

TROPICAL BOTANIC GARDEN AND RESEARCH INSTITUTE
PALODE, THIRUVANANTHAPURAM, KERALA, INDIA.

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ANNUAL REPORT
- 2001-2002



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From the Director's Desk

I have immense pleasure in presenting the Annual Report of the Tropical Botanic Garden and Research Institute, for the year 2001-2002. The Institute has made exponential progress over the years and the period under report is no exception. Remarkable achievements have been depicted both in the Garden Development and in the Research and Development sectors and novel extension activities including imparting training, arranging workshops and conducting seminars have been undertaken. There are 31 projects at present in the Institute funded externally of which 25 are ongoing and 06 are sanctioned this year.

One of the remarkable and memorable events of the year was the visit of Professor Sir Ghilleen Prance, Ex-Director of Royal Botanic Gardens, Kew, England, Botanical Consultant and the current Executive Director of Eden Project. Sir Prance spent two days with the scientists of TBGRI, exchanging ideas as well as interacting with every one associated with the development of the garden. The visit had boosted the morale of the entire staff and the ideas emanated through discussions with him have been translated fruitfully for the development of the garden.

Extensive exploratory field trips were conducted to various parts of the Western Ghats as well as to forest areas covering the entire peninsular India. A number of rare and endangered medicinal plants, palms, bamboos, orchids, tree species etc were introduced into the garden. Effective measures for their multiplication, understanding reproductive biology in detail and restoration methods were undertaken and as a result a number of species have been successfully reintroduced into their natural habitats as well as conserved in the garden.

National Gene Bank Programme of the Department of Biotechnology has been continued with substantial support during the period and based on the report, the same has been extended for the 10th Five Year Plan. The programmes covered are field gene bank, *in vitro* bank, cryobank and seed bank. Newer programmes have been inducted into this through which an almost throughput understanding of the conservation requirement can be achieved during the subsequent years. Chemical prospecting for valuable phytochemicals of therapeutic value and DNA fingerprinting have been undertaken in a number of valuable medicinal species and their accessions. 56 papers have been published during the period in leading journals and 20 papers were presented in many National and International Symposia during 2001-2002.

Bioinformatics Centre of TBGRI, sponsored by the Department of Biotechnology, is functioning since 1998 as a Distributed Information Sub-Centre. The programmes of the Centre is in line with the mandate of the Institute and focus on the data base generation of the Tropical Plant Wealth. The Centre, during the period, has progressed well in the creation of a novel database named 'Plant info' - an internet based software package which offers all available information (both published and local information) related to the plant wealth of Kerala. An extension centre is planned at Puthenthoppe within the city limits for better internet connectivity and easy accessibility to the end users. A number of quality planting materials, both of ornamentals, medicinal species as well as fruit trees were distributed to the Public/NGO's and Government Organizations.

The succeeding pages give a detailed report of the various activities of the Institute and is presented to all concerned for perusal.

Palode
July, 1, 2002

Prof. (Dr.) G. M. Nair
Director

TBGRI 2001-2002

at a glance

1	No of Projects undertaken	31
2	Patents filed	1
3	Publications	
	Books/ Booklets	10
	Journal - International	14
	Journal - National	42
	Total	66
4	Technical papers	
	Presented in seminar/conference etc.	
	International	2
	National	18
	Total	20
5	Awards /Honours	6
6	Seminar / Workshop conducted	4
7	Training imparted	7
8	Exhibitions conducted/ participated	9
9	Budget (Rs in lakhs)	
	Grant-in aid	236.70
	Receipt through projects (computed prorata)	125
	Total	361.70
10	Staff	
	Scientific	59
	Technical	34
	Non Technical	140
	Total	233

EXECUTIVE SUMMARY

Tropical Botanic Garden and Research Institute (TBGRI) was founded in 1979 with the objective of establishment of a conservatory botanic garden of tropical plant resources of the country. Now after 23 years, it has flourished into one of the premier R&D organizations in Asia, devoted to conservation and sustainable utilization of tropical plant diversity and a National Center of Excellence in *ex-situ* conservation of tropical plants.

TBGRI is an autonomous R&D organization established under the Government of Kerala. It is guided by a Governing Body and an Executive Committee consisting of eminent scientists and policy makers appointed by the Government. The Chief Minister functions as Chairman of the Governing Body and the Chairman, State Committee on Science, Technology and Environment functions as Chairman of the Executive Committee. The power of policy implementation is vested with the Director.

Situated at Palode, 40 km from the capital city, Thiruvananthapuram, TBGRI maintains a 121 hectare conservatory garden. Since its very inception, the functioning of TBGRI has been envisaged as that of a botanic garden and a research institute. The Garden and Research & Development represent two inseparable components of the institute.

The developmental programmes of the Garden system are implemented through the Division of Horticulture and Garden Development. Under this major Division, the garden is maintained through various functional units such as Arboretum, Bambusetum, Medicinal Garden, Palmetum, Orchidarium, Ornamental plants, Cacti and Succulents, Ferns and Gymnosperms and a Central Nursery.

Arboretum with over 800 species of trees, Bambusetum with 60 species, Palmetum of 102 species, Medicinal Garden with more than 700 species, Orchidarium holding 600 species and 150 hybrids, Fernery having 150 species, Gymnosperms with 35 species and a Field Gene Bank with 100 rare medicinal plants are the important components of the Garden. Besides these specialized conservatories, an ornamental plant collection with over 1000 species /varieties/cultivars are also maintained for the beautification of the garden.

Research and Development activities are carried out through 6 major

R&D Divisions viz. Plant Biotechnology, Microbiology, Ethnopharmacology & Ethnomedicine, Phytochemistry, Conservation Biology and Plant Systematics and Evolutionary Sciences. The well-established Library and Information Services Division supports the R&D activities. As a part of the Plant Systematics Division, a Herbarium (TBGT) was also established and maintained. The newly established Bioinformatics Centre sponsored by DBT is actively engaged in the Biodiversity cataloguing and creation of data-base.

During the report period (2001-2002), extensive exploratory field trips were conducted to various parts of Western Ghats, as well as to forest areas covering the whole of peninsular India. Over 250 accessions of medicinal plants, trees, palms, bamboos, orchids and rare endemic species were introduced into the garden.

In the sector R&D 31 externally funded research projects were successfully executed during the year. 56 research papers were published in National and International Journals. 1 family, 1 genus and 27 taxa were described as new to science. A research finding from the Ethnomedicine and Ethnopharmacology Division was filed for patent. Consultancy services for Decentralized Planning, Environmental Impact Assessment for Kerala State Electricity Board and assistance in formulation of Management Plans for Forest Department were also undertaken. Many scientists were nominated as members of Expert Committee in Planning Board, Electricity Board, Forest Department and Governing Bodies of other Research Institutions.

Over 5000 students and scholars utilized the services of TBGRI during 2001-2002 period. In addition, about 500 family groups and 75 foreigners also visited the Institute. Professor Sir Ghillelan Prance, former Director of Royal Botanic Gardens, Kew, UK. was our distinguished guest, during the year.

Extension services such as conducting exhibitions in connection with the Agricultural trade fairs, as well as imparting training and implementation of people's participatory programmes were also undertaken. Large numbers of planting materials of Bamboos, Medicinal plants, Cacti, Orchids, Anthuriums and exotic varieties were distributed to Government and Non Governmental Organizations and to the needy public, during the year.

Altogether, TBGRI has made substantial progress both in Garden Development and R&D activities during 2001-2002 period and the detailed report given in the following pages project them.



HORTICULTURE AND GARDEN DEVELOPMENT

The developmental programmes of this major Division are accomplished through the following Units:

1. Introduction, Accession, Plant Records and Quarantine
2. Central Nursery & Jasmines
3. Conservatory of Rare and Endemic Plants
4. Arboretum, *Ficus* Garden & Bonsai Plants
5. Palmetum
6. Orchids
7. Ornamental Plants, Cacti and Succulents
8. Medicinal Plants
9. Bambusetum
10. Ferns and Gymnosperms
11. Seed Bank

Introduction, Accession, Plant Records and Quarantine

This Unit's activity is focussed on the introduction and accession as well as related aspects. The following collections were added to the Garden during the year viz. trees (15 species), palms (12), medicinal plants (20), gene bank (66), cacti and succulents (5), bromeliads (10), aquatic plants (3).

Central Nursery

Central Nursery takes care of the multiplication and propagation of plants. Clonal multiplication through stem cuttings was done in 670 species, 2000 polybag plants were raised and 150 plants were repotted and kept as stock plants. A total of 1200 seedlings were transplanted, supplied as potted plants/ trays for exhibitions and distributed to other units and sister institutions like KFRI.

Jasminum Germplasm Enrichment

Two more cultivated varieties of *Jasminum* were added, making the present collection to 47. Periodic propagation, field plantings, etc. were also done.

Conservatory of Rare and Endemic Plants

The Conservatory maintains 100 rare and endemic plants of the Western Ghats. They are grown in a special area for educational purposes. Plants are labelled with brief descriptions to make the display viewer- friendly and informative.



Amherstia nobilis- highly ornamental tree in the Garden



The 'Fig fruit'- *Ficus auriculata*
at the Arboretum

Arboretum, Ficus Garden & Bonsai Plants

Arboretum has a rich and specialized collection of trees, shrubs and woody climbers, preserved in a natural niche. This programme was initiated in 1984 with periodic additions making the total live collection to about 800 species. Data on growth performance and phenology in respect of 400 trees were also recorded. Saplings were distributed to the public.

Ficus Garden, displaying the highly adaptable and variable group, is a major attraction of the Garden. The bonsai forms maintained separately are an added attraction. The know-how for *Ficus* bonsai development and maintenance are sought after by individual growers and agencies.

Palmetum

Palmetum maintains a collection of 102 species and 7 varieties in 67 genera of tropical palms. Six exotic species were introduced during the year. *Phoenix canariensis* and *Butia yatang* are the new additions. So far, 35 taxa have flowered in the Garden. Of this, fruit setting was observed in 22 taxa. Germination studies were conducted in *Cyrtostachys renda* (red palm), *Archontophoenix cunnighamiana* and *Chrysalidocarpus lutescens*.

As part of the conservation programme of indigenous palms of Western Ghats, seeds/seedlings of *Arenga wightii*, *Bentinckia condapanna*, *Calamus vattayila* and *C. brandisii* were collected, reared and are being maintained in the Garden.

