

ANNUAL REPORT 1988-'89



TROPICAL BOTANIC GARDEN AND RESEARCH INSTITUTE
TRIVANDRUM



The Chief Minister, Shri E. K. Nayanar, with our young scientists during his visit to the Garden

ANNUAL REPORT

1988 - '89

**TROPICAL BOTANIC GARDEN AND RESEARCH INSTITUTE
(T B G R I)**

PALODE, TRIVANDRUM - 695 562

KERALA, INDIA

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Grams : TROPGARDEN

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THE EXCITING YEARS

The report marks the end of five years' of hectic activities at Palode and it is perhaps appropriate to pause a moment to look back at some of the important milestones in the progress of the Institute.

In the beginning of 1984 the present garden site was only a tract of forest land on the fringes of Western Ghats devoid of all civic facilities. Distance from the city made transportation a formidable task and the soil-eroded steep slopes that formed the site posed serious problems to planners and landscapists. Due to various constraints, contractors were unwilling to take up jobs in this area and in the early stages construction work proceeded only at a snail's pace. To illustrate, more than nine months were spent to construct a culvert that made the garden site accessible to heavy-duty vehicles.

The scenario changed rapidly. In a record performance, engineers of the State Electricity Board extended, within nine months, 11 KV lines to the site from distant Bherathannur and the lines were energized in January 1985. By that time seven kilometres of telephone lines were drawn and our connection to the outside world was also established. Plans for the development of the Garden were already drafted and laboratory work as well as collections were started under the leadership of Professor A. Abraham, the Founder Director of the Institute. We were also fortunate to get the association of some of the best minds in India and abroad at the planning stage and primary attention was given to landscaping and building up facilities for raising living collections, plant introduction, conservation, and laboratory facilities for biotechnological and taxonomical research.

As early as 1985, a seed bank was established and the first Index Seminum published. Soon after, active exchange of seeds began with various international gardens and research centres. Facilities like orchideria, community pot centre, modern nursery sheds, conservatory, small reservoirs for aquatic plants etc were constructed. A small meteorological station was established. Phase I and II of the Road and Irrigation system were completed by 1986. A herbarium, now listed in Index Herbariorum, was developed. About 5 km of barbed wire fencing on the boundary was installed. The Visiting Scientists' Guest House and a small building for biotechnology laboratory were constructed and offices and laboratories were shifted to the garden site even before the construction of the main building began. Land was acquired for staff quarters, a master plan was prepared and by the end of 1988 construction of the first phase of quarters has been completed.

Along with construction, attention was focussed on the living collections which form the most important facet of the Garden. We have now over 720 species of medicinal plants and the collection, in the opinion of experts, is the finest in India. The orchideria contain 400 species of orchids collected from various parts of India as well as a representative group of imported hybrids. Five hundred species of trees have been introduced into the Arboretum of which 30% are from tropical countries outside India. An ambitious project to develop a Palmetum with 100

species of tropical palms has been started. The bamboosetum is also making fast progress. The *Ficus* collection today has 85 species of which more than 50% are exotic. The Garden also is proud of its acquisition of 7 out of the 9 surviving genera of cycads.

TSGRI has close links with the International Union for the Conservation of Nature and Natural Resources (IUCN) and a dozen species of endangered plants are grown here. Both conventional and biotechnological methods are used for the multiplication of endangered plants and plantlets of rare species have been distributed to individuals and institutions as and when available.

From the very beginning of this project, we realised the need for trained people to run a modern garden and efforts were made to build up a core of young men well versed in subjects such as modern horticulture, arboriculture, habitat conservation, seed storage, landscaping and garden management. With the liberal assistance the British Council and the Royal Botanic Gardens, Kew, a three-month training course was conducted by Mr Roy Bee, in 1987. One of the trainees has been selected for the International Trainees' Certificate course in Horticulture at Kew. He has returned after completing a year's training and is now in charge of the Ornamental Plants. A year after the training course given by Mr Roy Bee, Kew deputed Mr Flanagan to give a month's follow-up training for our staff. These projects actually mark the beginning of a series of training programmes planned for our staff and by the end of the eighth five year plan, we hope to have adequate staff trained in all aspects of modern horticulture, eco-rehabilitation and conservation which would enable us to start a course to train garden enthusiasts, horticulturists and conservationists.

One of the most satisfying developments during the last two years has been the increasing number of students—undergraduates, post graduates and research students—who visit and utilise the facilities of the Institute. Last year more than three thousand students from nearly one hundred institutions visited us. Every batch was received by a scientist who taught the students about plant diversity and gave a holistic view of evolution with the help of examples from our garden. This has proved time and again a unique experience for the students as well as teachers who got a meaningful insight into the past history of biological evolution and future projections of trends of evolution.

