and water absorption characteristics of light timbers suitable for Catamaran fabrication. (b) To select suitable alternatives to existing species. (c) To widen the choice of species for Catamaran fabrication. (d) To reduce burden on selected few species. (e) To reduce cost of Catamaran.

**Progress made :** Methods for evaluating various physical characteristics have been gathered. Catamaran grade timbers of five prime species have been enlisted and procured.

**Project 27 : Conservation and management of Coondapur mangroves, Karnataka. (IWST-41/WBD/2000-01/15)**

**Objectives :** (a) To preserve the mangroves in core zone (b) To conserve and manage the mangroves. (c) To develop nursery and germplasm preservation center.

**Progress made :** Preliminary survey conducted. Literature survey on various aspects of conservation and management techniques of the mangrove habitat, were collected.

**Project 28 : Chemical Induction of Heartwood in Sandal. (CFP-001)**

**Objectives :** To apply chemical for initiation/ rapid formation of heartwood.

**Progress made :** Procedure for injecting stimulant chemicals into standing plant has been standardized using two organic stimulants (paraquat dichloride and Etheral) and inorganics (Arnon- Hoaglands nutrient solutions). Periodically girth height, and peroxidise isoenzyme are being recorded.

**Project 29 : Phytochemical and pharmacological investigation on *Machilus macrantha* bark. (CFP-002)**

**Objectives :** To isolate the bark constituents for Chemical / Pharmacological investigation.

**Progress made :** Viscosity measurement on 5 % aq solution has been found to be efficient as qualitative tool for assessment of Jigat quality for binding efficiency before making agarbathi.

**Project 30 : Natural products – evaluation of Extractives of plant origin for biological and pharmacological activity – i) *Nothapodytes foetida* ii) *Garcinia indica*. (CFP-003)**

**Objectives :** To extract and separate the plant material for biocidal and pharmacological components.

**Progress made :** *Nothapodytes foetida* wood has been procured, processed and extracted. Two different samples of *Nothapodytes foetida* were subjected to sequential extraction with Hexane, Chloroform and Alcohol. Percentage extract was found more in alcohol extract.

**Project 31 : Evaluation of oil yield and Composition of new cultivars of high yielding varieties of aromatic and medicinal plants (i) *Patchouli* (ii) *Piper longum*. (CFP-004)**

**Objectives :** To study the composition of oil for exploitation and to select high yielding varieties.

**Progress made :** Two cultivars of Patchouli ( 27 samples) are being analysed for oil and compositional analysis . Field trials on Patchouli using biofertilizers and inorganic fertilizer were completed in collaboration with UAS, Bangalore. Samples were collected and processed for distillation of essential oil. Commercial *Piper longum* spikes were processed for isolation of Piperine.

**Project 32 : Development of Modern nursery technique of important forestry species of Goa - *Terminalia tomentosa*, *Xylia xylocarpa*, *Myristica fragrans*, *Bambusa arundinaceae* and *Dendrocalamus strictus*. (TIP-1)**

**Objectives :** To improve the propagation techniques of *Terminalia tomentosa*, *Xylia xylocarpa*, *Myristica fragrans*, *Bambusa arundinaceae* and *Dendrocalamus strictus*.

**Progress made :** Standardized the potting media for *Bambusa arundinaceae* for quality seedling production. Experiments have been laid out for standardization of



*Bambusa arundinaceae* seedlings in root trainers

potting media for *Dendrocalamus strictus*. Standardized container type and size for *Bambusa arundinaceae* (6 treatments, 4 replications) and biofertilizer trial for *Bambusa arundinaceae* (8 treatments, 3 replications).

**Project 33 : Studies on micropropagation, field evaluation and conservation of *Pterocarpus santalinus* and *Oxytenanthera stocksii*- threatened species. (TIP-2)**

**Objectives :** (a) To develop protocols for mass production of superior genotypes for increased productivity of desirable traits. (b) To evaluate cloned plant based on growth performance and other desirable traits.

**Progress made :** Optimized explant type, size, medium and growth hormones for shoot initiation and multiplication of *Oxytenanthera stocksii*. Conducted experimentation on explants and growth hormones for cell culture / callus induction in *O. stocksii*. Initiated experiments for establishment of cultures of *Pterocarpus santalinus*. Information collected about Plus Trees of *P. santalinus* from A.P. Identified tree in Bangalore for basic studies .

**Project 34 : Evaluation and characterization of clonally propagated sandal (*Santalum album* L.) accessions of diverse origin with special reference to heartwood content, oil content and other morphological characters. (TIP-4)**

**Objectives :** (a) To study variability in Sandal population for oil content and other related morphological parameters. (b) To find out the relationship of heartwood and oil content with tree morphology characters. (c) To find the influence of mother plants on the resulting progeny through the assessment of germination and seedling vigour. (d) To assess the value of isoenzyme analysis as a tool to demonstrate diversity and using this as indirect tool to locate superior mother plants.