Orchids

Orchids have been the star attraction of TBGRI since its inception. Both wild species and hybrids are being continuously added to make the collection rich and comprehensive. They are being maintained in five orchidaria. This forms largest living collection of orchids in South Asia and comprise 600+ species and 150 hybrids. A few species from Thailand, Malaysia, Vietnam, Panama and Venezuela received as gift from RBG, Kew are also being maintained here.

The long lost orchid *Vanda wightii* was rediscovered from Kannur in Kerala and Belthangadi in Karnataka during the year. This had been first collected by Robert Wight in Febru



Dendrobium secundum - an
Andaman orchid at the
Orchidarium



ary 1849 from Paulaghatcherry, Coimbatore and had since then remained unknown. The present rediscovery after 152 years is considered to be significant. Also discovered are two new species in the genera *Gastrochilus* and *Pteroceras* from Banasuranmala, Wayanad.

Ornamental Plants, Cacti and Succulents

During the period, this unit has managed display of different plant groups in pots and cultivation of shrubs in the Shrubbery near the office premises. Regular maintenance of the frontage of the Garden including making/maintenance of Floral beds, Carpet beds, Hedges, Avenues, Emblems, etc. was also done.

Germplasm Collection of Cultivars/Varieties of Ornamental Plants

Enrichment of the germplasm collections of *Bougainvillea*, *Bromeliads*, *Acalypha*, *Codiaeum*, *Dieffenbachia*, *Draecena*, *Heliconia*, *Hibiscus*, *Impatiens*, *Ixora*, *Plumeria*, *Lantana*, etc. was continued.

Bougainvillea collection: With the addition of 20 new varieties, a total of 30 varieties are represented in the garden.

Topiary : Two approach road sides, one leading to Guest House and the other to the nursery were utilized for making topiary. *Phyllanthus* sp. and a miniature *Ixora* sp. were used for this purpose.

Island beds: Two island beds were newly made, utilizing crotons, *Duranta*, *Carissa* and *Allamanda*.

Ixora collection : An *Ixora* garden was developed with 18 varieties. The collection comprises over 90 accessions .

Rose collection: A face lift was given by replanting the beds with 140 field plants.

Hibiscus collection : More than 40 varieties were added during the year making a total to 60 varieties.

Plumeria collection : More than 20 varieties were added making a total to 30 varieties.

Bromeliad collection: Ten more species were added to already existing 50 varieties.

Aquatic plants: Seedlings of giant water lily (*Victoria*



Humboldtia unijuga var. *trijuga* - rare endemic tree in fruits



Hedychium larsenii (*Zingiberaceae*) - a new species, described by TBGRI



amazonica) were raised from seeds and replanted in tanks, which also have native water lilies and some other aquatic plants.

Landscaping

The portion of the rock garden near the glass house and the rubble work linking the latter with the main road were remodelled during this period using about 25 xerophytic species.

The front area of the office was landscaped utilizing mainly *Tecoma stans*, *Allamanda cathartica*, *Caesalpinia pulcherrima*, *Calliandra* sp. in the upper two beds. The cut ends were covered with *Quisqualis indica* and *Lantana*.

Cacti and Succulents

They are maintained in a glass house erected for the purpose. During this period 23 additions were made raising the total number to 250 of which 100 are cacti.

Discovery of new variants of ornamental plants

Constant monitoring of samples of wild stock of native species maintained in the garden enabled to identify distinct variants of *Barleria cristata*, *Helicteris isora* (2 var.), *Ichnocarpus frutescens* (1), *Tabernaemontana heyneana* (1) and *Ruellia* sp. (1).

Medicinal Plants

Through intensive collection, the present holding total about 700 species. It is one of the best living collections in the country. The Itty Achuden Vaidyan's Garden, an informally landscaped constituent of the main body, covers an area of about 0.65 ha. with about 150 herbals on display and set in a scenic spot attract people from all walks of life. The traditional Kerala architectural features are characteristic of this garden. The informative label of each exhibit speaks of its utility in health care. The Herbal of the Week Pedestal features one species a week and so far 40 important medicinal plant species have been displayed. The demonstration plots of the herbal garden featuring *Dasapushpa*, *Dasamoola*, *Chyavanaprasa* and plants used in modern medicine, homoeopathy and tribal medicine are also major attractions.

The reproductive biological aspects of *Coscinium*



Entrance of 'Itty Achuden Vaidyan's Garden'



fenestratum, a much exploited medicinal plant was studied. Piperine and oil content of three accessions of *Piper nigrum* (two wild and one cultivated) were analyzed. A morphological marker was identified in the intraspecific variants of *Curcuma ecalcarata* with regard to oil content.

Bambusetum

Bambusetum, developed in an area of about 12 ha. is the largest collection of live bamboos in India. Regular additions are being made to this collection. Presently it comprises 660 accessions, belonging to about 60 species. This includes more than half of the species identified as priority species by the International Plant Genetic Resources Institute (IPGRI). Through experiments and constant monitoring, 12 commercially viable species have been identified for further cultivation in Kerala. Low cost techniques were standardized for the production of easy-to-carry polybag saplings. About 80,000 saplings have been distributed so far.

Studies on the reproductive biology of two species of bamboo, *Bambusa vulgaris* and *Ochlandra scriptoria*, have been completed. In *B. vulgaris*, a species which does not produce seeds, it is found that the factors responsible for failure of seed set are high rate of pollen sterility, absence of natural pollination and inhibition of pollen tube in the stigmatic papillae. In another significant study, floral biology and bee visits in six species viz. *B. bambos*, *B. vulgaris*, *Bambusa* sp., *Ochlandra ebracteata*, *O. scriptoria*, *O. travancorica* were monitored. As a result, grouping of Bamboos based on the nature of opening of florets and the co-existence of autophily, anemophily and hymenopterophily in *Bambusa* species was proposed. Phenological and growth characteristics of ten species were also analyzed.

Ferns and Gymnosperms

With new collections added from different parts of the Western Ghats in recent times, the fern collection has grown into the second largest in south India, holding 150 species in 70 genera, belonging to 30 families. Several rare and threatened taxa like *Angiopteris evecta*, *Araiostegia pulchra*, *Asplenium crinicle*, *A. nidus*, *A. polyodon*, *A. serricula*, *Botrychium daucifolium*, *Cheilanthes farinose*, *C. viridis*,



The Bambusetum - A view



Bee- pollinator on
Ochlandra travancorica



Standardized
in vitro multiplication
protocols of
12 species.

Cyathea gigantea, *C. spinulosa*, *Davallia bullata*, *Elaphoglossum beddomei*, *Helminthostachys zeylanica*, *Humata repens*, *Hymenophyllum denticulatum*, *Marattia fraxinea*, *Ophioglossum reticulatum*, *Osmunda regalis*, etc. The Royal fern, Tree ferns, Spleen worts, Squirrel foot fern, Fish bone ferns, Maiden hair ferns and Polypodiaceous members are the major attractions. Three species viz. *Diplazium polypodioides*, *Selaginella vaginata* and *Trichomanes* sp. were newly added to the existing collection.

Gymnosperms represent a long bygone era. The collection includes 35 species of 15 genera belonging to 7 families. Cycads are the main attraction and 7 of the 11 known genera were represented here. The only native conifer, *Nageia wallichiana* is also available in the collection.

Seed Bank

Collection trips were conducted periodically to procure seeds of desirable species and the collected seeds were subjected to different treatments for understanding the viability, performance in field. Seeds of *Oroxylum indicum*, *Tinospora sinensis*, *Amorphophallus paeonifolius*, *Sesbania grandis* and *Thespesia lampas* were collected and studied. Also added to the active collection in the seed bank are seed samples of 55 local plants. Storage and germination studies were also done on selected species.

National Gene Bank of Medicinal and Aromatic Plants

This programme, supported by the Department of Biotechnology, in a 20 ha. area was launched in 1993. It now holds 264 new accessions of 66 species, introduced during the period.

PLANT BIOTECHNOLOGY

Ex-situ Conservation through Micropropagation of Rare and Endangered Species

Rattan

Two species, *Calamus travancoricus* and *Calamus nagabettai* were collected from Kerala and Karnataka and established in pots and the field. Conventional propagation methods using seedlings and suckers of both the species were



standardized. Direct multiple shoot initiation was achieved in zygotic embryos in *C. travancoricus*. Rapid clonal multiplication from off shoots / suckers of *C. travancoricus* and *C. nagabettai* by inducing axillary bud formation from cut basal ends too was obtained in MS medium, supplemented with cytokinins.

Bamboos

In vitro multiplication protocols were standardized in *Dendrocalamus strictus*, *Bambusa vulgaris*, *B. arundinacea*, *B. balcoa* and *Ochlandra travancorica*, using mature nodes and zygotic embryos. Roots were induced in the multiplied shoots of *B. vulgaris*. Subsequently, hardened plantlets were established in the field.

Musa

Germplasm of 13 land races (traditional varieties) of *Musa*, which are facing extinction have been collected from different areas of Kanyakumari and Thiruvananthapuram districts. They are being maintained at TBGRI. All of them possess certain unique characteristics that are not available in present day commercial varieties

Mass propagation of the land race "Mati" from meristem was standardized. About 600 saplings of this were distributed among the TBGRI staff in order to evaluate their performance at different places. Observations are in progress.

Standardization of micropropagation is in progress for the well accepted varieties of *Musa* like Chenkadali, Ponkadali, Vellapalayanthodan and Champakannan.

Tree species

The project funded by the DBT, was started against the backdrop of destructive harvest of several priceless medicinal trees, for their plant parts like roots, bark or wood in the preparation of popular ayurvedic formulations such as Dashamoola, Chyavanaprasa, Ashtavarga etc. The species, *Oroxylum indicum*, *Premna corymbosa* and *Stereospermum suaveolens* are among those, facing rarity / extinction. The objective of the work was to carry out rapid micropropagation of elite clones and reintroducing them into their native / related habitats.



In vitro flowering in *Bambusa arundinacea*



RAPD Profile of 25 accessions of *Andrographis paniculata*



The nodal explants of juvenile shoots of elite mature trees were induced to produce shoots and roots in different culture media, using various hormonal combinations and additives. Rooted plants were hardened in mist chamber.