Steady progress has been made because of the excellent support of the Government, the Governing Body, the Executive Committee and the staff of the Institute. The growth of the Institute was greatly aided by the generous and continuous support we received from the British Council and the Royal Botanic Gardens, Kew. With the infrastructure now being built up and with the availability of sufficient funds and trained people, the Institute has every potential to develop to a great Garden and centre of excellence.

Professor A. N. NAMBOODIRI
Director, TSGRI

THE IMPLICIT CHALLENGES

The matter-of-fact report that follows gives a glimpse of our activities but makes only passive references to the challenges faced by this young Garden during its development.

The living collections increased rapidly but our inexperience did not reckon the magnitude of the problem of maintenance. Normal garden operations and management take an increasingly major share of our time and resources. Some of the accessions, especially the rare species, need special care for durable establishment and normal growth. Absence of facilities for environmental control makes the task of maintaining alien species even more difficult.

Maintenance also involves constant replacement of collections. Plants die of natural causes; pathogens, insect pests and other enemies too take their toll. Frequent collection trips are needed to replace the lost material and in the case of rare plants, existing species in the Garden have to be multiplied. TBGRI has the basic infrastructure for micropropagation and conventional multiplication although the propagation systems have to be updated and expanded.

The patronage extended by the public is heartening; even so it is a challenge to provide guided tours to the steadily increasing number of visitors who seek entry often without notice and even out of office hours. The number of students who use our facilities have doubled in two years and their requests for demonstrations and lectures have been happily acceded to in spite of the severe strain on our small staff. As an amenity and educational resource the Garden has made a mark. However, more effective means have to be evolved to assist the public, students and researchers in using garden facilities.

TBGRI, like several other institutions in Kerala, has to live with shortage of funds. An equally important constraint to progress is the lack of experienced hands in specialised areas such as scientific horticulture and conservation. Fortunately, this problem has been recognised from the inception of the Garden and a series of imaginative training programmes have been organised. Sufficient financial and technical support have to be obtained to continue these programmes and to generate enough expertise to meet the future needs of the Garden.

The past years were periods of problem solving and improvising and we are learning as we are growing.

A PREFATORY NOTE

The report is organised under three major heads—Taxonomy, Garden Development and Biotechnology.

Actually, the contents of these sections are slightly overlapping. Some matter on development of the bamboo setum and wild plant collections are included under Taxonomy while taxonomic references are seen in other sections. The medicinal plants are dealt under Garden Development but its micropropagation is discussed under Biotechnology. Also, conservational aspects such as collection, cultivation and multiplication of endangered plants are necessarily discussed under different sections.

To us, this is the most cogent way of organising the contents but we will not strongly contest if the discerning reader feels that the material should be arranged in another manner.

Data from supporting facilities such as Meteorological Station, Library, etc are given after reports from major sections.

PLANT TAXONOMY

Various research projects undertaken during the last year are progressing satisfactorily.

1. *Collection and Conservation of Bamboos*

This year the thrust was given to the collection and introduction of species belonging to Bambuseae from various sources.

In February, some areas of Kulathupuzha reserve forests were explored. Offsets of the 'lathi' bamboo and *Bambusa arundinacea* were collected. One *Bambusa arundinacea* clump in the area was found in flowering and specimens were collected for herbarium.

In March, an exploration tour was conducted covering Ottavenga, Wynad, Mannanthody, Tirunelly, Pakshipathalam, Coorg, Periya and Chandanathode areas and collected 41 field numbers. This includes 18 offsets of one straggling bamboo and three *Ochlandra* spp. One of these (*Ochlandra wightii*?) was found in flowering and about 60 specimens with flowers and fruits were collected for herbarium. This is a very valuable collection as this species usually flowers after long intervals.

Through the courtesy of the Silviculturist at KFRI, seedlings of one species of bamboo, *Oxytenanthera monostigma* were received and introduced in the garden.

Offsets of another species of Bamboo (*Bambusa* sp?) were collected from Papanasam. Bamboos growing in the campus of the Public Library, Trivandrum were also collected and planted in the site.

Seeds of the male bamboo, *Dendrocalamus strictus* were procured from the Forest Development Corporation, Gujarat. A large number of seedlings were obtained from these seeds and these will be transplanted in the next season.

Attempts were also made, in this year, to contact foresters and scientists of the country requesting their help in the development of the Bamboosetum. As a result, Dr. S. S. R. Bennet, Officer-in-charge, Botany Branch, Forest Research Institute, Dehra Dun visited the Garden and offered planting materials of bamboos grown in FRI. Mr. K. K. Gupta, DFO, Forest Resources and Survey Division, Haflong, Assam has sent seeds of *Melocanna baccifera* and *Oxytenanthera* sp. (Hill Jati).

