# CHAPTER III

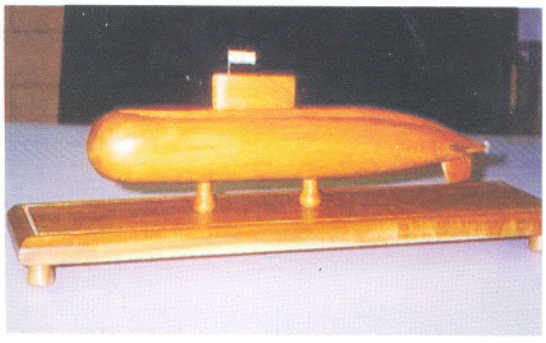
# INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY, BANGALORE

The Institute of Wood Science and Technology (IWST), Bangalore formed in 1988, is mandated to conduct research on wood science and technology as its national objective and focuses its research on important forestry research needs of the states of Karnataka, Andhra Pradesh and Goa at regional level. A Shore Laboratory at Visakhapatnam and a Forest Research Centre at Hyderabad have been established under the World Bank Aided FREE project under the control of IWST. It has field stations at Gottipura and Nallal near Bangalore, Yelawala near Mysore and Mulugu near Hyderabad.

## PROJECTS COMPLETED DURING THE YEAR 2002-2003

**Project 1: Study of anatomical, physical and mechanical properties of plantation grown timbers *Acacia mangium, Acacia auriculaeformis, Tecomella undulata* and *Eucalyptus tereticornis* clones [IWST 0001 /WPU001/1997-2003].** *For technical report contact, Principal Investigator- Dr. R.V. Rao.*

**Findings:** *Acacia auriculaeformis* (age, 8-13 years; average girth 42 to 60 cm) evaluated for anatomical and strength properties. Except fibre length (830-989 $\mu$m), other anatomical properties shown marginal differences with age. Wood is suitable for pulp and paper, furniture and handicrafts. The suitability indices of 13 years aged timber is very heavy, very strong, moderately tough, hard and a steady, suitable for tool handles, oars and paddles, sleepers, construction, furniture and packing cases/ammunition boxes.



A model prepared using *A. auriculaeformis.*

Furniture made of *A.auriculaeformis*

*Acacia mangium* (age, 8 years; girth, 36 to 48 cm) has the specific gravity in the range of 0.520-0.545 with non-significant pith to periphery variation. The heartwood percentage varied from 70-78%. Significant radial variation was found from pith to periphery in anatomical characters like vessel diameter (138.09-162.66 $\mu$m), vessel length (312.31-335.89 $\mu$m), vessel frequency (10-8), fibre diameter (21.58-20.62 $\mu$m), lumen diameter (14.88-13.65 $\mu$m). The timber can be classified as heavy, moderately strong, not tough and moderately hard. The timber after obtaining sufficient girth and proper processing including preservative treatment can be used for furniture.

*Tecomella undulata* (age 8 years; average girth 60 to 75 cm) has shown decrease in standard specific gravity from pith to periphery, linearly and bottom to top in axial direction. Shrinkage properties revealed that the shape retention (119) is better than teak (assuming teak as 100) . Timber is classified as heavy, moderately strong, not tough, very stable, moderately hard and recommended for furniture, doors, window shutters, frames, tool handles, agricultural implements, pallets, handicrafts and preparation of carom draughts.

*Eucalyptus tereticornis clones* has showed significant variation in specific gravity within clones. Variation in mechanical properties, studied in green condition was insignificant. However, some variation in mechanical properties was observed in air-dry condition. Turnery items and a new wood product (wire bound veneer box for 5 kg load) can be made using the small girth clonal material.

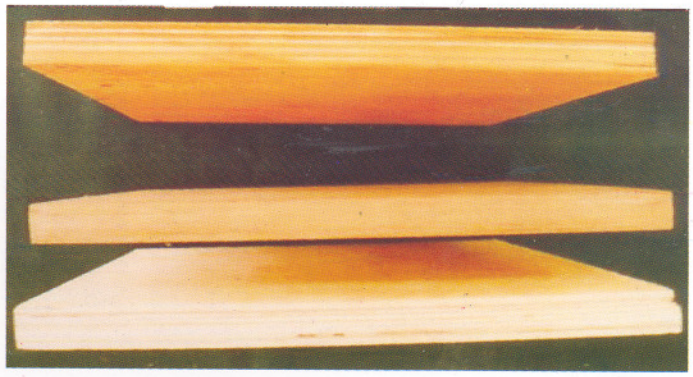
*Semicarpus kathalekanensis, a* species identified recently by Karnataka Forest Department from Sirsi range has been studied for its detailed wood structure for the first time.

**Project 2: Computer assisted wood identification [IWST0002WPU0002/ 1999-2002].** *For technical report contact, Principal Investigator - Mrs. T.R. Hemavathi.*

**Findings:** Final technical report entitled "Computer assisted wood identification (Codified card key features)" was prepared (252 pages). The report consists of codified information on genera and anatomical features for 286 species belonging to 97 genera representing 33 families.

**Project 3: Production of reconstituted wood products/wood composites-Laminated Veneer Lumber (LVL) from different plantation growth timber species and to study different physical and mechanical properties [IWST0010 WPU0010/2000-2003].** *For technical report contact, Principal Investigator - Dr. S.R. Shukla.*

**Findings:** LVL samples from 1 to 1.5 inches thickness were prepared from gurjan (*Dipterocarpus indicus*), muruku (*Erythrina stricta*), mango (*mangifera indica*), neem (*Azadirachta indica*) and dido (*Bombax insigne*) by mixing the veneers in different



LVL made of neem, gurjan and muruku

proportions (25%, 50% and 75%) and tested for different physical (specific gravity and shrinkage) and strength properties (MOE, MOR, internal bond strength, compressive stresses, nail and screw holding capacity). About 20-40% improvement was observed in specific gravity of LVR as compared to solid wood. The knife test have shown excellent gluing properties of these LVL samples.

**Project 4: Relationship of the wood properties of coppice plantation grown *Eucalyptus* species [IWST0013WPU0013/2000-2003].** *For technical report contact, Principal Investigator - Dr. S.K. Sharma.*

**Findings:** Studies on anatomical, physical and mechanical properties was completed. The average specific gravity in green condition varied from 0.710 to 0.700, average values of fibre length was 929 $\mu$m and 933 $\mu$m, fibre diameter 15 and 14 $\mu$m, fibre lumen diameter 7 $\mu$m, double wall thickness 8 and 7 $\mu$m, vessel diameter 156 $\mu$m and 143 $\mu$m and vessel element length 310 $\mu$m and 336 $\mu$m for non-coppiced and coppiced woods, respectively. Both, non-coppiced and coppiced woods turn very well, gives glossy finish after polishing, resemble mahogany and the profiles are very sharp indicating potential for value addition other than using it for fuel wood. A newly designed 18 kg capacity wire bound veneer box was fabricated from coppiced wood.