***In vitro* Production of Phytochemicals/Bioactive Compounds**

Plumbago rosea is a medicinal plant grown for its tuberous roots, which is used in several ayurvedic preparations as well as for extraction of a bioactive compound, plumbagin. Plumbagin possesses antimicrobial, pesticidal and anticancer properties.

For the production of plumbagin, normal and transformed root cultures have been established at the shake flask level. This technology has been patented.

P. rosea plantlets could be regenerated from transformed hairy roots. Such plants showed a different morphology with high root biomass, compared to other tissue culture-derived plants. Their performance in the field is under study.

Nothapodytes foetida is a good source for Camptothecin, (CPT) a high-value compound used against certain types of cancer. Callus cultures have been established in different concentrations of BAP and NAA. The callus was friable, its growth was slow, that only a three-fold increase in growth was observed in 45 days. Concentration of CPT was at tracer level. Its normal root cultures were developed using callus in MS solid medium containing high levels of NAA. The roots were very healthy. Work for establishing normal root cultures is in progress.

Two important antihypertensive alkaloids viz. ajmaline and ajmalicine were determined qualitatively and quantitatively from transformed ("hairy") root cultures of *Rauvolfia micrantha*, a rare and endemic medicinal plant. A comparative study was done on the yields of ajmaline and ajmalicine among normal, transformed and field-derived roots. An attempt was also made to grow the hairy roots in Nutrient-Sprinkle reactor. Study on the effect of polyamines (putrescine, spermine and spermidine) on yield of hairy root biomass, alkaloids and growth pattern is in progress.

Follow up work on hairy root cultures of *Withania somnifera* is in progress and the effect of different (2-6 %) concentra-



tion of sucrose and nutrients (half and full strength MS medium) for the rapid growth and improved biomass yield was determined. Phytochemical assays are underway.

Insecticidal property of the roots of *Janakia arayalpathra*, *Hemidesmus indicus* and callus cultures of *Jjanakia hamiltonii* against the stored grain pests, *Sitophilus oryzae* was studied in collaboration with CFTRI, Mysore.

Seed Biology of Native Endangered Plants

Hydnocarpus alpina and *Myristica malabarica*

Changes in antioxidant enzymes (peroxidase, polyphenol oxidase, catalase etc.) during the desiccation of their recalcitrant seeds were studied along with the assessment of primary metabolites like sugars, proteins, lipids, starch, amino acids and phenols

Aporosa lindleyana

Macromolecular changes and oxygen consumption studies on different stages in developing embryos of *A. lindleyana* were carried out.

Biochemical investigations

Detailed studies on desiccation and its effects on germination, viability and changes in content of free radical scavenging systems like peroxidase, polyphenol oxidase, SOD, leachate conductivity together with macromolecular changes were worked out on seeds of the endemic trees, *Elaeocarpus tuberculatus*, *Hopea parviflora*, *Mesua ferrea* and *Vateria indica*.

National Gene Bank for Medicinal and Aromatic Plants: *In vitro* bank

The National Gene Bank Programme of the institute (A National Facility under Department of Biotechnology, Government of India) consists of four main components, of which, *In vitro* Repository and Cryobank are being operated in the Biotechnology Division. Shoot cultures of *Janakia arayalpathra*, *Geophila reniformis*, *Kaempferia rotunda*, *K. galanga*, *Trichopus zeylanicus*, *Nervilia prainiana*, *N. aragoana*, *Rauvolfia micrantha*, *R. serpentina*, *Piper trichostachyon*, *Acorus calamus*, *Heracleum candolleianum*, *Mahonia leschenaultii*, *Coleus forskohlii*, *Curcuma longa*,



Rubia cordifolia, *Adhatoda beddomei*, *Cymbopogon flexuosus*, *Myristica malabarica* and *Holostemma annulare* are being maintained. *In vitro* regeneration protocol was standardized for *Vanilla andamanica* (an endangered species from Andaman and Nicobar Islands) and *Rotula aquatica* (a rare medicinal plant of the Western Ghats). Rooted mericlones of *Vanilla andamanica*, *Acorus calamus* (Triploid), *Heracleum candolleum* and *Mahonia leschenaulti* were established in community pots. Culture initiation and/or multiplication of *Morinda reticulata*, *Piper galeatum*, *P. hookeri*, *Rauvolfia beddomei*, *Utleria salicifolia* was also achieved. Micropropagated plants of *Janakia arayalpathra* established in the nursery have been successfully transferred to their natural habitat at Kallar (Thiruvananthapuram) forest segment and those of *Acorus calamus* into the field in TBGRI campus, similar to its natural habitat. Genetic integrity of *in vitro* derived mericlones of *Acorus calamus*, *Heracleum candolleum* and *Mahonia leschenaulti* was confirmed by esterase and peroxidase isozyme analysis and/or cytological and chemical analysis.

In the cryobank (-196°C), one accession each of *Tinospora sinensis*, *Piper galeatum*, *Andrographis paniculata* and *Asparagus recemosus* seeds and one accession of *Holostemma annulare*, as encapsulated shoot tips, were stored. Removing ammonium nitrate from the culture medium during different preparative procedures enhanced the survival of cryopreserved shoot tips of *H. annulare*.

A germplasm collection of *Acorus calamus* has been made. The accessions were characterized cytologically and categorized into tetraploid and triploid genotypes. Asarone content of the tetraploids, analyzed through GC-MS, constitutes 89% and that of triploids constitutes 36% of the total volatile oil composition.

Chemical and Genetic profiling of Medicinal and Aromatic Plants (MAP's) of Southwest and Northeast India

The work is currently focused on DNA fingerprinting of five species.

Programme on bioprospecting of *Andrographis paniculata* is being carried out in collaboration with Rajiv Gandhi Centre for Biotechnology, to develop elite genotype(s) of the



species as patentable plant varieties, using biotechnological tools. As part of the project, wide germplasm collection was made from different phytogeographical regions of the country and maintained under uniform conditions of growth. Phytochemical analysis of selected accessions, with respect to the diterpene lactone, andrographolide showed variation in distribution of the active principle. RAPD analysis using thirty-nine primers generated a total of 213 products, of which 146 was found to be polymorphic. Intraspecific variation analysis following standard statistical procedures revealed significant variability in the species, as evidenced by coefficient of genetic similarity (mean value of $GS = 0.82$). Further, superimposition of data on morphological, chemical and genetic analysis indicated a few of them as elite/superior genotypes. Analysis with more number of accessions collected from the Northern States of the country was done during the period.

The National Network Programme on "Bioprospecting of biological wealth of India using biotechnological tools" initiated by the DBT in 1997 comprises eight major centres and five satellite units. TBGRI is one of the satellite centres, collaborating with National Chemical Laboratory, Pune. The two plant species selected under this programme are *Rhododendron arboreum* and *Hypericum hookerianum*.

Rhododendron arboreum, like many other genera of Himalayan origin, is represented by only one species in the hills of South India and show a relatively high rate of endemism. A total of 35 accessions were collected- 13 from Northeastern parts, 6 from Munnar and 16 from parts of Nilgiris. Analysis of genetic variation between populations from North-East and South-West revealed high degree of genetic similarity within populations. However, between populations there is significant diversity as shown by mean GD value of 0.23. Among the groups, Ooty population showed relatively more diversity.

The genetic diversity in *Hypericum hookerianum* collected from six different sites including four sites of Nilgiris and two sites of Palani hills of Western Ghats was assessed. Out of the 40 primers tested, 20 produced amplification in all the samples. Phenograms on development reflected general tendency of individuals to cluster together by geographical proximity. It is suggested that Avalanche population is



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genetically more diverse than rest of the populations.

Chemical analysis of the species using HPLC is being carried out for possible detection of hypericin - a potent antidepressant and antiretroviral agent, originally reported from *H.perforatum*. Identification of elite genotype(s) is in progress

A total of 25 accessions of *Piper nigrum* (15 wild accessions and 10 cultivars) collected from different parts of the state on RAPD analysis showed reasonable variation (Mean GS = 0.91). Phenogram obtained showed clustering of groups on expected lines. Analysis is in progress to estimate the extent of genetic similarity between *P.nigrum* and other wild species of *Piper*

Genetic variability in *Curcuma* species is relatively less both at the intraspecific (mean GS=0.98) and interspecific levels (mean G.S = 0.96). RAPD analyses with 15 primers do not seem to link the observed morphovariability in *C.ecalcarata* to genetic factors. However, analysis is in progress with more number of primers. Chemical screening with respect to total essential oil content shows variation in % distribution (0.4 to 1.0) in *C.ecalcarata*.

Bioinformatics (Sub-DIC)

The Bioinformatics Subcentre established as part of the National Network Programme of DBT, mandated to develop database and software packages, that are relevant to the main R & D activities of TBGRI and also to conduct training and extension activities for other institutions, universities and colleges. During the year, the following work was done.

Established the computer and communication facilities and made them available to all the sections of TBGRI.

Established library facility at the Centre.

DBT has approved the continuation of this Centre during the 10th Plan (2002 – 2007), under its BTIS programme

Based on the mandate of the Institute, a database model "Plant Info" was designed in which all types of data related to plants can be stored and offers provision to easy accession and analysis of the data.

Prepared the blueprint of a mission mode project "Database of germplasm collection and R & D achievements of TBGRI".



MICROBIOLOGY

Survey, Inventory and Evaluation of Macrofungi

Mushrooms were collected from different forest localities of the Western Ghats. Collection sites included wooded areas and undisturbed localities of TBGRI campus, forests of Aryankavu, Kulathupuzha, Thenmala, Bonacaud, Chellangy, Peringamala, Iringole sacred grove and CPCRI campus. A total of 244 collections were added to the mushroom herbarium. Identification of mushrooms in exsiccate was carried out through out the year.

Survey and Inventory of Foliicolous Fungi

Conducted two field collection tours to Shendhurney Wild Life Sanctuary. Identified 150 foliicolous microfungi from the collections and deposited in Herbarium Cryptogamae Indiae Orientalis, New Delhi and a part of the collections is maintained in the Microbiology Division, TBGRI, Palode, under TBGT numbers. One family, Lembosiaaceae was proposed with the type genus *Lembosia*. Seventeen new species and four varieties were also described.