A trip to Forest Research Institute, Dehra Dun was conducted from 1st to 19th September. According to FRI reports there are about 35 species of bamboos in their collection. Rhizomes/offsets/seedlings and or cuttings of 18 species of bamboos were collected from FRI Bamboosetum. Although seedlings of one species, *Bambusa tulda* were lost during transit, this visit yielded 40 offsets and 24 cuttings which were planted in the Garden. In addition about 68 specimens belonging to 17 species were also collected for herbarium.

On October 17th, 24 seedlings of *Bambusa arundinacea* were planted on the eastern hill tip of the bamboosetum as a measure to prevent elephants from entering the site.

Seedlings of another species of bamboo *Phyllostachys pubescens*, were also obtained from Kew, this year.

In short, during this year considerable progress has been achieved in the development of the bamboosetum. The planting area has been extended and about 50 offsets/seedlings belonging to 25 species were planted. Seeds of 7 species were grown in the nursery of which 2 species did not survive. In addition, cuttings/seedlings/offsets etc. are planted in 23 pots. The bamboo herbarium is further enriched with about 140 specimens.

2. Studies on the sedges (CYPERACEAE)

During the Wynad-Periya-Mananthody exploration in March, 5 field numbers of about 20 specimens of Cyperaceae were collected. In May, about 75 specimens belonging to 25 field numbers were collected from Maruthuamala, Vattakottai and Courtallum of

Kanyakumari and Tirunelveli districts in Tamilnadu. About 60 specimens grown in pots in the bamboosetum site were also gathered and processed for display in herbarium. Their identification is in progress. A live collection of 60 plants belonging to 18 species is also maintained.

3. *Study and introduction of Wild Flowers of Kerala*

During the year 1988 main attention was given to develop a small area in the garden site with the established wild plants. This is being accomplished step by step as outlined below.

An area of about 15 cents tucked between the sloping side of the main building complex and the nursery road was located for this purpose. This was part of the secondary forest with first layer canopies formed by small forest trees. With least disturbance to these trees so as to maintain the canopy as such, the forest floor was completely cleared off keeping one or two individual stocks of shrubby plants like *Helicteres isora* and *Lantana camara* for their flowers, which formed the second layer canopy of the area.

Since the intention was to introduce species of shrubby plants, perennials and annuals growing wild in the forests and bearing beautiful flowers either in solitary nature or in clusters or having handsome foliage, it was felt reasonable to hunt for plants of such types initially from the natural forest area of the garden site itself. These species have established well in the area.

Species introduced from in and around Trivandrum include shrubs like *Clerodendrum paniculatum* (Verbenaceae), 2 species of *Hibiscus* (Malvaceae), *Turnera ulmifolia*, *Turnera ulmifolia* var. *angustifolia* (Turneraceae) *Ipomoea fistulosa* (Convolvulaceae), a species of *Cactaceae*, *Barleria prionitis* (Acanthaceae), perennials and annuals like *Asystasia dalzelliana*, *Asystasia gangetica*, *Justicia simplex*, *Justicia* sp. (Acanthaceae) *Limnophylla heterophylla* (Scrophulariaceae), *Desmodium* sp. (Fabaceae) *Cleome gynandra*, *Cleome burmanni* (Cleomaceae) and creepers and twiners like *Ipomoea pes-caprae*, *Ipomoea nil*, *Ipomoea cairica*, *Merremia tridentata* and a few other unidentified species.

Seeds were also used as source of wild plant species and plants like *Cassia mimosoides* (Caesalpinaceae), *Ipomoea hederifolia* (Convolvulaceae), *Clitoria ternatea* (Fabaceae) etc were raised by such methods.

Wild plants were also brought to the garden by exploring the forest area of Pathanamthitta district. Two trips were made last year to forest areas of Muzhiar and Shabarimala and many plantlings of shrubs, perennials, annuals and creepers belonging to about 30 species were collected. They have got established now in the site though two or three species still suffer from stunted growth. The established species include a shrubby fragrant flowered *Clerodendrum*, a species of *Bauhinia*, a shrubby Melastomataceae, two species of Zingiberaceae, one twiner of Vitaceae, shrubby member of Lecaceae, a sturdy species of *Munronia*, two perennials having handsome foliage, three species of *Ophiorrhiza*, and a prostrate perennial. All of them are new introductions to the garden.

As the introduced plants are from natural forest, many of them are shade-loving. Except the microecological requirements no definite pattern has been adopted while planting the species so as to give the area a natural look of forest undergrowth. When the planted species occupy more area of the forest floor, eventually the area will have, it is hoped, a carpeted look of lush green. The located area being the meeting place of two slopes with a small stream running through its notch during rainy season and upturning of the soil being necessary for planting, convolvulaceous creepers with soil binding capacity have been planted on these slopes.

The idea of giving the area an informal look by planting species with no definite pattern and establishing creepers as soil binders along the soil-upturned slopes were corroborated by Mr. M. Flanagan, reputed horticulturist from the Royal Botanic Gardens, Kew.