**Project 5: Development of seasoning and preservation techniques for bamboo and rattans [IWST-03/WSP-03/2000-2003].** *For technical report contact, Principal Investigator - Mr. N.K. Upreti.*

**Findings:** Dried specimens of *Bambusa tulda* without and with exposure to ammonia fumes (48 hours) followed by treatment with 6% solution of copper: chrome : boric compositions preservative indicated that there was no significant increase in the absorption of dry salt in the specimens exposed to ammonia fumes. The dry salt retention as per Indian standard specifications (8 kg/m$^3$) for bamboo used for structural and non structural purposes can be achieved without pre-ammonia pretreatment. Chemical seasoning of round *B. tulda* in green condition with 30 % aqueous solution of urea (w/v) mixed with 3 % aqueous solution of boric acid (w/v) at 45$^0$C temperature, used as anti-shrink and antifungal treatment, enabled forcedair-drying of the bamboo with negligible drying degrades, whereas the untreated bamboo showed drying degrades unacceptable for its use in round form.


Chemical Seasoning of *Bambusa tulda*

**Project 6: Investigation on the effect of growth stresses for better processing of plantation timbers [IWST-26/WSP/2000-03/9].** *For technical report contact, Principal Investigator - Mr. Pankaj K. Aggarwal.*

**Findings:** Strain gauge technique was modified to make it more non-destructive and growth strain were measured in *Eucalyptus tereticornis* and *Acacia auriculaeformis* of different age obtained from different localities. Growth strain was found to be more in *Eucalyptus tereticornis* (600 micro strains) as compared to *Acacia auriculaeformis* (300 micro strains). A positive relationship was observed between growth strain and each of volumetric shrinkage and MOE. Growth strain could be reduced by about 50% on steaming the logs at 90°C for 6 hours. The study would be helpful in identifying trees with low girth and in improving the quality of plantation species. Optimized conditions of steaming to reduce growth stress in logs will not only save the time but also reduces cost of plantation.

**Project 7: Evaluation of oil yield/composition of new cultivars/high yielding varieties of aromatic/medicinal plants - Patchouli and *Piper longum* [CFP-004/2000-2003].** *For technical report contact, Principal Investigator - Mr. K.H. Shankaranarayana.*

**Findings:** Out of 27 leaf samples belonging to 2 cultivars of patchouli, analysed for oil content, one high oil yielding sample and one having good patchouli alcohol content were identified. Piperine content of two cultivars of *P. longum* were compared with commercial grade sample and no significant difference was observed. However, between the two cultivars of *P. longum*, Vishwam variety contained more piperine. Chromatographic methods for isolation of patchouli alcohol from patchouli oil and alkaloid, piperine from commercial grade *P. longum* spikes have been standardized.

**Project 8: Investigation on pest problems of wood in packing cases and handicraft industries [IWST-31/WBD-11/1999-2003].** *For technical report contact, Principal Investigator - Mr. Raja Muthukrishnan.*

**Findings**: Survey revealed that 17 conventional and 8 alternate timbers are being used in the handicraft and packing case industries in Karnataka state. A check list of the beetle pests injurious to different conventional and alternate timbers was prepared. Wood preservatives like organophosphates, pyrethroids, neem products, cashew nut shell liquid etc. were tested against insect borers both in the laboratory and field.

**Project 9: Development of protocol for rearing wood borer larvae [IWST/WBD/012/2000-2003].** *For technical report contact, Principal Investigator - Dr. M. Balaji.*

**Findings:** Trapping of marine wood boring organisms was carried out at the fishing harbour on wood panels at monthly intervals. Test panels harbouring adult animals of *Lyrodus pedicellatus* were brought to the laboratory, acclimatized, reared separately, induced to breed and released the larvae into the ambient. The larvae were introduced into containers with untreated as well as CCA treated timber coupons and it was found that larvae successfully infest the new timber coupons. In coupons treated to lower CCA retentions (<6.2 $kg.m^{-3}$), the success rate of boring was found to be 50% whereas in coupons treated to higher retentions (33 - 44 $kg.m^{-3}$) the larvae could settle on the substratum but

not invade into it. Further studies conducted with CCB treated panels (8-12 kg.m$^{-3}$) revealed that settlement of larvae on these panels was relatively greater than that on CCA treated panels.

**Project 10: Studies on termite problems on trees and timber and development of termite testing facilities [IWST-36/WBD-14/2000-03].** *For technical report contact, Principal Investigator - Dr. R. Sundararaj.*

**Findings:** The synthetic pyrethroids viz., fenvalerate and permethrin were found equally effective like that of the organophosphrous chlorpyriphos in protecting the timber against termites. *Odontotermes horni* has been identified as major wood eating termite in Karnataka. lindane gave 100% protection against arboreal termite infestation for 6 months after treatment, while 20% plants under fenvalerate, cypermethrin, blitox (0.1%), chlorpyriphos and permethrin treatments showed infestation. Neem formulation was not found effective against termites.

## PROJECTS CONTINUED DURING THE YEAR 2002-2003

**Project 1: Wood quality parameters for improving planting stock of *Bambusa arundanacea, Pseudooxytenanthera stocksii* and *Dendrocalamus strictus* [IWST0009 WPU009 / 1999-2004].** *Principal Investigator - Dr. R.V. Rao.*

**Status:** Modulus of rupture test of *Pseudooxytenanthera stocksii* showed its value in the range of 210-900 kg/cm$^2$. Similarly the value of compressive stress was found in the range of 193-660 kg/cm$^2$ and specific gravity varied from 0.545-0.810. Specific gravity, fibre length and vascular bundles/cm$^2$ of clums of *Bambusa arundanacea* collected from Bangalore were 0.355 to 0.565, 2.7 mm and 2.25 to 2.4, respectively.

**Project 2: Plasticisation of palms and bamboo [IWST0005WPU005/2001-2003].** *Principal Investigator - Mr. S.K. Sharma.*

**Status:** Project could not be continued during the year due to fault in the machinery. One year extension upto March 2004 is requested.

**Project: 3 : Efficacy of preservative in enhancing durability of timber (Development of alternative preservatives for more economic value and schedules for their incorporation in wood) [IWST-26/WSP/2000-05/9].** *Principal Investigator - Mrs. D. Venmalar.*

**Status:** Cashew Nut Shell Liquid (CNSL) and a plant extractive was incorporated with copper ions to develop an eco-friendly preservative and *Hevea brasiliensis* specimens were treated by employing dipping and pressure process. 26 kg/m$^3$ and 40 kg/m$^3$ absorption of preservative could be achieved in 24 hr and 72 hr, respectively in dipping process while in case of pressure process adequate level of preservative, 42 kg/m$^3$ could be achieved at a pressure of 10 lb/sq inch in 30 minutes, consequently saving the energy and time as compared to dipping process. *Hevea brasiliensis* samples treated by brush coating with copper incorporated CNSL were completely protected against termite upto 12

months of exposure, while about 20% damage was observed in panels coated with CNSL alone, whereas the untreated panels were destroyed with in 6 months.