**Progress made :** Core samples from 25 accessions have been collected from clonal germplasm bank Gottipura, Bangalore. Morphological parameters like girth, bark thickness, heartwood and sap wood diameter of these accessions have been recorded.

**Project 35 : Standardization of protocol for viability testing and prolonging the viability and vigor of seed in storage. (TIP-5)**

**Objectives :** (a) To formulate the protocol for seed storage. (b) To study the symptoms and causes of seed deterioration during storage. (c) To develop standard techniques to rapidly assess seed viability in order to determine planting value. (d) To supply good quality seed for nursery operation

**Progress made :** Studies have been conducted to standardize the best media and pretreatment for germination. Viability study for ten clones has been carried out. Data analysis is in progress. Experiment has been laid to study seed water relation.

**Project 36 : Determination of calorific value and combustion characteristics of selected fuel wood species. (IWST-6/WE/2000-01/2)**

**Objectives :** (a) To determine the calorific values of different species. (b) To determine the combustion characteristics of different species.

**Progress made :** Experiments on determination of calorific value, CHNO analysis of *Acacia auriculaeformis* and *Eucalyptus* sp., its variation with tree height, sapwood and heartwood, variation with age has been finalised.

**Project 37 : Pyrolysis of wood and lignocellulosic materials. (IWST-6/WE/2000-01/3)**

**Objectives :** (a) To compare thermal behaviour of the biomass components under inert and oxidising atmosphere. (b) To study mechanism of thermal degradation of wood and its constituents. (c) To study pyrolysis kinetics of lignocellulosic materials. (d) Characterisation of charcoal.

**Progress made :** Thermochemical decomposition of wood of *Acacia auriculaeformis* in air was studied in the temperature range of 150 °C to 250 °C for different duration upto 400 minutes. A significant weight loss occurred above 200 °C, mainly due to degradation of carbohydrates followed by decomposition of lignin at longer exposure and higher temperature.

**PROJECT 38 : Studies on enzymatic hydrolysis of wood and other lignocellulosics. (IWST-6/WE/2000-01/1)**

**Objectives :** (a) To develop an effective and economic pre-treatment techniques. (b) To increase the yield of sugars from hydrolysis of cellulose and hemicellulose.

**Progress made :** Preliminary experiments on acid hydrolysis of wood completed.

**EXTERNALLY AIDED PROJECTS - FREEP**

**PROJECT COMPLETED DURING THE YEAR 2000-2001**

**Project 1 : Research on Sandal (FREEP/IWST-1)**

**Sub-Project : Identify provenance areas, collect and test seeds to develop a gene base for genetic improvement.**

**Sub-Project : Study variation in heartwood and oil productivity and quality between different provenances, progeny with a view to develop propagules of higher productivity.**

**Objectives :** To develop a gene base for genetic improvement of Sandal.

**Result :** Nine provenances of sandal have been identified under different ecoclimatic zones. Status of these provenances was confirmed by isoenzyme studies on the basis of wide gap in genetic distance. Bangalore provenance was found to be superior among nine identified provenances based on genetic diversity studies / maximum heterozygosity. A rapid UV spectroscopic method has been developed for quantitative estimation of sandal oil in core samples taken from standing trees. Studies on heart wood / oil content *vis-a-vis* GBH in respect of three provenances have indicated that trees of GBH > 80 cms contained 4% oil which remains nearly constant, while heartwood content progressively increases. Peroxidase isoenzyme in living bark tissue bears an inverse relationship with oil content. Based on this a simple, less expensive Peroxidase colour reaction has been developed to detect high yielders of sandal in the field. A protocol has been developed for DNA extraction under RAPD study.

**Project 2 : Research on Sandal**

**Sub-Project : Develop nursery practices, including *in vivo* and *in vitro* propagation techniques for mass production of high quality planting stock.**

**Objectives :** (a) To standardize root trainer based nursery technique for mass production of quality seedlings. (b) To develop protocol *in vitro* mass production of quality planting stock.

**Result :** Standardized primary host, Biofertilizer, Synthetic fertilizer and Seedling quality parameters for raising of Sandal seedlings in root trainers. Various parameters for mass production of quality seedlings have been standardized. Optimized the conditions for vegetative propagation through root suckers. Standardized techniques for high frequency *in vitro* multiple shoot induction and multiplication, Low frequency *in vitro* and *ex vitro* rooting was obtained. Recovered complete plantlets through direct somatic embryogenesis.