At present about 45 species have got established in the area. Another 10 species are ready for planting. The present area can well be occupied fully by these species by sexual and vegetative propagations. Steps are already initiated towards this direction.

4. *Studies on the wayside flowering plants of Trivandrum*

This project was undertaken last year with the intention of preparing a popular book on common plants of Trivandrum. Standing within the limited framework of facilities and manpower 10 half-day collection trips were conducted and about 825 specimens belonging to 225 species were collected so far. 180 species were completely identified and the rest 45 species are only tentatively identified. Their identification has to be confirmed in consultation with a reference herbarium. Draft write-up of about 130 species with information on species nativity, distribution, rarity and abundance, botanical description, economic or other importance etc is already prepared. Rest of the work is in progress. 25 species are so far illustrated. This work is being carried out with the help of Garden Assistants and Artist of the Institute.

5. *Palynological work*

With the intention of undertaking the study of Quarternary mangrove palynology of Kerala coast, pollen grains of mangrove species were requested from different herbaria and so far pollen grains of 10 mangrove species from herbaria of Kew (UK), BSI, Coimbatore (MH) and CESS, Trivandrum were received. More species are expected from different circles of BSI and work will begin in due course. Thought has been given for the establishment of a pollen herbarium of Kerala plants, mainly of forest trees as this will help to study the Quarternary palynology of the state in due course.

6. *Taxonomic Studies on the Insectivorous Plants of India*

Utricularia spp. of Sikkim and Kerala are studied in detail. Two bigger plants of *Nepenthes khasiana* were brought for introduction from Shillong. Saplings carefully raised from seeds brought from Shillong produced small pitchers and proved to be a major attraction to visitors.

7. *Taxonomic studies on Indian Orchids*

Tirunelli expedition made in March resulted in the collection of 15 field numbers of plants for the herbarium. Orchids such as

Bulbophyllum elegantulum, *B. fischeri*, *Dendrobium jerdonianum*, *Luisia macrantha*, *Papilionanthe subulata*, *Zeuxine gracilis*, *Vanda* sp. were introduced to the garden.

A Midget Mystery called Tsjerou Tecka Maravara.

This neat little dwarf orchid which strongly reminds Rheede's TSJEROU TECKA MARAVARA has been playing a sort of hide and seek game for over a quadruple of years. It surely had been playing the same game for more than three centuries when van Rheede first caught it in a drawing published in his celebrated work on Malabar plants. Some unknown collector also collected the very same *Bulbophyllum*, here again without flowers. Even without flowers it was sure that it could be a *Bulbophyllum* of unknown alliance. At last, this June it produced flowers thereby allowing us to unravel the mystery fully. It proved to be a new species of *Bulbophyllum* with no relatives in the nearby regions.

New reports of orchids

- (1) *Trias bonaccordensis* Sathish, sp. nov.

Study and re-sketching of this species originally collected from Bonaccord forests at an altitude of 1050 m and was under cultivation were completed. Comparisons with other species showed *T. bonaccordensis* is more related to *T. stocksii* Benth. ex Hook. f. a common species of the Western Ghats. *T. bonaccordensis* is a lovely species with solitary flowers, 2 cm across when fully open and creamy yellow with crimson red spots. So far known only from the type locality where it is very common in the transition zone vegetation, perhaps available in the adjoining areas also.

- (2) *Bulbophyllum rheedei* Sathish, sp. nov.