**Project 4: Analysis of wood and its constituents by fluorescence and FTIR spectroscopic technique - A non-destructive tool for rapid characterization of wood [IWST-34/WSP-11/ 2000-2004].** *Principal Investigator - Dr. K.K. Pandey.*

**Status:** FTIR spectroscopy of pine and beech wood decayed by *Coniophora puteana,* a brown-rot fungi revealed that the fungi degraded carbohydrates preferencially, this results an increase in syringy moiety in beech and guiaicyl moiety in pine. Consequently, increasing the lignin carbohydrate ratio. In wood decayed by *P. chrysosporium*, a white-rot fungi, the lignin content decreased as decay progressed, as did the xylan content. In the white-rot fungi, *Coriolus versicolor*, lignin and carbohydrate reduction occurred at a similar rate, simultaneous with slight preference for lignin.

**Project 5 : Studies on lignin filled thermoplastic composites [IWST/WSP/006/2000-2003].** *Principal Investigator - Mr. Ajay Karmarkar.*

**Status:** Using a new technique called 'Polymerisation Filling Technique', one step formation of homogeneously filled composites with high degree of filler content was achieved. High efficiency filler-anchored catalyst system was prepared by substituting the hydroxyl functional groups present on the lignin molecule by cocatalyst (Methylaluminoxane) and then contacting the cocatalyst carrying filler with a cyclopentadienal containing transition metal catalyst. This catalyst system can polymerise $\alpha$- olefins.

**Project 6: Thermodynamics of moisture adsorption and desorption in wood [IWST-39/WSP-12/2000-2005].** *Principal Investigator - Dr. S.P.S. Rawat.*

**Status:** Thermodynamics of moisture adsorption and desorption in wood was studied. In particular, changes in free energy, enthalpy and entropy were determined both for adsorption and desorption. Studies on enthalpy-entropy compensation effect were made and a linear relationship was found to exist between them. This effect was linked to Le Chatelier's principle.

**Project 7 : Chemical induction of heartwood in sandal [CFP-001/ 2000-2006].** *Principal Investigator - Mr. K.H. Shankaranarayana.*

**Status:** Sandal trees were injected with 4$^{th}$ dose of heartwood stimulant chemicals viz. paraquat and etherel. Different parameters like girth, height etc. were recorded. Peroxidase enzyme activity in the living bark tissue of treated and control plants was measured.

**Project 8 : Phytochemical and pharmacological investigations on *Persea macrantha* [CFP-002/1999-2004].** *Principal Investigator- Mr. K.H. Shankaranarayana.*

**Status:** Sequential extraction bark powder of *P. macrantha* was carried out with polar solvents. Extracts containing active contents were collected and yield determination and purification are in progress.

**Project 9 : Natural products evaluation of extractives of plant origin for biological and pharmacological activity - *Nothapodytes nimmoniana, Garcinia indica* [CFP-003/2000-2005].** *Principal Investigator - Mr. V.G. Angadi.*

**Status:** Sequential extraction of *N. nimmoniana* wood and *G. indica* fruits using different polar solvents was carried out. Extraction using hexane followed by methanol was found to be effective for biological and pharmacological activities.

**Project 10: Eco-restoration of degraded mangrove habitat along Goa coast [IWST-2/WBD-1/ 2000-2005].** *Principal Investigator - Mr. Surekha Sawant.*

**Status:** Observations on the growth and survival of the mangrove seedlings at the afforested area at Ribander, along the Mandovi sanctuary at Goa revealed biodeterioration of *Rhizophora mucronata* and 70% are heavily infested by the marine foulers leading to the death of the seedling. The main stem of the seedlings was found attacked and the growth of the foulers was about 5-10 cms. The main fouling group responsible for the destruction of the seedling was the barnacles, followed by the oysters. Soil analysis for the nutrients in the natural and afforested mangrove areas was carried out.

**Project 11: Role of biofertilizers in ecorestoration of problematic site like mine reject soil in Goa [IWST-28/WBD-3/1997-2005].** *Principal Investigator- Mr. H.C. Nagaveni.*

**Status:** Planting work of *Cassia fistula, Acacia auriculiformis, Casuarina equisetifolia, Lagerstroemia frasigenica* and *Dalbergia latifolia* along with biofertilizer treatment was taken up in Tatodi (iron mine-dumps area).

**Project 12: Species, provenance and clonal test trials on *Casuarina* species in north Andhra coast [IWST/WBD/004/2000-2004].** *Principal Investigator - Dr. V. Kuppusamy.*

**Status:** An area of 1 hectare coastal land in Chippada, a coastal village near Visakhapatnam was identified for provenance and clonal test trails of *Casuarina* species and necessary administrative approval have been obtained for raising plantation in next monsoon season.

**Project 13: Investigations on the potential of medicinal an aromatic plants as source of botanical insecticides [IWST-20/WBD-5/2000-04].** *Principal Investigator- Dr. R. Sundararaj.*

**Status:** Methanolic leaf extracts of *Clerodendrum inerme* showed remarkable phytopesticidal properties comparable with *Azadirachta indica* against the teak defoliator (*Hyblaea puera*) and teak skeletonizer (*Paliga machoeralis*). However, freshly prepared neem oil @0.5% was found to be better than neem-based formulations available in the market against the spiraling whitefly (*Aleyrodicus disperses*). Neem oil @0.5% alone or in combination with 0.02% chlorpyriphos effectively controlled the whitefly for more than two weeks.

**Project 14: Impact of disturbances on canopy insect biodiversity: An assessment of forest health [IWST-22/WBD-6/2000-2004].** *Principal Investigator - Mr. Y.B. Srinivasa.*

**Status:** Required equipment has been purchased during March, 2003 and the project is initiated.

**Project 15: Studies on entomofauna of mangroves of Karnataka, Goa and Andhra Pradesh [IWST-24/WBD-7/2000-2004].** *Principal Investigator - Dr. O. K. Rema Devi.*

**Status:** In different seasons, hundred insect species belonging to 40 families of 9 orders were collected from west coast of India (Karnataka and Goa) and identified. psychids were the major defoliators of *Rhizophora* especially in the nursery and seedling stages. Frugivores were abundant in *Avicennia* sp. Rearing of important pest species were attempted in the laboratory conditions.

**Project.16: Control of biodeterioration of wood with the help of eco-friendly preservative and bioactive substances on staining and decay fungi under terrestrial conditions [IWST-13/ WBD-8 /2000-04].** *Principal Investigator - Mrs. H.C. Nagaveni.*

**Status:** Antagonism was observed with *Lantana camara* dye and *Persea macrantha* plant extract against plant pathogens like *Fusarium oxysporum*, *Rhizoctonia solani* and *Macrophomina phaseolina.* Work on antagonistic properties of *Garcinia indica* and *Nothapodytes nimmoniana* against pathogenic fungi and wood rotters was carried out. Work on natural durability of *Acacia* sp. and *Cleistanthus colinus* against wood rotters is being carried out. Esterification of rubberwood with anhydrides and further oligoesterification with epichlorohydrin have given protection against both white and brown wood rotters.