Screening of Actinomycetes for Antibiotic activity

Four Actinomycete strains with potential antibiotic activity were isolated from the forest soils of Neyyar Wild Life Sanctuary of Kerala state. They were characterized, identified and deposited in Microbial Type Culture Collection and Gene Bank (MTCC), Chandigarh. They are :

1. *Streptomyces setonii* TBG-19NRA1 (MTCC 3756)
Antibacterial
2. *Streptomyces atroolivaceus* TBG-28S1A46 (MTCC 4148)
Antibacterial
3. *Streptomyces clavifer* TBG-MNR 13 (MTCC 4150)
Antibacterial and,
4. *Streptosporangium nondiastaticum* TBG-75A20 (MTCC 4149) Antibacterial

The cultural conditions and physiological parameters were standardized for the optimum production of antibiotic compound using the strains of *Streptomyces setonii* TBG-19NRA1 and *Streptosporangium nondiastaticum* TBG-75A20.

New to Science

Fungi

Asterina lauracearum,
Asterina lobeliacearum,
Prillieuxina elaeagni, *Asteridiella dilleniae*, *Irenopsis murrayae*, *Meliola invisiae*,
Meliola adenanthericola, *Meliola canthiicola*, *Meliola lepianthedis*, *Meliola toonae*, *Meliola abrahamii*,
Diplococcium atrove lutinum, *Asterina diospyri*,
Amazonia goniothalami,
Asterina arecacearum
Asteridiella komb eensis,
Meliola dysoxyl-mala barici.

Meliola hydnocarpi
Hansf. var. indica, *Meliola caesalpiniae* *Hansf. & Deight. var. indica*, *Meliola memecylica* *Hansf. var. longiseta*, *Meliola aethiops*
Sacc. var. keralica.



Lactarius ignifluns- a new species of mushroom

Cellulolytic Activity

Cellulolytic activity of a bacterial strain (*Pseudomonas* sp.) was estimated and the optimal culture conditions were standardized. Cellulase enzyme was purified which contained two endoglucanases (extra- cellular) and one α -glucosidase (intra- cellular).

Litter decomposition in tropical forests

Litter production and accumulation in the forests of Palode and Kallar regions of the Western Ghats of Kerala was studied. Seventeen species were identified as the dominant species of the area. Phytosociological analysis of the dominant species was conducted. Litter fall for three consecutive years was studied. Maximum litter fall was noticed in the months of February and March. Leaves contribute the maximum litter followed by twigs, flowers, fruits etc. Maximum leaf fall occurred from *Aporosa lindleyana*. Litter decomposition was estimated on the basis of weight loss and CO_2 evolution. After four months, 28% weight loss was recorded. This has increased to 53% in six months. After one year, the weight loss was 80% and more or less complete decomposition (98.5%) occurred after 18 months. Maximum weight loss was observed in the month of July and the minimum in September. CO_2 evolution ranged between 30.6 to 165.8 mg/g/L in Palode forests and 28 to 146 mg/g/L in Kallar forests. Maximum CO_2 evolution was noticed in the month of June and the minimum in February. Substantial increase in the nutrient content of the soil was noticed after 18 months incubation of the litter on the forest floor.

Mycorrhizal association of endemic trees of Western Ghats

Five highly useful medicinal plants in the vulnerable to endangered category viz. *Celastrus paniculatus*, *Heracleum candolleianum*, *Holostemma annulare*, *Janakia arayalpathra* and *Nothapodytes foetida* were selected for mycorrhizal studies. Root and soil samples were collected periodically. 600 AM spores were isolated from the rhizosphere of these trees and mounted. *Glomus* was observed as the dominant genus and 6 species were identified viz. *G. clarum*, *G. pustulatum*, *G. fasciculatum*, *G. triculatum*, *G. tenerum* and *G. intraradices*. Root colonization was determined and *Janakia arayalpathra* was observed as highly mycorrhizal



Streptomyces strain in culture



(80% root colonization). Field trips were also conducted to collect the root and soil samples of two endemic palms viz. *Arenga wightii* and *Pinanga dicksonii*. Spore load and root colonization of these palms were determined. AM spores isolated from the rhizosphere were inoculated to Sorghum plants for AM culture production.

Genetic diversity studies in the genus *Pleurotus* using molecular techniques

Bioprospecting of 15 species of *Pleurotus* (Oyster mushrooms) was done. The study was focussed on analysis of interspecific variation in the genus *Pleurotus* (Basidiomycotina – Agaricales), which consists of a number of cultivated edible species, also having potent medicinal values. The effect of mushroom extract on basic immunological parameters like haemoglobin content, total leukocyte count, peritoneal macrophages, granulocyte-agranulocyte ratio etc were analysed, using animal model systems. 4 enzymes (esterase, peroxidase, malate dehydrogenase, superoxide dismutase etc) were also studied. RAPD analyses using 20 primers were studied and genetic distance between each species was established.

Strain improvement studies on *Pleurotus* by mutation and hybridization

Few high yielding hybrids of different *Pleurotus* sp. were developed by interspecific hybridization. Three mutant strains of *Pleurotus citrinopilatus* with high yield and protein content (E5, U74 and U76) were developed by EMS treatment and UV irradiation.

ETHNOMEDICINE AND ETHNOPHARMACOLOGY

Benefit Sharing

Technology of drug 'Jeevani' has been transferred to a reputed Ayurvedic drug manufacturing company, for a period of seven years. In this deal, TBGRI has received 10 lakhs rupees as license fee and 2% royalty on exfactory sales price.

Based on the technology transfer of 'Jeevani', TBGRI has decided to part with 50% of the license fee and royalty with the Kani tribes who provided a lead for the development of the drug.



Recognition of IPR & implementation of Article 8(j) of CBD*

Through this equitable benefit sharing, TBGRI has opened up a new path in scientific research by implementing Article 8(j) of the Convention of Biological Diversity (CBD) and recognizing the IPR of Kani tribes.

Benefit sharing (mechanism worked out)

Kani tribes registered a Trust called 'Kerala Kani Samudaya Kshema Trust', with the guidance of TBGRI and remitted Rs.5 lakhs plus royalty to the trust account.

Benefit sharing (mechanism implemented)

Later, in consultation with TBGRI, the executive committee of the trust decided to facilitate the three Kani tribes who divulged the information about Arogyapacha. Accordingly, they were felicitated by the trust and Rs 20,000 each was given to Sri. Mallan Kani and Sri. Kuttymathankani (Total Rs. 40,000) and Rs.10, 000 to Eachankani (Grand total Rs 50,000) as prize/compensation. This amount has been taken from the first year interest of the 5 lakhs rupees remitted to the trust account. They also decided to keep Rs. 5 lakhs as the permanent asset of the trust, in the bank and only the interest of that money will be utilized for the welfare activities of Kani tribes.

As a part of their welfare activities the trust has also extended help by giving Rupees 2500 as fixed deposit in the name of two Kani girls aged 8 and 10 whose mother was killed by a wild elephant.

Benefit Sharing (conclusion)

A novel model developed by TBGRI for benefit sharing-which

1. Implemented Article 8(j) of CBD
2. Recognized IPR of Kani tribes
3. Protected traditional knowledge of Kani tribe
4. Extended short term benefits to the informants (three Kani tribesmen)
5. Extended long term benefits to the Kani tribal community.

*Article 8(j): Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices;



Drugs ready for Technology Transfer

Herbal Health Care Kit

It contains safe, effective, inexpensive and ecofriendly herbal remedies. These formulations are the outcome of a unique blend of traditional and Ayurvedic medical knowledge, with that of modern science and technology. It consists of 10 herbal preparations (5 drugs for oral use and 5 for external application) for treating common ailments like fever, diarrhoea, gas trouble, burns, traumatic injuries etc. For more details, see the table given below.

INTERNAL APPLICATION

Name of the drug	Presentation	Indication
TBR001	Granules	Dehydration in Diarrhoea and Vomiting
TBR002	Capsule	Fever
TBR003	Tablet	Diarrhoea, Dysentery
TBR004	Tablet	Gas trouble, Constipation, Intestinal colic
TBR005	Tablet	Cough, mild asthma

EXTERNAL APPLICATION

TBR0010	Ointment / Oil	Burns
TBR0011	Ointment / Oil	Cuts, Wounds, Minor injuries
TBR0012	Ointment / Oil	Sprain, Inflammation, Dislocation
TBR0013	Ointment	Head-ache, Common
TBR0014	Oil	Ear-ache

Ethnopharmacological assays

An anticancer herbal formulation

An anticancer herbal formulation was based on animal experiments. It is a mixture of *Janakia arayaipathra* root (alcohol extract) and *Trichopus zeylanicus* leaf powder. It exhibits potent anti-cancer activity against Ehrlich Ascitic Carcinoma in mice. Further studies including clinical trials are being undertaken.

Herbal drug for stimulation of water and electrolyte absorption

Detailed studies on *Hemidesmus indicus* root (water extracts) showed that it is a potent stimulator of water, Na⁺ and K⁺ absorption from rat small intestine. This observation may be significant for the management of water and electrolyte loss from patients suffering from diarrhoea etc.



Elephantopus scaber- an anticancer plant under investigation



Helminthostachys zeylanica-tribal medicine used against liver disorders

Lipidperoxidant effects

In vitro tests revealed significant lipidperoxidant effects in *Spilanthus* sp, *Helminthostachys zeylanicus* and *Chonemorpha* sp.

Cytotoxic and antitumour effects

Elephantopus scaber was seen to possess cytotoxic and antitumour effects on cultured tumour cells and *in vivo* experiments.

Aphrodisiac property

Helminthostachys zeylanicus, an endangered fern of Western Ghats, showed significant aphrodisiac property.

Antiallergic property

Ixora coccinea flower (hexane extract) showed significant antiallergic property as revealed from inhibition of mast cell degranulation.

Hepatoprotective effect

The hepatoprotective effects of *Spilanthus* sp, *Helminthostachys zeylanicus* and *Rhinacanthus* species were confirmed.

Other programmes

Alcohol extract of *Vanda tessellate* flower showed remarkable aphrodisiac activity in male mice and stimulated its mating performance. This herbal drug was more potent than a commercial aphrodisiac drug (ABM capsule) in animal experiments. Preliminary toxicity evaluation in mice showed no toxic effects.

Remarkable antidiabetic property was observed in the alcohol extract of *Cassia kleinii* leaf. It was effective in both alloxan-induced and streptozotocin-induced diabetic rats. Interestingly, it was effective in both type I and II diabetes models. It did not exhibit hypoglycemic effect in fasted normal rats or any conspicuous general toxicity in mice. It was more potent than glibenclamide, a standard drug for type II diabetes.