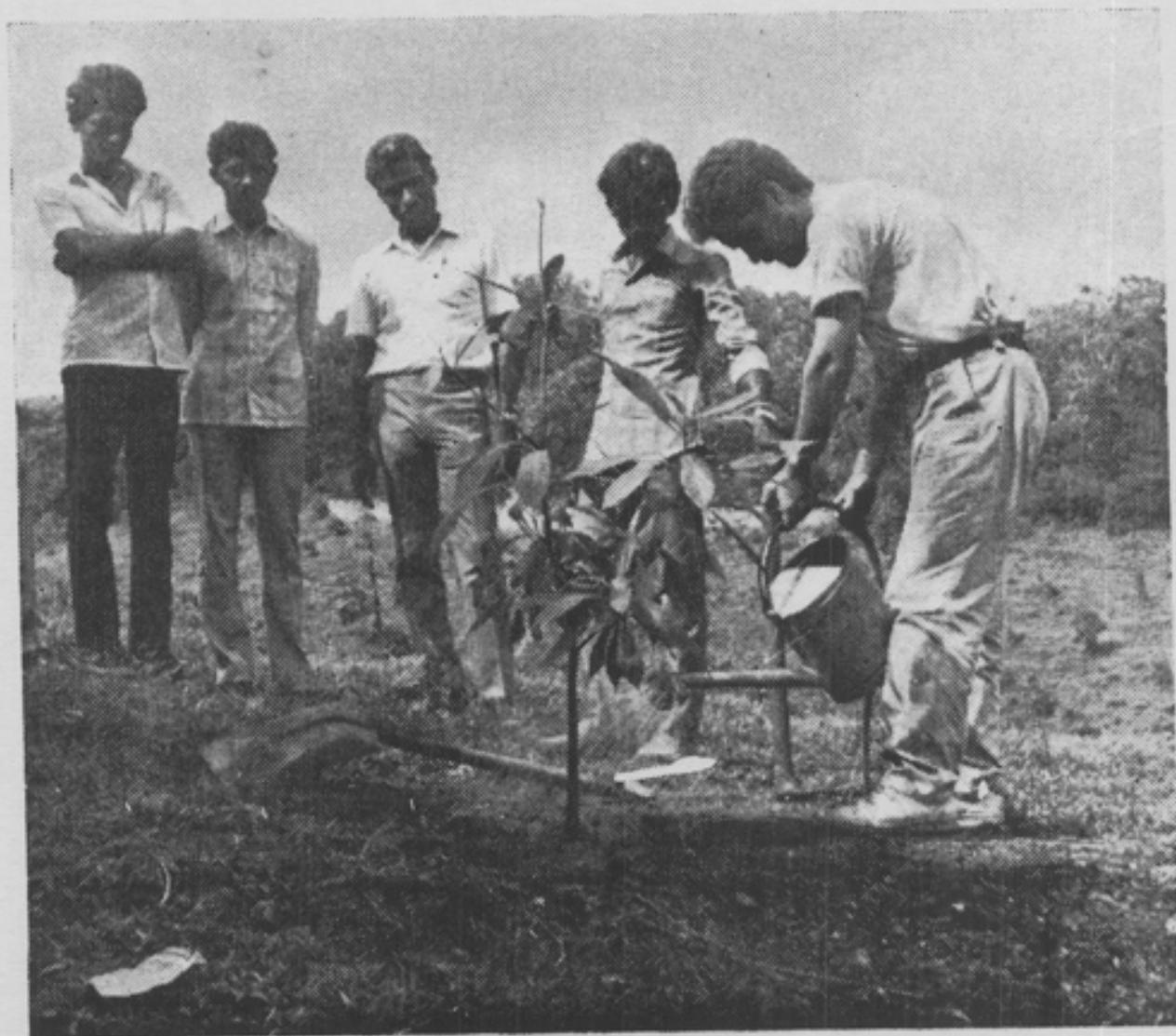
Even at the time it was collected from the garden area four years back this species promised to be interesting. Studies on fresh flowers proved beyond doubt that this is new to science. This view has been concurred by Dr. G. Seidenfaden.

Orchids recorded as new to Kerala

1. *Bulbophyllum elegantulum*. Originally recorded from Coorg (Karnataka) and later on reported from Nilgiris, this species has been collected from Wynad area in the recent exploration.



Mr. Andrew Picken, First Secretary, Education and Science, British Council, during his tour of the Garden.



Mr. Mark Flanagan, Royal Botanic Gardens, Kew, planting a sapling at the end of a follow-up course in horticulture he gave to our scientists.



Bambusa ventricosa (Buddha's belly bamboo)



Seven of the nine surviving genera of cycads are represented in the Garden.



Castanospermum australe. Castanospermine, isolated from the plant is under evaluation for treatment of AIDS infection.



Ficus drupacea var. *pubescens*.
A four year old plant in pot.



Minister for Health, Shri A. C. Shanmugha Das, during his visit to the Garden.



Our scientist, Mr. Jacob Thomas, receiving the International Trainee's Certificate from Sir David Attenborough at the Royal Botanic Gardens, Kew.

2. *Luisia macrantha* Blatt. & McCann. Originally reported from North Canara, this species with its very large flowers are fairly common in Chandanathode-Periyar regions.

Eco-restoration of rare and endangered orchids at TBGRI

Work has already been started on naturalising the native orchids of rare and endangered category. An area has been selected and attempts were made to grow Blue Vanda and other interesting orchids in that area.

8. Studies on the flora of Agastyamalai

During the year four collection trips were conducted to Agastyamalai and nearby areas. About 1800 field numbers were collected for Herbarium. 50 saplings were collected for introduction to the garden. A new species of *Pothos*, *P. crassipedunculatus* was collected from Agastyamalai during these trips.

Herbarium

The herbarium is enriched with the addition of 1892 mounted sheets and 6,998 duplicate specimens during this year. 1298 specimens are processed and kept for mounting. 2924 card indices were prepared during this year. 1046 specimens were accessioned and added to the herbarium. 150 sheets were identified. Another 3482 sheets are at various stages of identification with taxonomists. The up-to-date position of the collection is as follows:

Total specimens processed	35,162
Mounted herbarium sheets	10,017
Duplicates	25,145
Processed (but not mounted) specimens	2,498
Total families	159
Total genera	1,010
Total species	2,022
Accessioned specimens	5,386
Card index prepared	5,368

Remounting of the herbarium sheets of Prof. K. Narayana Iyer, generously donated by his daughter, Prof. (Mrs.) N. Lekshmi, Ayurvedic Research Institute, Trivandrum, was completed during this year.