**Project 17: Application of pheromone technology for the management of teak heartwood borer, *Alcterogystia cadambae* Moore [IWST-29/WBD-9/2000-04].** *Principal Investigator - Dr. O.K. Rema Devi.*

**Status:** Studies on the larval biology of teak heartwood borer and *Alcterogystia cadambae* have been successfully carried out using artificial diet. Field observations of five divisions of north Canara on the life history and ecology of the pest continued. Artificial diet with powders of bark, sapwood and heartwood individually and in combinations were tried for the rearing of different stages of larvae. Moth populations of this pest in the field are being monitored using Robinson's light trap.

**Project 18: Studies on durability of selected Indian secondary timbers against marine wood biodeterioration agents in the marine environment along Karwar coast (Karnataka) [IWST-30/WBD-10/2000-2004].** *Principal Investigator - Dr. K.S. Rao.*

**Status:** The test panels sample of 20x10x3 cms size of *Paraserianthes falcataria (Albizia falcataria)* and *Bombax ceiba* were impregnated with tribuyaline tin methyl meta acrelate, a copolymer resin supplied by Naval Materials Research Laboratory, Ambernath, at different pressure and treatment time to standardize treatment schedule. 20 kg/m$^3$ preservative absorption was achieved in *Bombax*

*ceiba* by creating a pressure of 50 lbs/sq. inch and maintaining it for 1 hour. By extending the time period for 3 hours, the absorption was more than 65kg/$m^3$. Whereas for *P. falcataria* 29 kg/$m^3$ preservative absorption was possible at of 50 lbs/sq inch pressure for of 4 hours.

**Project 19: Conservation and management of Coondapur mangroves, Karnataka [IWST-41/WBD-15/2000-2004].** *Principal Investigator- Dr. K.S. Rao.*

**Status:** Observations on the phenological aspects on the mangroves of two areas of Coondapur were recorded. Studies on biodeterioration of the mangrove wood and plants were carried out. It was found that about 40% of the mangrove trees were riddled to varying degrees by the marine wood borers. *Bankia rochi* and *Sphaeroma terebrans* were found to be causing the damage to the mangrove plants Coondapur area.

**Project 20: Development of modern nursery techniques for propagation of important species of Goa. *Terminalia tomentosa, Xylia xylocarpa, Myristica fragrans, Bambusa arundinaceae* and *Dendrocalamus strictus* [TIP-1/2002-2004].** *Principal Investigator- Dr. T.S. Rathore.*

**Status:** Laid down experiments for the standardization of potting medium and container size for *Terminalia tomentosa* and *Dendrocalamus strictus* to reconfirm the previous results. The *B. arundinacea* seedlings produced using the protocol developed were planted at Forest Research Centre, Hyderabad to test the survival rate and growth. Terminated experiments on standardization of potting medium, container size and biofertilizer for *D. strictus.*

**Project 21: Studies on micropropagation, field evaluation and conservation of *Pterocarpus santalinus* and *Oxytenenthera stocksii* a threatened species [TIP-2/2000-2005].** *Principal Investigator- Dr. T.S. Rathore.*

**Status:** Experiments were conducted on various media and growth hormones and optimized conditions for high frequency shoot multiplication in liquid medium on *P. stocksii.* Experiments were executed on media and auxins on *in vitro* root induction from *in vitro* shoot multiplication cultures and optimizing medium, growth hormones for *in vitro* rooting of *P. stocksii.* Experiments were also conducted on various growth hormones (auxins; IAA, NAA and Cytokinin; Kn and BAP) for shoot initiation and optimizing growth hormones in *P. santalinus*. Standardized explant type, medium, growth hormones for callus induction for somatic embryogenesis in *P. santalinus* and *P. stocksii.*

**Project 22: Phenological studies of Clonal Seed Orchard (CSO) for teak in Karnataka [TIP-3/2000-2004].** *Principal Investigator- Mr. Ashutosh Srivastava.*

**Status:** Analysis of the results obtained from the floral induction experiment conducted during 2001 indicated that application of ethereal, 400 ppm and drenching of soil with 2% $KNO_3$ were effective in inducing floral buds in low flowering clones BAH 27 and HAL 1. However, none of the chemicals under study had any effect on non flowering clones KKT 37 and BAH 28. Fresh experiments

using Paclobutrazol, Salicylic acid, Etheral and $KNO_3$ were laid down during the year 2002-2003.

**Project 23: Evaluation and characterization of clonally propagated sandal (*Santalum album*) accession of diverse origin with special reference to heartwood content, oil content and other morphological characters [TIP-4/2000-2004].** *Principal Investigator - Mr. Arun Kumar A.N.*

**Status:** Estimation of oil content from pith to periphery for 80 trees have been completed. Observation on bark thickness, sapwood width and heartwood width have been recorded and quantified. Preliminary quantification of the relationship between girth, heartwood and oil content has also been completed. Seed from 16 accessions were collected and various seed parameters were recorded.

## NEW PROJECTS INITIATED DURING THE YEAR 2002-2003

**Project 1: Assessment of wood quality (anatomical studies) of 8-10 year old *Acacia auriculaeformis* and *Acacia mangium* hybrids [IWST/WPU/X01/2002-004].** *Principal Investigator - Mrs. T.R. Hemavathi.*

**Status:** Specific gravity of *Acacia mangium* hybrid and *Acacia auriculaeformis* hybrid (5 trees each) was determined. Determination of tissue proportion for *Acacia mangium* hybrid and fibre morphology, vessel morphology for *Acacia auriculaeformis* hybrid are in progress.

**Project 2. Evaluation of wood quality parameters of plantation grown *Eucalyptus citriodora* for different end uses [IWST/WPU/X02/2002-2005].** *Principal Investigator - Dr. R. V. Rao.*

**Status:** Five trees of *Eucalyptus citriodora* were collected from Sakaleshpura, Hassan, Karnataka and cut at different heights to study within tree and between tree variation both in vertical and radial direction. Morphological characteristics like bark thickness, height, girth, sap wood and heart wood percentage were noted. Data on specific gravity of bark at 4 heights were collected. Conversion of planks for studying on specific gravity and anatomical properties have been initiated.