Database on Ethnomedicine

Added 30 more ethnomedical information on 30 plant species, gathered from different tribal communities.



Drug Standardization

Successfully completed the work on Development of Pharmacopoeial Standards of 17 Medicinal Plants used in Indian System of Medicine and submitted the final report to the Department of Indian Systems of Medicine, Government of India.

Completed development of standards of 6 medicinal plants jointly with Phytochemistry Division under the ICMR project.

Pharmacognostical Studies

Completed Pharmacognostical Studies of *Trichopus zeylanicus* ssp. *travencoricus* Burkill ex Narayanan and *Janakia arayalpathra* Joseph & Chandrashekar, two medicinal plants used by the tribal healers of Kerala.

World Bank Consultancy Programme

The Pilot Participatory Programme on Conservation and Sustainable Utilization of Medicinal and Aromatic Plants consists of 9 major activities with the objectives of empowering the tribal people for self-reliance and improving the quality of their life. The program follows a holistic approach linking with local Biodiversity, Indigenous Knowledge, Ayurveda, Modern Science and Technology. It is a consultancy programme aided by World Bank under the Kerala Forestry Programme.

The programme, now successfully implementing in 8 Kani tribal settlements at Kottur, (Thiruvananthapuram district) and one Malapandaram tribal settlement at Achenkovil (Quilon district.), covering 187 households.

Activity no.1 (Contact and General Awareness Programme) was implemented. The feedback showed that 93% participants assessed the programme as excellent, while remaining as good.

The second activity ('Grama darshan' – scanning the tribal settlement) is being continued. During the year, the mapping of tribal settlements & adjoining forest area was carried out. The health and socio-economic survey was completed jointly with the Department of Community Medicine, Medical College, and Thiruvananthapuram. The tribal population of Achenkovil and Kottur was found to live in extreme distress; there was lack of education and food.



Low income and low quality of water, if at all available, made their lives miserable. A detailed report on this has been submitted. The work on documentation of indigenous knowledge and preparation of biodiversity register is in progress.

The implementation of third activity (conservation and cultivation of medicinal and aromatic plants) in the field is now in progress

Under the activity 4 (value addition and chemical prospecting) 2 value added products were formulated: herbal tea and cough syrup. Installation of two essential oil extraction units in the tribal area is also in progress and rest of the activities will be implemented in the field according to the time schedule.

PHYTOCHEMISTRY

Phytochemical Investigation of Medicinal and Aromatic plants

Phytochemical analyses of 5 medicinal and aromatic plants (*Garcinia imberti* (Clusiaceae), *Vitex peduncularis* (Verbenaceae), *Acrotrema arnottianum* (Dilleniaceae), *Lagenandra ovata* (Araceae) and *Heracleum candolleianum* (Apiaceae) were carried out for their secondary metabolites and several pure compounds of the class steroids, terpenoids, flavonoids etc were isolated and characterized and some of the compounds show promising pharmacological activity/anti microbial property.

Extraction and Analysis of Essential oil

Essential oil from the rhizomes of *Ammomum canicarpum* (Zingiberaceae) was extracted and analyzed by Gas Chromatography. Antimicrobial study of the oil reveals promising activity against some strains of bacteria and fungi.

Sixteen compounds were identified from the essential oil of the roots of the plant *Heracleum candolleianum* by gas chromatography-mass spectrometry. The plant endemic to Western Ghats is used by the tribals against arthritic pain and swellings. Anti inflammatory study carried out by carrageenan induced rat paw oedema method confirmed the anti-inflammatory property of the oil.



Interaction with tribals in People's Participatory Programme



Essential oil from the rhizomes of 45 species of Zingiberaceae was extracted and analysed by gas chromatography, thin layer chromatography etc. and the data were used for the chemotaxonomic studies of the family. The work led to a Ph.D degree in Botany by the University of Kerala in 2001.

Essential oil from 14 accessions of endemic *Curcuma* species were extracted and analyzed by Gas Chromatograph. Quantitative estimation and distribution of major components were studied along with curcumin estimation with a view to assess the economic potential of the species.

Installation of large scale essential oil extraction plants in the tribal areas of Kottur and Achencoil are under trail.

Standardization of Medicinal Plants

Six plants (*Elettaria cardamomum*, *Cinnamomum zeylanicum*, *Myristica fragrans*, *Murraya koenigii*, *Alstonia scholaris* and *Musa paradisiaca*) were standardised with respect to various parameters as ash value, soluble extractives, TLC, GC and HPLC profile, estimation of major active compounds etc. and monographs of the plants were prepared and submitted to the Indian Council of Medical Research (ICMR), Govt. of India, which is now in the process of publication.

Pharmacopoeial standards of 17 medicinal plants containing pharmacognostic, chemical and ayurvedic parameters were developed and submitted to the Department of Indian Systems of Medicine, Ministry of Health and Family Welfare, Govt. of India. This will form part of the Ayurvedic Pharmacopoeia of India to be published by the Ministry of Health and Family Welfare, Govt. of India.

Study on Polyprenol distribution in Euphorbiaceae and Arecaceae

Polyprenols are rubber like substances distributed in the plant kingdom which may serve as a source of hydrocarbons or other industrially useful products. Nineteen plant species of the family Euphorbiaceae and 34 species of Arecaceae were studied for their total content of polyprenols and also to determine the dominating prenologues.

Pharmacopoeial standards for 17 raw drugs were developed



CONSERVATION BIOLOGY

Flora of Eravikulam National Park

The work resulted in the collection of 1002 species of angiosperms and 120 species of pteridophytes. Analysis and categorization of flora under different threat categories are being done for evolving future conservation strategies. Seven new species and eleven rediscoveries have been obtained.

Database on Western Ghats Angiosperms

A database on Kerala plants has been completed and gathered information is being consolidated. This covers more than 4000 species and there are upto 35 entries per species, including data on correct nomenclature, synonymy, habit, geographical distribution and uses.

Plant - Animal Interaction

Study is in progress on interaction between *Cullenia exarillata*, an ecologically important species and vertebrate community in the tropical forests of Silent Valley. Phenology of *Cullenia*, feeding habits of vertebrates and several aspects involved in pollination have been worked out.

Population Biology of *Janakia aryalpathra*

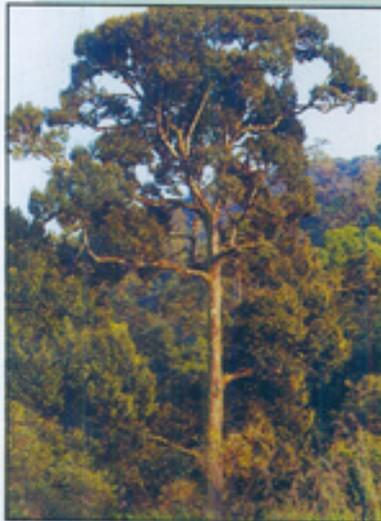
Population biology study is almost completed. This included growth dynamics, distributions, pollination and pollinators, cytology, dispersal mechanism, genetic variations, edaphic conditions and ecology of associated species. Study on population structure is in progress.

Amphibian Fauna of Kerala and their Ecology

Thirty different ecological habitats in Kerala forests were analyzed for Amphibian fauna. Taxonomic identification of 230 species including four new genera and 120 new species was completed. The study on relationship and types of associates of amphibian fauna with plant community is in progress.

Pollen Analysis of Faecal Matter

To understand the yearround food species and food habits, of six species of animals with reference to their habitats and ambient vegetation, their faecal matter was collected from the forests in Thiruvananthapuram, (bats), Eravikulam National Park (Nilgiri tahr) and Silent Valley (lion tailed macaque, Nilgiri langur, palm civet and Malabar giant squirrel). Their analysis is in progress.



Cullenia exarillata - a major food species of primates in the Western Ghats.



Janakia aryalpathra- a rare endemic, lacking natural history informations



Pollen Analysis of Body Parts of Malabar Giant Squirrel

This is being carried out to understand the role of Malabar Giant Squirrel in pollination of different forest species, with special reference to the Silent Valley Forest.

Aerobiology of Kerala

Aerobiological sampling was conducted for three years from 1997-1999 in different parts of Kerala using Burkard, Rotorod and Anderson sampler. Results are being consolidated. It will provide a spectrum of air-borne pollen and spores of Kerala.

Palynology

As part of the study on pollen and spore flora of the Western Ghats, polliniferous materials of 80 species were collected. Pollen studies of 25 species and spores studies of 60 species of pteridophytes were made and Light microscopic work of 50 species was completed.

PLANT SYSTEMATICS AND EVOLUTIONARY SCIENCES

Floristic studies

The division periodically conducts exploration trips to different ecological settings of the state, to study the floristic diversity and ecology of different eco-regions. During these surveys, special emphasis was laid on searching and relocating rare and endangered species in the Western Ghats of Kerala State. During the period under report, a total of 33 field trips were conducted to different forest types, resulting in a collection of 1359 specimens for herbarium and documentation. Further data gathered during these studies were utilized to compile the flora of the respective areas and also to contribute to the Red Data Book. A total of 900 specimens were critically studied, their identity determined and incorporated to the existing collection in the herbarium.

Ethnobotanical studies of North Kerala

The study was undertaken to tap the indigenous knowledge of plants, animals and other abiotic resources accumulated over a period of time, which otherwise remained aloof. During the period, a detailed enumeration of the



New to Science

(Flowering Plants)

Grewia palodensis
Ischaemum abrahamii
Ischaemum fischeri
Ischaemum wayanadense

Biophytum reinwardtii var.
keralanum
Strobilanthes barbatus var.
bonaccordensis

plants used by the tribal communities of Northern Kerala was carried out. The study revealed 253 plants used as single drugs belonging to 214 genera in 94 families. Some of the notable species used in single drug formulation are *Didymocarpus tomentosa*, *Pterocarpus marsupium*, *Pterospermum rubiginosum*, *Toddalia asiatica*, *Uleria salicifolia* and *Ventilago bombaiensis*. In addition, 114 edible plants belonging to 101 genera and 59 families were also recorded. The edible plants are classified based on their useful parts which resulted in identification of root / tubers of 10 species, stem of 20, leaves of 43, flowers of 5, fruits of 49 and seeds of 15 species respectively. Important among them are *Ardisia solanacea*, *Bidens bipinnatus*, *Caesalpinia mimosoides*, *Crotalaria laevigata*, *Cynanchum alatum*, *Solena amplexicaulis* and *Tetrastigma leucostaphylum*. Detailed enumeration work of 72 compound drugs, 43 artefacts, 15 fish stupefication and 6 fiber yielding species are in progress.