MICROBIOLOGY

A programme of work on the Rhizosphere and Mycorrhizal microorganisms of the trees growing in the natural forest area and in the arboretum area of TBGRI was taken up during this year.

As a first step, root samples of *Dalbergia latifolia* (an economically important tree yielding Rose Wood) growing in the natural forest and also in the Arboretum area were collected. These samples were plated out on glucose-peptone-agar medium for isolating the fungal colonies present in the root surface (Rhizosphere). The Rhizosphere fungi developed in the petri-plates were isolated and grown in culture tubes containing malt-agar medium.

To compare the rhizosphere fungi with the fungi present in the surrounding soil, samples were collected one metre away from the root from which samples were collected. These samples were also plated out in the glucose-peptone-agar medium. Colonies appeared on the petriplates were isolated and grown in culture tubes containing malt-agar medium. Identification of all these cultures is in progress.

The number of fungal colonies (1,42,000/g soil) present in the soil samples collected from the Arboretum area was found to be more compared to the number of fungi (1,35,750/g soil) present in the samples collected from the natural forest area.

The number of fungal colonies present in the Rhizosphere (1,48,795 and 1,46,250/g root) was more compared to the colonies present in the soil samples collected from that area (1,42,000 and 1,35,750/g soil). This phenomenon was noticed in both type of samples collected from the natural forest area and the Arboretum area.

GARDEN DEVELOPMENT

Plant Introduction

Plants of various groups were introduced into the garden by the combined effort of scientists attached to Plant Taxonomy and Garden Development.

With the addition of eighteen species of tropical palms from the Royal Botanic Gardens, Kew, the present collection of palms have gone up to 75 species.

Eighteen species of Bamboos were introduced from the Forest Research Institute, Dehra Dun. *Phyllostachys pubescens* was introduced from the Royal Botanic Gardens, Kew. Another important introduction is the 'Lathi' Bamboo collected from Kulathupuzha.

Thirteen species of orchids were introduced this year to the existing species collection.

Twenty more species of medicinal plants were added to the herbal garden. The strength of the germplasm of the medicinal plants is now raised to 720 species.

Eighteen shrubs, eleven herbs and eight twiners and creepers were added to the wild flower collection.

With the introduction of 60 species of arborescent plants the number of woody species have increased to 500. Planting materials/seeds of 164 species/varieties were introduced to the ornamental section, including 9 new varieties of miniature rose.

With the addition of the rare cycads *Bowenia serrulata* and *Macrozamia (riedlei)*, seven out of the nine genera of cycads are now represented in the garden.

During this year, the Royal Botanic Gardens, Kew, have supplied saplings of five species of cycads, eighteen species of palms and seventeen species of trees/shrubs, to be introduced in the garden.

Some of the interesting introductions of this year are the Jade vine (*Strongylodon macrobotrys*), a giant climber of the pea family native to Philippines and endangered in the wild, Olive (*Olea europea*) and *Amherstia nobilis*, the beautiful flowering tree of Burma.

Arboretum

During the previous years, introduction of new tree species to the Arboretum was very rapid because all the plants introduced

were new to the Garden. But now, after the introduction of 440 species by the end of 1987, we had to search for species which are not introduced so far. As a natural consequence, a rapid increase in number was not achieved this year. About 60 arbore-scent species were added this year with which the total collection of woody species increased to 500. At present, extensive survey of forest areas of Trivandrum district is being conducted and an attempt is being made to introduce unrepresented species into our Arboretum.

During this year's planting season (June-July 1988), 30 species were planted in the Arboretum. At present a total of 390 species have been planted and over 100 species are grown in pots for planting at the appropriate times.

So far, all the planted trees are showing excellent growth. The first plantings (of 1985) have attained a height of 20-25 feet and a girth of 10-15 inches. The newly obtained altimeter makes the measuring of the tree height much easier.

Labelling of the established trees, on the basis of the new uniform labelling pattern accepted for the Garden was started and about 300 plants were labelled. Labelling of the *Ficus* display at the entrance of the Garden was done with the new engraved aluminium labels.

Computer facility available at the Institute was used for the compilation of Arboretum data. Based on the International Transfer Format, thirty three characters were used to make complete information of the trees introduced in the Arboretum.