**Project 3: Evaluation of treatability of selected refractory hardwoods [IWST/WSP/X01/2002-2005].** *Principal Investigator - Mr. P. Narayanappa.*

**Status:** Project initiated and preliminary investigations are in progress.

**Project 4: Evaluation of ammonia based preservatives against Indian termites [IWST/WSP/X02/2002-2004].** *Principal Investigator- Mr. P. Narayanappa.*

**Status:** Project initiated and preliminary investigations are in progress.

**Project 5: Studies on fiber formation in wood [IWST/WSP/X03/2002-2005].** *Principal Investigator - Dr. S.P.S. Rawat.*

**Status:** Literature review was carried out.

**Project 6: Analytic studies on visco-elastic behaviour of wood and tree biomechanics [IWST/WSP/X04/2002-2005].** *Principal Investigator- Dr. S.P.S. Rawat.*

**Status:** Literature review was carried out.

**Project 7 : Studies on forced air drying of plantation grown timbers [IWST/WSP/X05/2002-2004](2002-2004).** *Principal Investigator- Mr. N.K. Upreti.*

**Status:** Work on *Acacia auriculaeformis* is in progress.

**Project 8: Development of colouring reagents based on enzyme - substrate reaction for differentiating oil yielders of sandal in field [IWST/ CFP / X01/ 2002-2007].** *Principal Investigator - Mr. V.G. Angadi.*

**Status:** Initially 50 sandal trees were selected. Estimation of oil content in the selected trees is in progress. Twelve substrates / chemicals have been identified for studies. Tests for solubility of substrates to carry out reaction is in progress.

**Project 9: Biosystematic studies on parasitoid complex of sandal coccids and their utilization in biological control [IWST/WBD/ X01/2002-2005].** *Principal Investigator - Mr. Y.B. Srinivasa.*

**Status**: Sandalwood populations at IWST campus and Gottipura are being regularly surveyed to document the parasitoids of various *coccid* species. As of now 30 morpho species (dominated by the families *Aphelinidae* and *Encyrtidae*) of different parasitoids have been documented. Data is also collected on the population dynamics of the parasitoids and their host *coccid* sp.

**Project 10: Ethnobotanical studies of Godavari valley in Andhra Pradesh [TIP-5/2002-2007].** *Principal Investigator - Dr. N. Rama Rao.*

**Status:** Collection of literature on ethnobotany of Godavari valley of Andhra Pradesh has been completed. Tribal areas have been identified for collection of data with the help of Andhra Pradesh Forest Department and Tribal Welfare Department. Ethnobotanical data on 27 plant species have been collected from Rampachodavaram area of Godavari valley.

## EXTERNALLY AIDED PROJECTS

## PROJECTS COMPLETED DURING THE YEAR 2002-2003

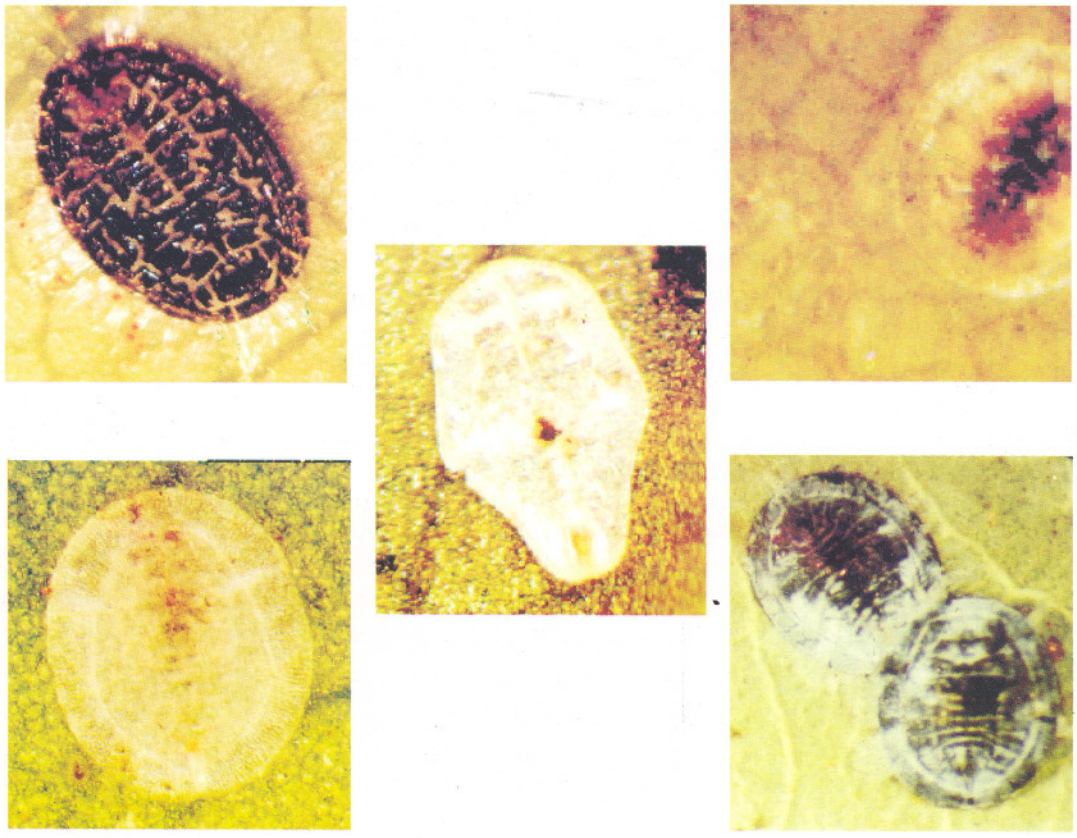
**Project 1: Evaluation of physical and mechanical properties of *Acacia* hybrids [IWST/WPU/Aca.Proj./01-08-200131-03-2003].** *For technical report contact, Principal Investigator - Dr. R.V. Rao.*

**Findings:** Physical and mechanical properties of *Acacia auriculaeformis* hybrid (8 years), *Acacia auricualaeformis* from spring valley (8 and 15 years), *Acacia mangium* hybrid (8 years and 15 years), *Acacia mangium* local (8 years) and *Acacia auriculaeformis* local (8 years) were evaluated in green and air dried conditions. Based on strength data, suitability indices of these wood species were worked out with respect to teak, taken as 100 and recommended

for different end uses. A report on evaluation of physical and mechanical properties of *Acacia* hybrids was also prepared and submitted to M/s Mysore Papermills Ltd., Shimoga.

**Project 2: Studies on the diversity of the aleyrodid (Aleyrodidae: Homoptera) fauna of south western ghats** *Principal Investigator - Dr. R. Sundararaj.*

**Findings:** A total of 164 species of whiteflies of which 50 species are new to science have been identified from the western ghats of south India. In addition, two new genera viz., *Davidiella* gen. nov. and *Icfrealeyurodes* gen. nov. were reported. Five species of whiteflies are reported for the first time from India. Several new hosts for different whitefly species have also been recorded. A checklist of 376 species of Aleyorodids so far known from India was prepared.