### **Project 3 : Research on Sandal**

**Sub-Project : Study of various pathogens and develop suitable protective measures.**

**Objectives :** To develop suitable prophylactic / control measures against pests and pathogens of Sandal.

**Result:** Incidence of diseases and pests completed in all Sandal bearing areas. Pathogens, pests collected during the studies were isolated and identified. The major pests on Sandal are sap suckers belonging to Coccidae, wood borers belonging to Coleoptera and Lepidoptera and termites both bark eating and wood eating species. Package of programme developed for controlling pests and diseases. Studies revealed that photosynthetic efficiency and transpiration rate reduces as the spike disease advances.

## **ONGOING PROJECTS DURING THE YEAR 2000-2001- FREEP**

### **Project 1 : Tree Improvement (FREEP/IWST-2)**

**Sub-Project : Establish and evaluate provenance and progeny trials, including assessment of trials already laid out by SFDs.**

**Objectives :** (a) To survey the SPA, CSO, SSO, + trees in respect of Teak and Eucalyptus in Karnataka and Andhra Pradesh. (b) To select SPA and CSO of these species taking phenotypic characters along with variability, yield, growth rate, quality of timber, diseases and pest resistance. (c) Mass multiplication through vegetative or through Tissue Culture for improved productivity.

**Achievements:** Literature base survey was made on CSO, SSO, SPA and CPT of Teak and *Eucalyptus tereticornis* of A.P. and Karnataka. Clone of *E. tereticornis* developed by ITC Bhadrachalam Paper Board Ltd., have been assessed. Six hundred seedlings raised for progeny trials. Monitored insect pests of CSO of teak raised by IWST and control methods followed. Seedlings of 49 families of teak were used for the establishment as a progeny trial cum SSO in Bhakarapet Range near Tirupati, Andhra Pradesh. Early growth performance were recorded. SSO cum progeny trials of 170 families and 3 ha. SSO cum progeny trial of 224 families of *Casuarina equisetifolia* at Nellore, A.P. were established. Analysis of growth parameters was completed. Mortality rate of those progenies were also evaluated. Heritability and selection of superior trees from progeny test was statistically analysed. Silviculturally unaccepted trees were roughed in 3 ha. Casuarina SSO.

### **Project 2: Tree Improvement (FREEP/IWST-2)**

**Sub-Project :** Study variability of growth rate, yield, quality of timber, resistance to disease and pathogens, identification of provenance and superior phenotypes.

**Objectives :** (a) The tree improvement project consists of 4 sub-projects each one related to the other. In the first sub-project, survey of SPA, CSO, SSO, + trees in respect of Teak and Eucalyptus in Karnataka

and Andhra Pradesh has to be made. (b) To survey, select SPA and CSO for the species taking phenotypic characters along with variability, yield, growth rate, quality of timber, diseases and pest resistance. (c) Mass production either through vegetative or through Tissue Culture for improved productivity.

**Achievements :** Consolidation of work related to 5 clones of 4 1/2 year old *E. tereticornis* is completed. Six clones were studied for variation in specific gravity, fibre morphology and vessel morphology. Three clones of eighteen months old *Eucalyptus tereticornis* of VMG, were studied for specific gravity and anatomical properties. One CPT of *Eucalyptus* hybrid and five CPTs of *Eucalyptus tereticornis* were studied for wood quality assessment.

### Project 3 : Utilization of alternative timbers for Catamarans. (FREEP/IWST-3)

**Sub-Project : Reduce investments in and increase service life of Catamarans through improvement in protection of alternative timbers for Catamaran fabricators.**

**Objectives :** To reduce investment and increase the service life of Catamarans through improvement in protection of alternative timbers for Catamaran fabrication.

**Achievements :** Achieved better understanding on seasonal settlement of borers, foulers and their reproductive cycles, predatory activities and their tolerance levels to widen hydrographical conditions and the tolerance levels of wood borers to various wood preservatives in Krishnapatnam and Visakhapatnam harbour. Eighteen species of wood boring organisms and over seventy species of fouling organisms were identified from the treated and untreated panels. Around hundred timber species of Catamaran and Non-Catamaran grade were tested at Krishnapatnam and Visakhapatnam harbours for natural durability. The results revealed that the life can be enhanced to 5-6 folds by using suitable wood preservatives. Alternative wood preservatives like CCA and ACZA treated panels gave promising results. Various species like *Ailanthus excelsa*, *Ailanthus malabarica*, *Elaeocarpus recurvatus*, *Erythrina variegata*, *Evoidia roxburghioana*, *Ficus mysorensis*, *Kydia calcyna*, *Mangifera indica*, *Macranga peltata*, *Measopsis emini*, *Melia dubia*, *Populus ciliata*, *Samanea saman*, *Tetramels nudiflora*, *Toon aciliata* and *Trema orientalis* were identified as potential alternative species for Catamaran fabrication apart from *Bombax cieba*, *Albizia falcataria* and *Albizia chinensis*. Different methods like sap displacement, diffusion, double diffusion, boucherie process, brush coating, spraying and water repellency method were tried for protection of Catamaran logs apart from conventional methods. The fungi infected samples were collected from Krishnapatnam and Madras harbours, cultured, isolated and identified 7 species. CCA toxicity evaluation in fish, *Oreochromis mossabica* was completed. A database on the performance of timbers under marine conditions is prepared using a Relational Database Management System. Over 150 research articles are included in the database.