Palmetum

One of the significant achievements during the period was the initiation of work for developing a Palmetum. Experts from Royal Botanic Gardens, Kew have recommended that our Garden is having very suitable climatic conditions for growing tropical palms. Kew was also happy to share their palm collection with us, because in their conditions many palms do not flower. During the last three years we were collecting seeds and seedlings of palms from all over the world by exchange programmes and nearly half of our total collection was contributed by the Kew

Gardens. After discussing with the scientists from Kew, the natural vegetation area (No. 2.) of the garden was selected as the location of the Palmetum. The first planting was done in June. About 35 species were planted out of the total collection of 70 species. The smaller seedlings in the nursery will be planted in the next season.

Medicinal Plants

The germplasm collection of medicinal plants was raised to 720 species by the addition of 20 species this year mainly through collection trips conducted to Maruthuamalai, Vattakotta, Papanasam, Mundanthurai, Changily, Velamanoor and Mully.

As a part of the development of medicinal plant garden a biotope for growing succulent plants having medicinal importance was made and about 20 spp. were planted in this area. Slopes in the terraces in the medicinal plant garden were planted with low growing medicinal species and emergants. Shrubby medicinal species were planted as an extension of the present shrubbery near the *Centella* lawn. A new nursery area was developed near the community pot centre. Maintenance of the plants in the Garden and helping the visitors to know more about the plants were the other duties attended.

During the plant collection trips about 100 field numbers of herbarium specimens were collected and added to the medicinal herbarium. A museum comprising 250 identified raw drugs and other exhibits showing various aspects of medicinal plants was organized.

During the period of report planting materials of medicinal plants were supplied to the following institutions:

1. 40 spp. to the Social Forestry wing of Kerala Forest Department.
2. 36 spp. to the Horticultural Department of Karnataka State.
3. 30 spp. to Vaidyarathnam Ayurveda College, Oloor, Trichur.

4. 6 spp. to Herb Garden, Kottakkal Arya Vaidyasala.

Planting materials of a few species of medicinal plants not represented here were collected from;

1. Central Institute of Medicinal and Aromatic Plants (CIMAP) Lucknow.
2. NBRI Herb Garden at Bandhra, Lucknow

Germplasm Centre and Seed Bank

The second edition of the Index Seminum was published during this year, which was completely revised with the addition of 173 new species and deletion of 166 species, based on demand and seed viability. As a result of these changes, the present list includes 600 species, which is slightly larger than the previous edition. Copies of the index seminum were sent to the botanic gardens and universities around the world with which we are in contact, to strengthen the present seed exchange programme. Collection of seeds of plants enlisted in the index were going on and seeds of over 300 species were collected, processed and stored in the cabinet, ready for exchange.

This year the demand for seeds of our plants from institutions around the world was higher than during the previous year. About 230 seed samples were sent to the following 29 centres.

National Bureau of Plant Genetic Resources,
Regional Station, Trichur

Jardin Botanique Cantonal de Universite-
Lausanne, Switzerland

Conservatoire Botanique de Wallonie
Genappe, Belgium

Palmengarten, Frankfurt, FRG

Botanischer Garten, Sektion Biowissenschaften,
Martin Luther Universität, Halle, DDR

University of Copenhagen Botanical Garden,
Copenhagen, Danmark

Ezeiza Botanical Garden, Buenos Aires, Argentina

Department of Pomology and Floriculture, College of Horticulture, Vellanikara, Trichur.

Royal Botanic Gardens (Lower Nursery), Kew, Surrey TW9 3AB, U.K.

Hortus Botanicus, Vacratot, Hungaria

Botanischer Garten, Menzinger Stra Be 61-67, D-8000, Munchen 19, FRG

Jardin Botanique, De La Ville De Bordeaux 33000, Bordeaux, France.

Pacific Tropical Botanical Garden, Hawaii, 96765, USA

Botanical Garden, University of Helsinki, Finland

Botanic Gardens, Toowong, Queensland, Australia

Laboraterio de Analise de Sementes (LAS), RIO de Janeiro, Brasil

Hortus Botanicus, Universiteit Van Amsterdam, Netherlands

Plant Science Laboratories, University of Reading, England

Hortus Botanicus Austro-Sinensis, Guangzhou, China

Botanisher Garten U. Botanisches Museum, Berlin Dahlem, D-1000, Berlin

Estacao Agronomica Nacional, Oeiras, Portugal

Botanischer Garten der Universitat Wien, Austria

Zentralinstitut fur Genetik and Kulturpflanzen-forschung, Gatersleben, GDR

Fruit Spirit Botanic Gardens, Dorroughby, Australia

The Nippon Shinyaku Institute for Botanical Research, Kyoto, Japan

Botany Department, University of Toronto, Canada

Museum National D'Histoire Naturelle, Paris, France

Director of Recreation and Open Spaces, Liverpool City Council, Liverpool, U.K.

Curator, Avenida Canning, 1425 Buenos Aires, Republica Argentina.

While we were distributing seeds of our plants, we were also receiving seeds of important exotic plants from the various botanic gardens/universities abroad (listed below) based on their seed lists.

Botanischer Garten and Botanisches Museum, Berlin

Orto Botanico Dell Universita, Padova, Italia.