Systematic study on Balsam

The systematic study on balsam resources of the state under the project "Survey, inventory and collection of horticulturally promising wild balsam of Western Ghats of Kerala State" has been successfully completed. The collections were mainly obtained from Sabarigiri, Munnar, Anaimudi, Nilgiri- Wyanad plateau and Aralam Sanctuary area. During the reporting period, 6 exploration trips each of one week duration, were conducted to various evergreen and shola forests of Western Ghats which led to the collection of 65 wild species of Balsam, and their systematic entities have since been established. Promising 5 wild species and 10 hybrids were selected for multiplication and more than 2000 saplings were raised for restoration and popularization programs.

Reproductive biology

The reproductive biology studies of certain *Impatiens* of the Western Ghats were carried out to find out intrinsic causes affecting seed set. The study included *in vitro* and *in vivo* pollen germination of five species namely *Impatiens balsamina*, *I. diversifolia*, *I. gardneriana*, *I. verticillata* and *I. campanulata*. The stigma remained receptive after flower opening in all cases. The study revealed that *I. balsamina* showed a maximum receptivity of 90% upto 15 hrs. and pollen had a germination of 67%. *I. diversifolia* and *I. gardneriana* have extended receptivity of 80% and 70% upto 18 hrs and pollen



germination recorded up to 56% and 51% respectively. In case of *I. verticillata*, only 60% of stigma receptivity with 36% pollen germination was observed in spite of its receptivity being extended upto 15 hrs. Maximum extended period of upto 21 hrs with 50% receptivity was observed in *I. campanulata*, but strikingly, the pollen germination was as low as 27%. In *I. balsamina*, *I. diversifolia* and *I. gardneriana* pollen tubes reached the ovary and successfully fertilised the ovules. The fertilised ovules developed into seeds with more than 90% viability. But in *I. verticillata* and *I. campanulata*, pollen tubes developed swollen tips and did not penetrate the stigmatic region, hence the seed set is totally absent.

Ecological studies of RET species

The study is a continuation of the previous year's work, with the objective of establishing the causes of rarity in their respective ecosystems of 5 rare and endemic species viz. *Gluta travancorica*, *Ochreinauclea missionis*, *Goniothalamus rhyncantherus*, *G. wightii* and *Popowia beddomeana*. The study has been designed in 5 tasks, such as population structure, vegetative and reproductive dynamics, conservation strategies and restoration programmes. In the case of *Gluta travancorica* and *Ochreinauclea missionis*, population structure, dynamics, conservation and restoration programmes have been completed. In others, observation on the structure and functional aspects are being continued. Simultaneously, vegetative propagation methods are also employed to standardize the vegetative multiplication, in order to raise clonal population for reintroduction programme.

Rescue and Restoration of RET medicinal plants

The project on rescue and restoration of medicinal plants was launched with financial assistance from FRLHT, aimed at restoring the populations of RET medicinal plants, which are under the risk of overexploitation. The study centered around the population structure, dynamics, environmental effects, extinction risks, growth performances, conservation strategies etc. Presently 15 endemic and RET plants, growing in the Agasthymala, Kulamavu and Wayanad MPCAs in Kerala were taken up. The candidate species are *Coscinium fenestratum*, *Canarium strictum*, *Dysoxylum malabaricum*, *Embelia ribes*, *Garcinia morella*, *Knema attenuata*, *Myristica dactyloides*, *M. malabarica*,



Impatiens fruticosa - an endemic balsam of the Nilgiris



The 'Wild nutmeg'- *Myristica malabarica* endemic to the Western Ghats.



Ochreinauclea missionis, *Persea macrantha*, *Piper barberi*, *P.mullesua*, *P. longum*, *Trichopus zeylanicus* ssp. *travancoricus* and *Vateria indica*. Permanent plots were established in all the 3 MPCAs to monitor the dynamics at monthly intervals for 3 years from 2000-2003. Simultaneously, air layering, grafting, treating stem cuttings with hormones, seed storage studies etc. were taken up as part of conservation strategies. As part of the multilocation trials, 3000 seedlings of these species have been raised and supplied to six MPCAs for assessing their growth performances.

Biosphere Reserve Programmes

As lead/coordinating centre for Niligiri and Gulf of Mannar Biosphere Reserves, the division is engaged in the development of a comprehensive database on both these Biosphere Reserves. During the reporting period, the division brought out a comprehensive status report on these two Biosphere Reserves, in accordance with the UNESCO's nomination form, based on which Niligiri and Gulf of Mannar Biosphere Reserves were recognised by the UNESCO and since has been posted in the MAB-net. The division is in close interaction with the different R&D institutions associated with research in these Biosphere Reserves.

Environmental Impact Assessment Studies

The division was engaged in conducting environmental impact assessment for hydel projects of KSEB, from time to time. During the report period, the division has carried out the EIA for Perumthenaruvi Small Hydel Scheme and the Puyamkutty Hydro - Electric Project. The project reports of Perumthenaruvi had already been submitted. The EIA of revised Puyamkutty scheme, with respect to different submergible level options is under preparation. During the course, the floristic elements and their distribution patterns in the project and catchment zone has been analysed through regular field explorations for over a period covering pre and post monsoon seasons.

Quantitative Assessment and Mapping of Non Wood Forest Products (NWFPs) in Southern Kerala

To assess the quantum of availability of NWFPs in Southern Kerala, a study has been initiated, with the financial assistance from the Kerala State Forest Department. The study include habitat analysis, distribution pattern, and cur-



rent methods of harvesting and regeneration status of various species of this category. They are being assessed to establish the ecological sustainability of NWFPs in the long run. The study in the ensuing period includes assessment, mapping and quantification of NWFP's of 3 forest ranges and 2 wildlife sanctuaries under Trivandrum forest division. 12 field trips of one week duration were made, covering all habitats and vegetation types. During this survey and exploration, 285 species were collected from Palode, 344 species from Paruthypalli, 210 from Kulathupuzha, 233 species from Peppara and 144 species from Neyyar wildlife sanctuary. The programme resulted in the development and standardization of a unique methodology for quantification of NWFPs.

Herbarium management

Apart from the updating nomenclature, based on recent publications and principles of ICBN, 5049 specimens were processed in addition to establishing the identity and incorporation of 900 specimens in the herbarium stock. Also prophylactic activities, aimed at warding off pests are also regularly being carried out, as part of herbarium management. An account of herbarium activity during the period is summarised below.

Number of specimens processed	5049
1) Mounted for filling	328
2) Unmounted for reference	1026
Number of specimens incorporated	900
Number of nomenclature corrections carried out	2334
Indexing of General Herbarium specimens	2334
Number of sheets renovated	1782
Maintenance and fumigation	17300
Maintenance of reference specimen	28000
Number of enquiries attended	766
Number of tour programme conducted	
33 Number of classes/training conducted	14

LIBRARY AND INFORMATION SERVICES

During the year, the library acquired 69 books and 106 books were received on gratis. The total holding now consists of 7225 books. The library also subscribes 100 journals. The library continued to provide specialized services

Herbarium holds
7300 specimens
belonging to 1198
genera and 2967
species in 186
families, including
61 type speci-
mens



Sir G.T. Prance addressing TBGRI staff

Indexing services, Reference services, News Paper Clipping services and Photocopying services.

Reference facilities were provided to students and researchers from universities and other research institutions. There were 175 external users during the period.

PEOPLE AND TBGRI

Visitors

1. Sri Palat Mohandas IAS, Agriculture Production Commissioner, Govt. of Kerala, 19th November 2001
2. Prof. (Dr.) G.T. Prance, FRS, Former Director of Royal Botanic Garden, 13th January 2002
3. Trainees of Kerala Forest School, Arippa
4. Students of CSI, Paraniyam
5. Students of Mitraniyettan People College, Vellanadu
6. Students of Sri Vidhyadhiraja College of Pharmacy
7. Students of Government Middle School, Erumbakkadu
8. Students of NSS College, Nilamel
9. Members of Shalom Marthoma Church, Anchal
10. Students of All Saints English Medium School, Vithura
11. Students of S.T. College, Tirunelveli
12. Students of Govt. H.S., Chithara
13. Students of National Training College, Pravachambalam
14. Students of The American College, Madurai
15. Students of S.B. College, Changanassery
16. Members of Sree Narayana Samskarika Samithi, Varkala.
17. Students of School of Architecture, Indore, M.P.
18. Students of S.T. College, Tuticorin
19. Students of Dept. of Botany, University of Kerala
20. Students of HSST, Govt. HSS, Mithrumala
21. Students of Manarul Huda English Medium Residential School, Nedumangadu
22. Students of Sarvodaya Vidhyalaya, Nalanchira
23. Students of G.V. H.S.S., Vellanadu
24. Staff of Nirmithi Kendra, Thiruvananthapuram
25. Students of S.N. Public School, Chenkottukonam
26. Students of B.S.M.S., Tirunelveli
27. Students of Govt. VHS for Girls
28. Students of Govt. College for Women, Trivandrum



Sir Prance in the Garden



29. Students of NSS College, Pandalam
30. Students of St. Thomas School, Anchal
31. Participants of Academic Staff College, Kariavattom
32. Students of Gujarat Ayurveda College, Gujarat
33. Students of SRV GBS, Kottarakara
34. Students of VK Kani Govt. H.S., Pangode
35. Students of St. Thomas College, Palai
36. Students of Birla College, Kalyan
37. Students of Govt. College, Madappally
38. Members of Kerala Sasthra Sahithya Parishad
39. Students of UPS, Pezhummoodu, Thiruvananthapuram
40. Students of Kunenpu University, Karnataka
41. Students of D.B. College, Pamba
42. Students of BPM English School, Mangalapuram, Thiruvananthapuram
43. Students of Govt. VHSC, Vattiyookavu, Thiruvananthapuram
44. Students of Nalanda College, Chadayamangalam
45. Students of Medical College, Trivandrum
46. Students of Alvas Ayurveda Hospital, Moodibidri
47. Students of University College, Trivandrum
48. Students of S.N. College, Punalur
49. Students of Govt. College, Nedumangadu
50. Students of Ayurvedic Medical Association of India
51. Students of Govt. HS for Girls, Kanjiramkulam, Thiruvananthapuram
52. Members of Residents Associations, Kunnukuzhi, Thiruvananthapuram
53. Students of SMV, Govt. Model HSS, Trivandrum
54. Students of S.N. College, Varkala
55. Students of Govt. UPS, Kudappanakkunnu
56. Students of Kamaraj College, Tuticorin
57. Staff of SBT, Puthenchantha, Trivandrum
58. Students of GHSS, Kuzhimathikkadu
59. Students of Bishop Abraham Memorial College, Tuticorin
60. Students of KNM Govt. College, Kanjiramkulam, Thiruvananthapuram
61. Students of Sri Krishnadevaraya University, Karnataka
62. Students of LPS, Thiruvalla
63. Students of Sri Sethu Parvathy Bhai HS, Kadakkavoor
64. Members of Mitranikethan Krishi Vigyan Kendra, Vellanadu