Untreated panels of *Palaquim ellipticum*,  
*Macaranga peltata*

**Project 4 : Utilization of alternative timbers for Catamarans. (FREEP/IWST-3)**

**Sub-Project : Introduction of balance 148 Catamarans (out of 200) made of processed timbers as trials of laboratory tested timbers.**

**Objectives :** To introduce 200 Catamarans made of processed timbers as trials of laboratory tested timbers.

**Achievements :** A total of 10 Catamarans in Krishnapatnam and 6 in Chennai were launched. Plank built Catamarans made of *Anogeissus latifolia* were treated with CCA at Visakhapatnam and ready for launching.

**Project 5 : Utilization of alternative timbers for Catamarans. (FREEP/IWST-3)**

**Sub-Project : Generating awareness of and popularise techniques for increasing service life of Catamarans by involving timber treatment industry, fisheries departments, NGOs etc.**

**Objectives :** To generate awareness and to popularize techniques for increasing service life of Catamarans by involving timber treatment industry, fisheries departments, NGO's etc.

**Achievements :** Demonstration programmes on CCA treated Catamarans were conducted in 6 villages of Andhra Pradesh and Tamil Nadu. Linkages developed with Fishery Dept., Forest Dept., NGO's Bibliography- 205 references collected.

**Project 6 : Planting Stock Improvement Programme. (FREEP/IWST-4)**

**Objectives :** (a) To establish Seed Production Area of Teak, Casuarina and Eucalyptus. (b) To establish Seedling Seed Orchard cum progeny trial and Clonal Seed Orchard of Teak, Sandal, Casuarina and Eucalyptus. (c) To establish Vegetative Multiplication Garden of Teak, Eucalyptus and Bamboo. (d) To establish a model nursery.

**Achievements :** Culling operation for 25.8 ha in Teak SPA completed. Standardised potting media for *Bambusa arundinaceae* and *Ceiba pentandra* for quality seedling production in root trainers.



Teak branch cuttings from clonal multiplication garden under rooting in the mist chamber



## **EXTENSION**

### **Facilities generated and services rendered**

#### **Consultancy to various agencies**

- ♣ 58 samples were tested and a number of enquiries were attended in the field of identification of wood samples and reported upon.
- ♣ 8 enquiries were attended and 17 samples were tested in the field of preservation and 1 sample for durability studies.
- ♣ 17 samples were tested and a number of enquiries were attended in the field of NWFP.
- ♣ 3 samples were tested and a number of enquiries were attended on entomological and pathological aspects.
- ♣ Revenue Rs. 1,38,400/- earned as testing charges.

#### **Library and documentation - computer facilities - time spared and revenue earned.**

LAN and Internet facilities were provided in the Institute.

- ✓ **Other Extension Activities are reported in the Introduction - Forestry Extension, ICFRE.**

## FINANCIAL STATEMENT DURING 2000-2001

<b>I. PLAN</b>		<b>EXPENDITURE (RS. IN LAKH)</b>
A.	REVENUE EXPENDITURE	
	(a) Research	89.31
	(b) Administrative Support	43.95
	(c) Others specify	17.82
B.	LOAN AND ADVANCES	
	(a) Loan Advances (Conveyance)	1.00
	(b) House Building Advance	0.73
C.	CAPITAL EXPENDITURE	
	(a) Building & Roads	- -
	(b) Equipments, Library Books	0.006
	(c) Vehicles	- -
	(d) Others specify	- -
<b>TOTAL FOR PLAN (A+B+C)</b>		<b>152.816</b>
<b>II. NON-PLAN</b>		
A.	REVENUE EXPENDITURE	
	(a) Research	58.02
	(b) Administrative Support (Salary)	26.20
<b>TOTAL FOR NON-PLAN</b>		<b>84.22</b>
<b>III. FUNDED PROJECT</b>		
A.	World Bank Project	93.76
<b>TOTAL FOR FUNDED PROJECT</b>		<b>93.76</b>