164 species of whiteflies under 40 genera identified

## PROJECTS CONTINUED DURING THE YEAR 2002-2003

**Project 1 : Weathering of wood surfaces [2002-2005].** *Principal Investigator- Dr. K.K. Pandey.*

**Status:** Experiments on accelerated weathering of *Hevea brasiliensis* (rubber wood) and *Pinus roxburghii* are being conducted. Effect of direction of cut (tangential vs radial) were carried out. Studies on effects of irradiation intensity, surface temperature and humidity are in progress. Analysis of colour changes of

rubber wood by UV-Vis is in progress. Irradiation was carried out and quantified by CIE colour parameters L*, a*, b* and E*.Chemical modification of *Hevea brasiliensis* and *Pinus roxburghii* by benzoyl chloride was carried out and its kinetics and accelerated weathering was studied.

## NEW PROJECTS INITIATED DURING THE YEAR 2002-2003

**Project 1: Bio-invasion, SPS measures and import of wood and wood products into India.** *Principal Investigator -Dr. K.S. Rao.*

**Status:** The project is a TIFAC (DST) study for a period of one year, initiated on 05-03-2003.

**Project 2: Refinement of protocols for rapid clonal propagation of sandal and red sanders; demonstration of field performance and evaluation of genetic fidelity.** *Principal Investigator - Dr. T.S. Rathore.*

**Status:** Project approved on 6th January 2003 with modified budget. 1st installment of Rs. 14.26 lakhs received in January. Equipments worth Rs. 7.00 lakh has been procured. JRF/SRF are being appointed.

**Project 3 : Characterization and quantitative analysis of decayed wood by fluorescence and fourier transform infrared spectroscopy. [2003-2006].** *Principal Investigator - Dr. K.K. Pandey.*

**Status:** Project started in March, 2003. Experiments are to be initiated.

**Project 4 : Transfer of forestry and wood science technologies for the benefit of rural and sectoral communities of eastern plains of Karnataka.** *Principal Investigator - Dr. K.S. Rao.*

**Status:** Demonstration programme on forestry and wood science technologies have been conducted in three districts of Karnataka viz., Gulbarga, Hassan and Kolar. The programmes were attended by farmers, sawmill owners, representative of wood industries and forest department officials, etc.

**Research achievements**

| Name of State | No. of projects completed during 2002-2003 | No. of ongoing projects in 2002-2003 | No of projects initiated during 2002-2003 |
|---|---|---|---|
| Karnataka and Andhra Pradesh | - | 2 | - |
| Karnataka, Andhra Pradesh and Goa | - | 2 | - |
| Karnataka | 2 | 4 | 5 |

## Technology assessed and transferred

Three demonstration programmes were conducted during 2002 to 2003. 200. Farmers, SFD officials and Village Forest Committee members were appraised of the root trainer based quality seedling production of sandalwood, bamboo and macro propagation of bamboo.

## Education and trainings organised

1. Compulsory training course for 15 IFS officers on "Intellectual Property Rights in Forestry Issues" from 23 to 27, Sept., 2002.
2. Training was imparted to 9 officials of Naval Dockyard, Visakhapatnam from 18-11-02 to 23-11-02 in the field identification and wood preservation from 25-11-2002 to 29-11-2002.
3. Training course on timber joinery to the in-service officials of Naval Dockyard, Visakhapatnam from 9.12.2002 to 13.12.2002.

## Trainings received

1. Shri Sanjai Mohan, IFS, IWST attended in service course at Indira Gandhi National Forest Academy, Dehra Dun from 6th to 17th January, 2003.
2. Dr. Avinash M. Kanfade, IFS, attended training on ISO 9000 at Bangalore on 14th and 15th March, 2003.
3 Institute conducted training programme on latest techniques for bamboo artisans on 06-1-2003 and 11-3-2003 at Angamalli Cluster, Kerala.


Training programme to bamboo artisans at Angamalli Cluster, Kerala

. Trainees preparing a model of cradle using split bamboo.


Inauguration of Advanced Wood Working Training Centre at IWST, Bangalore on 12.3.2003

# Publications

## Research papers

1. Aggarwal, Pankaj K.; Chauhan, S.S. and Karmarkar, Ajay (2002). Reduction of growth stresses in logs of *Acacia auriculaeformis* by heat treatment. *Wood News* 12(2) 36-39.

2. Aggarwal, Pankaj K; Chauhan, S.S. and Karmarkar, Ajay (2002). Variation in growth strain volumetric shrinkage and their inter relationship in *Acacia auriculaeformis*. *J. Tropical Forest Product* 8 (2): 135-142.

3. Angadi, V.G.; Jain, S.H and Shankaranarayana, K.H. (2002). Genetic diversity between sandal population of different provenances in India - *Sandalwood Research Newsletter* -4.

4. Angadi, V.G.; Jain, S.H.; Rajeevalochan, A.N.; Ravikumar, G. and Shankaranarayana, K.H.(2002). A note on Peroxidase reagents to distinguish between high and low yielders of sandal (*Santalum album* L.) in field. *Sandalwood Research Newsletter*, July 7.

5. Angadi, V.G.; Ravikumar, G.; Rajeevalochan, A.N.; Kumar, P. and Shankaranarayana, K.H. (2002). UV- spectroscopic method for identifying high cineole yielders in *Eucalyptus* hybrid oil samples. *The FAFAI Journal,* 4(37- 38).

6. Chauhan, S.S.; Aggarwal, Pankaj K; Karmarkar, Ajay and Pandey, K.K. Moisture adsorption behaviour of esterified rubber wood. *Holz-als-roh-und-werkstoff,* 59(4) 250-253.

7. Dubey, A.K. and Sundararaj, R. (2002). Development and survival of the spiralling whitefly *Aleurodicus dispersus* Russell (Homoptera: Aleyrodidae) on some tree species. *Journal of Applied Zoological Researches,* 13 (2 - 3): 185-187.

8. Khali, D.P. and Rawat, S.P.S. (2002). Studies on the moisture adsorption behaviour of chemically modified wood using the Brunnauer-Emmett-Teller theory. *Journal of Timber Development Association of India,* 48 (3-4): 41.

9. Kothiyal, Vimal; Sudheendra, R. and Rao, R.V. (2002). Strength properties of different clones of *Eucalyptus tereticornis* from Andhra Pradesh, India. *Journal of Tropical Forest Products,* 8 (1): 39-11.

10. Kumar, Arun; Srinivasa, A. N. and Chauhan, S. S. (2002). Convergence, Compensation and constancy in growth rates of teak. *Current Science,* 83(7): 808-809.

11. Kuppusamy, V.M. Rao, V., Balaji, M. and Rao, K.S (2002). Influence of ponding on the diffusion treatment of *Bambusa bambos* in green condition. *Wood News,* 12 (1): 36-39.

12. Kuppusamy, V.M. Rao, V., Balaji, M. and Rao, K.S. (2002). Preservative absorption response of planks of *Anogeissus acuminata* for plank-built catamarans. 32nd Annual Meeting, *Internat. Res. Group on Wood Preserv., Stockholm.* Document No. IRG/WP 02-40245: 1-16.