Over 5000
students and
scholars utilized
our services



65. Students of Arulmiju Kumara Gurupada Swamikal Arts College
66. Students of Sri Sai Ram Siddha Medical College and Reseach Centre
67. Students of Sri Parama Kalyani Centre for Environmental Sciences, Tirunelveli
68. Students of Manonmaniam Sundernar University, Tamil Nadu
69. Students of Fathima Matha National College, Kollam
70. Students of Sri Nath College, Bangalore
71. Students of Sainik School, Kazhakkootam, Thiruvananthapuram
72. Students of Sri Jayendra Saraswathy Ayurveda College, Nazarethpet
73. Students of Carmel Polytechnic, Punnapra, Alapuzha
74. Members of CARD, Krishi Vigyan Kendra, Pathanamthitta

In addition, 500 family groups visited TBGRI. Also, 75 visitors from USA, UK, Germany, France, the Netherlands, Belgium, Finland, Sweden, Switzerland, Thailand and Sri Lanka visited the Institute.

EXTENSION ACTIVITIES

1. Dr. G.M. Nair, Director delivered a lecture at the INSA meeting at Munnar in December 2001
2. Dr. G.M. Nair chaired session on Biotechnology and presented the recommendations at the seminar 'Keralam Nale' organized by Malayala Manorama at Cochin in January 2002
3. Dr. G.M. Nair gave extension lectures in meeting of several NGO's and Academic Staff Colleges of University of Kerala and Cochin
4. Participated in exhibition conducted in connection with the Kerala Science Congress 2002, Kochi.
5. Organized exhibition in connection with implementation of World Bank Consultancy Programme at Kottur, Thiruvananthapuram.
6. Participated in local agricultural festivals conducted at Vithura and Palode.
7. Organized an exhibition on products developed by TBGRI in connection with the exhibition organized by STEC at Thiruvananthapuram in May 2001.
8. Organized a seminar, exhibition and Oushadha Sasya



- Samrakshana Jadha at Achancovil, in connection with the implementation of pilot participatory programme on conservation and sustainable utilization of medicinal and aromatic plants under the World Bank Consultancy Programme.
9. Organized a seminar and exhibition and Oushadha Sasya Samrakshana Jadha at Kottur, in connection with the implementation of pilot participatory programme on conservation and sustainable utilization of medicinal and aromatic plants under the World Bank Consultancy Programme.
 10. Mr. K. Radhakrishnan and Mr. E.S. Santhosh Kumar were deputed for identification of plants growing in Government Secretariat Campus during December 2001, as part of awareness programme organized by 'GREENS' an NGO of Secretariat employees.
 11. Mr. Jose P.A conducted a class on propagation of Red listed medicinal plants for forest guards and watchers of MPCAs of Kerala at Kalpetta on 8th August 2001.
 12. Mr. Jose P.A. attended the second meeting of the Management, Planning and Supporting team of Shenduruney Wild Life Sanctuary at Thenmala.
 13. Organized a seminar on cultivation and trade prospects of medicinal and aromatic plants in collaboration with the directorate of Arecanut and Spices, Government of India at TBGRI.
 14. Organized an exhibition from TBGRI in connection with the international seminar on Ayurveda, held at Gujarat Ayurveda University, Jamnagar.
 15. Training was given to 4 batches of 10 individuals on Mushroom Cultivation, Spawn Production, Post Harvest Care, Value Added Products etc.
 16. A short-term training course was conducted at TBGRI to the members of the Peerumedu Development Society on value added products from mushrooms.
 17. A one-day workshop and exhibition was organized on "Problems and Prospects of Mushroom Cultivation in Kerala State" for the mushroom growers and dealers on 28th. February 2002 at YMCA hall Thiruvananthapuram. More than 150 participants attended the programme.
 18. Training imparted to MSc (Biotechnology) Student from the Dept. of Biotechnology, University of Kerala,



About 3000
public enjoyed
the Garden

Kariavattom for the preparation of his M.Sc Dissertation titled 'Optimisation of cultural conditions for anti-microbial antibiotic accumulation by an *Actinoplanes* sp. TBGA125'.

19. Trained one BSc (Biotechnology) student from S.D. College, Alapuzha.
20. Three day training programme as " Computer as an aid for making scientific quality publications to 10 Scientist of TBGRI was conducted from 17-10-2001 to 19-10-2001. The training included topics on "Microsoft word- 2000, Excel -2000, Power point -2000 and Internet and its applications".
21. Provided one day training on the topic "Introduction to Bioinformatics, internet and biotechnology related search tools" to five P.G. students in Biotechnology, KSR College of Arts and Science, Tiruchengode, Tamil Nadu on 2-07-2001.
22. As part of extension activities, the Biotechnology division has imparted training programmes on tissue culture of ornamental and medicinal plants for interested entrepreneurs and advanced training in Biotechnology, Molecular biology and Bioinformatics for post-graduate students from different states of India. During the report period the division gave training to a total of 18 students from different colleges and university departments all over India

EXTERNALLY FUNDED PROJECTS

1. Taxonomic data organization of wild species of *Piper* and *Curcuma* in India and DNA finger printing studies of selected endemic species. Department of Biotechnology. Outlay: Rs. 20.68 lakhs.
2. Exploration, survey, germplasm collection and evaluation of ornamental Balsams with special reference to Shola forests. Kerala Forest Department. Outlay: Rs- 7.10 lakhs.
3. Rescue and restoration of RET medicinal plants at Agastyamala, Kulamavu and Wayanadu Medicinal Park Conservation Areas, Kerala, India. Foundation for Revitalization of Local Health Traditions, Bangalore. Outlay: Rs- 15.45 lakhs.
4. Environment impact assessment of Pooyamkutty Hydel Project. Kerala State Electricity Board, Government of



- Kerala. Outlay: Rs- 9.75 lakhs.
5. Quantitative assessment of Non Woods Forest Products. Kerala Forest Department. Outlay: Rs. 22.19 lakhs.
 6. Development of standards of medicinal plants and preparation of monographs thereof. ICMR. Outlay: Rs- 16 lakhs.
 7. Pilot participatory programme of conservation and sustainable utilization of medicinal and aromatic plants. Kerala Forest Department. 2001-2002. Outlay: Rs- 22 lakhs.
 8. Chemical prospecting and DNA finger printing of *Andrographis paniculata*. Department of Biotechnology. 1998-2002. Outlay: Rs- 13.07 lakhs (jointly with Rajiv Gandhi Centre for Biotechnology).
 9. Conservation through micropropagation and re-introduction of rare and highly sought after tree species used in Ayurveda. Department of Biotechnology. Outlay: Rs- 11.9 lakhs.
 10. Conservation of selected rare and economic rattan palms of W. Ghats through *in-vitro* multiplication and reintroduction. Ministry of Environment and Forests. Outlay: Rs- 6.54 lakhs.
 11. Regeneration of plants of *Agrobacterium rhizogenes* induced hairy roots and comparative field performance of conventional tissue culture and hairy root derived plants of *Plumbago rosea* L. State Committee on Science Technology and Environment. Outlay: Rs- 3.89 lakhs.
 12. Development of pharmacopeal standards in Indian Systems of Medicines drugs. Ministry of Health and Family Welfare, Government India. Outlay: Rs-14.75 lakhs.
 13. Antiviral and antifungal studies on some indigenous plants of Western Ghats. Ministry of Health and Family Welfare, Government of India. Outlay: Rs- 5 lakhs.
 14. Sustainable utilization of under exploited medicinal plants of Western Ghats, with particular reference to those used against liver ailments. State Planning Board, Kerala, Department of Planning and Economic Affairs, Government of Kerala. Outlay: Rs- 25 lakhs.
 15. Anticancer studies on selected medicinal plants of Western Ghats. Kerala Forest Department. Outlay: Rs-6.05 lakhs.

R & D divisions
executed 31
externally
funded projects



16. Hepatoprotective studies on selected medicinal plants of Western Ghats. State Committee on Science Technology and Environment. Outlay: Rs-3.6 lakhs.
17. Pilot participatory programme of conservation and sustainable utilization of medicinal and aromatic plants. Kerala Forest Department. Outlay: Rs- 22.08 lakhs.
18. Pharmacological screening of selected traditional medicinal plants of Western Ghats of Kerala and molecular characterization of promising species. Kerala Forest Department, Outlay: Rs 10.05 lakhs.
19. Bambusetum maintenance, production of bamboo saplings and studies on bamboo hybrids. Western Ghats Development Programme, Planning and Economic Affairs Department, Government of Kerala. Outlay: Rs - 10 lakhs.
20. Studies on the ecology, conservation biology and restoration of four important medicinal shrubs of Western Ghats, State Committee on Science Technology and Environment. Government of Kerala. Outlay: Rs- 3.87 lakhs.
21. Exploration, characterization, documentation and ex-situ conservation of wild crop relative and forage legumes of Western Ghats. National Bureau of Plant Genetic Resources, New Delhi. Outlay: Rs- 3.99 lakhs.
22. Eco-taxonomic studies of the Grassland vegetation of Kerala- A step in biodiversity conservation, CSIR, New Delhi. Outlay: Rs- 3.62 lakhs.
23. Survey, evaluation and documentation of mushroom germplasm of the Western Ghats of Kerala. Kerala Forest Department. Outlay: Rs- 3.85 lakhs.
24. An integrated approach for the sustainable development of mushroom industry with active participation of the tribals and the weaker sections in selected localities of Kerala. Department of Biotechnology. Outlay: Rs- 9.09 lakhs.
25. Studies on the anti-fungal and anti-viral activities of certain medicinal plants of Western Ghats. State Committee on Science Technology and Environment. Government of Kerala. Outlay: Rs- 2.14 lakhs.
26. Studies on the microbial biomass and its role in nutrient addition and litter decomposition in the hill Shola forests of Munnar and Wayanad Forest divisions, Kerala Forest Department. Outlay: Rs- 5.73 lakhs.
27. Black mildew diseases on Wattle (*Acacia* species) in Kerala



- State. Kerala Forest Department . Outlay: Rs- 3.91 lakhs.
28. The Floricultural potential of the native orchids of Western Ghats and their sustainable utilization. Western Ghats Development Programme. Planning Commission. Outlay: Rs- 70lakhs.
 29. Reproductive biology of three endangered orchids of southern Western Ghats. Department of Science and Technology. Government of India.
 30. National Gene Bank for Medicinal and Aromatic Plants, Department of Biotechnology, Govt. of India.
 31. Bioprospecting of Biological Wealth using Biotechnological tools. Department of Biotechnology, Govt. of India. Outlay Rs. 24.19 lakhs.