13. Kuppusamy, V.M. Rao; V., Rao, K.S. and Balaji, M. (2002). Leaching of CCA from *Bombax ceiba* Catamarans In operation for 15 years, *Ibid. Document* No. IRG/WP 02-50191: 1-6.

14. Nagaveni, H. C. and Vijayalakshmi, G. (2002). Effect of VAM and *Azotobacter* inoculation on growth and biomass production in forestry species. *Indian Journal of Forestry,* 25.

15. Nagaveni, H.C.; Remadevi, O.K.; Sharma, M.N. and Rao, R.V. (2002). Studies on the durability of plantation grown *Tecomella undulata* (sm) SEEM. *J. of Timber Development Association of India,* 48 (1and 2): 32-36

16. Nagaveni, H.C.; Remadevi, O.K.; Sharma, M.N. and Rao, R.V. (2002). Studies on the durability of plantation grown *Tecomella undulata* ( Sm.) Seem. *J. Timber Development Association of India,* 48 (1 and 2): 32-36.

17. Oevering, P.; Pitman, A.J. and Pandey, K.K. (2003). Wood digestion in *Pselactus spadix* Herbst-a Weevil attacking marine timber structures, *Biofouling* , 19, 249S-254S.

18. Pandey, K.K. (2003). Natural and accelerated weathering of rubber wood, Proceedings of *Symposium on Advances in Polymeric Building materials* Poly Built, Roorkee,130- 136.

19. Rao, K.S. Current trends of wood use. An Indian perspective: *Wood News,* 12(2) :12-15.

20. Rao, K.S.; Rao, R.V. and Aggarwal, Pankaj K. (2002). Development in solid wood use from plantation species in building material. Workshop-National building code: New dimension for revision at Bangalore, 25-28, June.

21. Rao, Vijendra, R. Hemavathi, T.R. and Sujatha, M. (2002). Wood Anatomy of *Tecomella undulata* (Sm.) Seem (Bignoniaceae). *J. Timber Development Association of Indi.,* 48 (1 & 2): 37-41.

22. Remadevi, O.K.; Nagaveni, H.C. and Muthukrishnan, Raja (2002). Evaluation of the efficacy of CNSL as a wood preservative against termites and fungi. *Journal of Timber Development Association of India,* 48 (3&4): 15-19.

23. Remadevi, O.K.; Nagaveni, H.C.; Muthukrishnan, Raja and Sharma, M.N. (2002). Rhinoprime protective coating for wood. *Wood news,* 12(2) : 41.

24. Remadevi, O.K.; Sundararaj, R. and Muthukrishanan, Raja (2002). Evaluation of the efficacy of permethrin as a termiticide for timber protection in field condition. In "Environment, Biodiversity & Bioethics: Current Trends and Future Directions" (Ed. M. Selvanayagam).

25. Shankaranarayana. K.H.; Ravikumar, G. and Patil, K.B. (2002). Aroma enriched products from less odorous sandalwood oil fraction of the industry. *The FAFAI Journal* , 4(39-40).

26. Singh, G.; Singh, Bilas; Kuppusamy, V. and Bala, N. (2002). Variations in foliage and soil nutrient composition in *Acacia tortilis* plantation of different ages in north-western Rajasthan. *The India Forester,* 128 (5): 514-522.

27. Srivastava, A.; Rathore, T.S.; Joshi, G. and Reddy, K.S. (2002). Modern nursery practices in production of quality seedlings of important forestry species using root trainer technology. *My Forest,* 38 (3): 257- 263.

28. Sundararaj, R.; Remadevi, O.K. and Muthukrishnan, Raja (2003). Comparative efficacy of some insecticides in ground contact against subterranean termites. *Pestology,* 27 (2): 16-18.

## Brochure/pamphlets

- Pamphlets on "Ammonia fumigation" and "Ammonia plasticization" in Kannada.
- Brochure on "Eucalyptus" in Kannada.;
- Pamphlet on "Catamarans" in English.

## Conferences/meetings /workshops/seminars/symposia Organised

- A Workshop on "Grow more Sandalwood" organised by FAFAI, Mumbai and KSDL, Bangalore and supported by IWST conducted at IWST on 24.5.02.
- Conducted demonstration programmes on "Forestry and Wood Science Technologies" under JBIC of Karnataka Forest Department at following places:

  (i) Gulbarga on 27th and 28th Aug., 2002.

  (ii) Hassan on 13th and 14th Sept., 2002.

  (iii) Kolar on 17th March, 2003

  (iv) Somwarpet on 30th March, 2003.

  Village Forest Committees members, farmers, plant growers, saw miller, forest department officials, carpenters and students participated in the programme.
- Demonstration of portable distillation unit to tribal people was held on 15/02/2003 at Cheenai wildlife Sanctuary, Munnar Forest Division, Kerala State.
- A Seminar on "Advances in Wood Science and Technology" was organized on 22nd February, 2003.

## Participated

- Participated in 90th Indian Science Congress held at Bangalore during 3/01/2003 to 7/01/2003. An exhibition stall depicting the activities of ICFRE was put up for display.
- Participated in "India International Wood Technology, 2003" (IIWT) exhibition at Chennai by displaying a stall of institute activities at Chennai from 21-24 Feb,2003.
- Shri Ajay Karmarkar participated in International Conference on plastic and environment opportunities and challenges organised by Shriram Institute for Industrial Research, New Delhi on Feb. 24-25, 2003.

- Dr. S.P.S. Rawat participated as a delegate in XVII International Symposium on Glycoconjugate from Jan., 12-15, 2003 at Bangalore.

- Shri N.K. Upreti attended a seminar on "Sun Tech Days" organised by Sun Microsystems at Indian Institute of Science, Bangalore on 21-22, March, 2003.

- Dr. K.S. Rao, Director delivered a talk on "Tree Biodiversity Conservation through Wood Preservation " in a workshop on "Biodiversity Conservation" organized by NRDC, Hyderabad on 12-14, August, 2002.

- Shri Pankaj Aggarwal attended workshop on "National Building Code: New Directions for Revision" and presented a paper on "Development in solid wood use from Plantation species in building material" authored by Dr. K.S. Rao, Dr. R.V. Rao and Pankaj K. Aggarwal. The workshop was organised by NCCB on 25-26, June, 2002 at Bangalore.

- The following officers and scientist attended the national seminar on "Management of Degraded Forest for Biodiversity Enhancement and Carbon Sink Expansion" at TFRI, Jabalpur on 15th and 16th, January, 2003.

  i. Dr. K.S. Rao, Director, IWST. (He also co-chaired one of the technical session.)

  ii. Shri Suresh Chandra Gairola, Group Coordinator, IWST.

  iii. Shri Ch. Murlidhar Rao, I/C FRC, Hyderabad.

  iv. Dr. G.R.S. Reddy, Scientist-E, FRC, Hyderabad.

- Officers, Scientists and Research Scholars of the institute attended the National Conference on Zoology-Vision for 21st Century from 28th to 31st, December, 2002 and the following papers were presented.