MEMBERSHIPS

1. Dr. G.M. Nair was nominated in following committees
 - a) Expert member, committee for setting up Biotech Park in Kerala (KINFRA)
 - b) Member, committee for Biosphere Reserve, Government of Kerala
 - c) BOS in Agriculture, VHS Government of Kerala
 - d) Member, Medicinal Plant Board, Government of Kerala
2. Dr. A. Subramonyam, Member, Governing Body, Amala Cancer Institute, Thrissur.
3. Dr. S. Rajasekharan, Member, Subject Expert Committee for Forest Biodiversity and Health in Decentralized Planning, Kerala Planning Board.
4. Dr. C. Sathish Kumar, Co-ordinator, All India Co-ordinated Research Project on the Taxonomy of the Indian Orchids, State Committee on Science, Technology and Environment. Government of India.
5. Dr. A.G. Pandurangan, Member Task Force to advise Chief Conservator of Forests (Wildlife) on the Establishment of Agasthyavanam Biological Park.
6. Dr. A.G. Pandurangan, Member, Expert Group in assistance to Botanical Garden/Centre of Ex-situ Conservation by the Ministry of Environment and Forests. Govt. of India.
7. Dr. A.G. Pandurangan, Member Committee to conduct Environment Impact Assessment of Mullaperiyar Dam, Govt. of Kerala.
8. Dr. N. Mohanan, Member, Management Plan Review



Team, Kerala Forest Department for preparing Management Plans for Neyyar, Peppara and Shenduruny Wildlife Sanctuaries.

9. Dr. A.G. Pandurangan, Dr. N. Mohanan, Dr. C. Sathish Kumar, Dr. P.J Mathew and Dr. Bejoy Mathew, Judges, Thiruvananthapuram Flower Show, January 2002.

RECOGNITIONS AND AWARDS

1. Dr. P.G. Latha short-listed for National Women Bioscientist Award, 2001.
2. K. Radhakrishnan received the award of appreciation and gold medal in the World Congress of Holistic Health and Spiritual Sciences held from 18-20 January 2002 at Mumbai.
3. Dr. C.G. Sudha, Biotechnology National Associateship, Department of Biotechnology, Govt. of India.
4. Dr. S.D. Biju completed a three months training and research programme on Amphibian taxonomy in the Laboratoire des Reptiles et Amphibiens, Museum National d' Histoire Naturelle, Paris. He also visited the British Museum of Natural History, London, Brussel's Museum, Belgium and Vienna Museum, Austria for the study of Amphibians of Western Ghats.

Ph.D. Awarded

1. Mathew Dan: 'Chemo-systematic and phylogenetic studies on South Indian Zingiberaceae with special focus on essential oils, Ph.D., University of Kerala.
2. Susan Chacko: 'Phytochemical investigation of some rare tropical medicinal plants species'. Ph.D., Gandhigram Rural Institute, Madurai.
3. Lakshmi G. Nair: 'Conservation through micropropagation and restoration of selected woody medicinal plants', Ph.D., University of Kerala.
4. Justin Pakia Jacob: 'Genetic improvement of a few edible mushrooms of Kerala', Ph.D., University of Kerala.

Recognition for TBGRI

Gujarat Ayurveda University has recognized TBGRI as a centre for doing Ph.D. research.



LINKAGES WITH OTHER INSTITUTIONS

1. Kerala State Planning Board in Decentralized Planning.
2. Kerala State Electricity Board in Environmental Impact Assessment.
3. Collaborative Research Programme with Sri Chithra Tirunal Institute of Medical Sciences, Regional Cancer Centre, Rajiv Gandhi Centre for Biotechnology, National Chemical Laboratory, Pune and Arya Vaidya Pharmacy, Coimbatore.

PATENTS

Patents filed

A process to prepare a herbal preparation for cancer from *Janakia arayalpathra* and *Trichopus zeylanicus* leaf. Inventors : A. Subramoniam, S. Rajasekharan, P. Pushpangadan, V. George and G. Sreekandan Nair. (File No: MAS/659/2001)

PUBLICATIONS

Books/Handouts/Book Chapters

Biju SD 2001. A Synopsis for the Frog Fauna of the Western Ghats, India. Occasional Publication 1. pp 1-24. *Indian Society for Conservation Biology*, Palode.

Latha PG, Acham Abraham, Suja SR and Rajasekharan S 2002. Current trends and future prospects in plant derived antimycotics. In: 'Plant Derived Antimycotics' MK Rai and Donatella Mares (Eds.), Haworth Press Inc, NY, USA .

Pradeep NS, Vrinda KB and Abraham TK 2002. "Koon" (in Malayalam). TBGRI Publication.

Rajasekharan S, George V, Shanavaskhan AE, Mathew Dan, Sabarish K, Navas M Anilkumar ES and Shiju PN 2001. Cultivation and trade prospects of medicinal and aromatic plants (Malayalam). The World Bank Consultancy Programme under the Kerala Forestry Programme, 67 Pages.

Rajasekharan S, George V, Shanavaskhan AE, Vinod Kumar TG, Sabarish K, Mathew Dan and Navas M 2001. Conservation and sustainable use of medicinal and aromatic plants with people's participation (Malayalam). Published for the World Bank Consultancy Programme under the Kerala For-



Publications

International Journals	: 14
National Journals	: 42
Books/ Booklets	: 10

estry Programme, 76 Pages.

Sanjappa M, Sathish Kumar C and Biju SD 2002. Indian brushes with orchids- Orchid Icones of Central National Herbarium, Botanical Survey of India, 4 Pages.

Sathish Kumar C 2001. Orchids of Sikkim- A historical perspective. pp 101-143. In: Orchids: Science and Commerce, Pathak P, Sehgal RN, Shekhar N, Sharma M. and Sood A. (Eds.). Bishen Singh Mahendra Pal Singh, Dehra Dun.

Seeni S, Gangaprasad A, and William Decruse S 2001. Species seedling flasks: An urgent need for *ex situ* conservation and sustainable economic utilization of the Western Ghats Orchids. pp 383-396 .In: Orchids: Science and Commerce, Pathak P, Sehgal RN, Shekhar N, Sharma M. and Sood A. (Eds.). Bishen Singh Mahendra Pal Singh, Dehra Dun,.

Sreekumar S, Biju C K and Krishnan P.N. 2001. Training guide 'Microsoft Word 2000 and Power Point 2000.'TBGRI .

Subramoniam A and Gayathri S 2002. Development of standardized aphrodisiac herbal drugs. pp 185-195. In: Role of Biotechnology in Medicinal and Aromatic Plants. Vol. VI (Special volume on diseases) Khan IA and. Khanum A (Eds). Ukaaz publications, Hyderabad.

Research Papers Published in Journals

Braun U, Hosagoudar VB and Abraham TK 2001. *Diplococcium atrovelutinum*. from India. *Journal of Economic and Taxonomic Botany* 25: 284-286.

Dubois A, Ohler A and Biju SD 2001. A new genus and species of *Ranidae* (Amphibia, Anura) from south Western Ghats, India. *Alytes* 19: 53-79.

Evans DA, Subramoniam A, Rajasekharan S and Pushpangadan P 2002. Effect of *Trichopus zeylanicus* extract on energy metabolism of mice at rest and during exercise. *Indian Journal of Pharmacology* 34: 32-37.

George V, Muthukrishnan M and Chojnacki T 2001. The occurrence of polyprenols in Euphorbiaceae. *Acta Societatis Botanicorum Poloniae* 70: 39-41.

George V, Susan C and Sethuraman MG 2001. Chemical composition of the essential oil from the rhizomes of *Heracleum*



candolleum. *Essential Oil Research* 13: 80-81.

Hosagoudar VB 2002. Key to the species of the Genus *Meliolina*. *Zoos' Print Journal* 17: 786-787.

Hosagoudar VB, Abraham TK, Biju CK and Hyde KD 2001. Fungi from palms XLVII. A new species of *Asterina* on palms from India. *Fungal Diversity* 6: 69-73.

Hosagoudar VB, Abraham TK and Biju CK 2001. Re-evaluation of the family Asterinaceae. *Journal of Mycopathological Research* 39: 61-63.

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Hosagoudar VB, Biju CK and Abraham TK, 2001. Meliolaceae of Kerala, India-X. *Journal of Economic and Taxonomic Botany* 25: 68-71.

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Hosagoudar VB, Biju CK and Abraham TK 2001. *Sarcinella vernoniae* (Dearn. & Barth.) Hughes and its hyperparasites from Kerala. *Journal of Economic and Taxonomic Botany* 25: 281-283.

Hosagoudar VB, Biju CK and Abraham TK 2001. Diversity in the Follicolous micromycobionts in Peppara and Neyyar wild life sanctuaries, Thiruvananthapuram, Kerala, India. *Journal of Economic and Taxonomic Botany* 25: 297-307.

Hosagoudar VB, Biju CK and Rajkumar G 2001. A new species of *Meliola* (Ascomycetes Miliolales) from Kerala, India. *Zoos' Print Journal* 16: 595-596.

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One family , one
genus, 21 spe-
cies and 6 variet-
ies were de-
scribed as new
to science.



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Koshy KC, Harikumar D and Narendran TC 2001. Insect visits to some bamboos of the Western Ghats, India. *Current Science*.81: 833-838.

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