  (i) Gairola, Suresh Chandra "Wild life management in Maharashtra with special reference to Sanjay Gandhi National Park, Mumbai".

  (ii) Raji, B. and Remadevi, O.K. "Insect Diversity in the Mangrove forests along the West Coast of India" (Paper was presented by Raji B. and won the Young Scientist award consisting of Gold Medal and Certificate).

  (iii) Dubey, Anil Kumar and Sundararaj, R. "Aleyroids breeding in Teak (*Tectona grandis* Linn. F.) in Western Ghats of south India" (Paper was presented by Anil Kumar Dubey).

  (iv) Muthukrishnan, Raja, Remadevi, O.K., and Sundararaj, R. "Beetle pests of timbers used for handicraft and packing- cases in Karnataka: A survey Report" (Paper presented by Raja Muthukrishnan).

- Dr. Avinash M. Kanfade, Shri Pankaj Aggarwal, Dr. Y.M. Dubey, Shri A.S. Kambo participated in the seminar on "Green Wood Alternates-Emerging technologies" organised by IPIRTI, Bangalore at Chennai on 23/02/2003.

- Dr. T.S. Rathore, Shri R.S. Peddappaiah, and Shri Ashutosh Srivastava, participated in National Seminar on Organic Farming held at Bangalore

on 21st and 22nd February, 2003, organized by Regional Biofertiliser Development Centre, Bangalore.

- Dr. O.K. Remadevi and Dr. Sundarraj, R. attended the Seminar on "Bt-cotton global performance and future strategies " held at held at Monsonto Research Centre, I.I.Sc., Bangalore on 28.02.2003.

- Dr. Sundarraj, R. attended the National Seminar on " Organic Farming with special reference to organic inputs": held at Institute of Agricultural Technologists, Bangalore from 21st to 22nd, February, 2003.

- Dr. K. S. Rao, Director, IWST attended the following seminars/ workshops:

  a) "Round table consultations on *Gmelina arborea* improvement programme" during 4th to 6th, March, 2003 at R.F.R.I., Jorhat and chaired two technical sessions.

  b) "National Seminar on Conservation and Management of Marine Biodiversity" during 21st to 22nd March 2003 at Kanyakumari and made presentation on " IWST/ICFRE contribution in marine faunal diversity".

- Dr. K.K. Pandey attended a symposium on Advances in Polymeric Building Material and presented a paper at CBRI Roorkee, Uttaranchal on 6-7 March, 2003.

- Dr. Avinash, M. Kanfade attended the workshop on " Bamboo flowering in Karnataka State" organized by Karnataka Forest Department at Bhadrawati, District-Shimoga on 4th March, 2003 and presented paper on "Flowering in bamboo with special reference to north east region."

- Dr. R. Sundararaj attended the symposium on "Biocontrol of Lepidopteran pests" organized by Society for Biocontrol Advancement and Project Directorate of Biological Control, Bangalore from 17th to 18th July, 2002.

- Participated in Workshop on "Forestry Climate change-assessing mitigation potential and cost" at Delhi on 23rd-24th September 2002.

- Participated in Workshop on "Agroforestry- prospects and challenges" at Coimbatore on 22nd Nov., 2002.

- Participated in the workshop on "Technological innovation & Research Advancement for applicant in Joint Forest Management" on 3rd-4th Feb. 2003.

- Participated in workshop on "Round table consultation on *Gemelina arborea* improvement programme" on 4th-6th March, 2003.

- Participated in exhibition Biotech India-2003, "Ist International Exhibition cum conference on Biotechnology" at New Delhi on 4th-5th Feb., 2003.

## Linkages and collaboration

1. Collaborated with M/s Mysore Papermills Ltd., Shimoga and Karnataka Forest Department.

2. Dr. K.S.Rao, Director attended meeting with Biotechnology International, Department of I.T. and Biotechnology, Government of Karnataka on 30/01/2003.

3. An Advanced Wood Working Training Centre (An-Indo-Italian Joint Project by IWST-ICE-ACIMALL) was jointly inaugurated by Shri R.P.S. Katwal, IFS, Director General, Mr Aniello Musella, Director, Promotion and Project, ICE, Rome and Mr. Giancarlo Anselmi, Vice-President, ACIMALL, Milan on 12-03-2003 in the institute premises.

4. Interaction with Japanese scientists - Research on Sandal on 13th September, 2002

## Awards

- Dr. K.S. Rao, Director of the Institute was awarded gold medal in recognition of his contribution to the discipline of Life Sciences in general and Zoology and Environmental Sciences in particular during the 13th National Conference on Zoology-Vision for 21st Century held at Bangalore University from 28th 31st December, 2002.

- Shri Raji, won the Young Scientist award consisting of Gold Medal and Certificate by presenting paper " Insect Diversity in the Mangrove forests along the West Coast of India"

Participated in 90th Indian Science Congress Exhibition at Bangalore from 3rd - 7th January, 2003.

## Distinguished visitors

- The Hon'ble Members of Parliamentary Standing Committee on Science and Technologies; Environment and Forests visited the institute on 6th Sept., 2002.

- Shri K.H. Ranganath, Hon'ble Minister for Forest and Environment, Govt. of Karnataka visited the institute on 17th April, 2002.

- Prof. B.K. Chandrashekhar, Hon'ble Minister forIinformation Technology and Bio-technology, Govt. of Karnataka visited the institute on 24-5-2002.

- Dr. D.N. Tewari, Member Planning Commission, visited the institute on 22-8-2002.
- Shri H.S. Brahma, IAS, Pvt. Secretary EFS&T, Govt. of Andhra Pradesh and Chairman. APCOST, visited the institute on 29th April, 2002.
- Mr. Aniello Musella, Director, Promotion & Projects, ICE, Rome, Italy, Mr. Vittorio Mecozzi, Italian Trade Commissioner, Mumbai and Mr. Giancarlo Anselmi, Vice-President, ACIMALL, Milan and other Italian delegates visited the institute on 12-03-2003.
- Mr. Guiguelmo Galli, Commissioner, Italian Trade Commission visited the institute on 4-12-2002.
- Shri B.K. Singh, IFS, PCCF, Maharashtra Forest Department inaugurated the Training course on Field Identification of Timber between 18-11-2002 to 23-11-2002 .
- Mr. M. Kinoshita, First Secretary, Embassy of Japan; Mr. Y. Oikawa, Asst. Professor, TUAT visited the Institute on 13th Sept., 2002.
- Shri R.B.S. Rawat, IFS, Secretary, Central Medicinal Boards visited the Institute on 6/6/02.
- Dr. Akash Chopra, Director, Biosys Group, UK visited on 22nd May, 2002. A three member Madagaskar delegation on biodiversity conservation visited the institute on 21-8-02.
- Mr. Angus Wallace and Malcolm Farmer of OSMOSE (Timber Treatment Company), Australia visited the institute on 18th September, 2002.