Royal Botanic Gardens, Kew, U.K.

Fruit Spirit Botanic Gardens, Dorrroughby, Australia

Botanical Garden, University of Helsinki, Finland

Botanischer Garten, Munchen, Nymphenburg, F.R. Germany

Hortus Botanicus, Universitatis Comeniane, Bratislava, Czechoslovakia

The Nippon Shinyaku Institute for Botanical Research, Kyoto-607, Japan

Botanisher Garten, Martin-Luther-Universitat, Halle(s), GDR

Conservatoire, Botanique de Wallonie, Genappe, Belgique

Forest Research Institute, DehraDun

Jardin Botanique Cantonal, Lausanne, Switzerland

Institute of Ecology and Botany of the Hung. Acad. Sci., Vacratot, Hungary

Jardin Botanique National de Belgique, Meise, Belgium

Lalbag Gardens, Bangalore

Govt. Botanic Gardens, Ooty

During the report year we received seed samples of 523 exotic species and all these seeds are under different germination trials. The germplasm centre was able to develop seedlings of about 40% of the introduced seeds and seedlings of 70 species were handed over to different sections during this period.

Ornamental plants

During this year, the shrubbery was extended towards the medicinal plants garden with the addition of 75 more new ornamental shrubs of various families. As an innovation, various *Coleus* and *Canna* varieties were planted mixedly, beyond the shrubbery. Other changes were also introduced to make the area more attractive.

The concept of 'Island beds', new to the garden, was introduced, where perennial plants are planted and displayed in groups to give mass effects. Four such beds were prepared adjacent to the shrubbery as a piece of attraction to the visitors.

Another type of planting, 'standard bedding' was also started in the garden. It has got a central standard plant, a few dot plants and a ground cover. Six such beds were prepared in the lawn in front of the guest house.

Towards the end of the year, certain policies were formulated for the better management of plants and man power, in the garden. Production and display of plants at a professional standard, expected from a modern botanic garden, was the most important one. All the stocks of plants were assessed to identify the species/ variety with desirable standards and those need to be repropagated and disposed. Based on this, assessment and necessary works were started, initially with the large collections like crotons, coleus, etc., which will be continued with the other groups as well. Another important new policy was to minimise the number of potted plants for display purposes and to give permanent placement for maximum number of plants grown in pots, used for displays. In connection with this, plans were prepared for certain groups of plants, like shade loving plants, Bougainvilleas, variegated plants, *Dracaenas*, climbers, etc. Plantings were initiated with Bougainvilleas and climbers on the slope at the far end of the guest house, and necessary planting materials are being propagated for the proposed variegated plants display.

A small forest area was selected to develop a woodland garden to accommodate the large collection of shade loving plants coming under the families: Araceae, Begoniaceae, Gesneriaceae, Marantaceae, etc., which were not on display in the strict sense. An informal design was prepared and planting of over 250 plants was completed. The plants were grouped into bold drifts to make the maximum impact on planting, in order to make it very attractive.

Attempts were also initiated to improve the overall ornamentation of the garden using proper displays. It has been decided to build a pool of bedding plants to be used for displays suitable to the garden and plans were prepared to make a few formal beds for the purpose. Another addition is the display plot made of the grass, *Pogonatherum*, around the flag post, which will be extended towards the main gate, later. Potted plants, flowering or foliar, could be used in rotation to give a change, in the display plot. The large number of potted crotons were brought together and arranged as a display, above the *Ficus* display area.

Detailed plans for landscaping the rear of the main building were prepared and the drawings with the selected plants list were forwarded to the experts at the Royal Botanic Gardens, Kew, U. K. for suggestions. The landscaping work was initiated with the work on the preparation of two slopes dressed with top soil for turfing with grass.

A plant collection trip was conducted to Bangalore and Ooty to procure suitable plants for the above landscaping work and for other purposes. Planting materials/seeds of about 164 species/varieties were introduced to the Garden from different places and they are being nurtured at the nursery. The new accessions include plants like *Amherstia*, *Brownea*, *Camellia*, *Magnolia*, *Olea*, *Hedera*, *Strongylodon*, *Abutilons*, *Brameliads*, *Juniperus* etc.

Apart from these developmental activities routine maintenance including lawn maintenance, feeding, weeding, mulching, pruning, staking, rose budding, propagation etc., were also continued with improved standards.

Central Nursery

The accepted concept of the Central Nursery was set into action by reorganizing the propagation and growing-on facilities

of the three concerned divisions (Arboretum, Medicinal and Ornamental) utilising the potting shed as its centre, also by providing common pots, fertilizers, composts, etc. A propagation frame for germinating seeds and rooting cuttings was constructed and commissioned to provide suitable conditions and it is proved to be very successful. Varying sized pots, starting from 2" size, basically of two types, shallow and deep, to suit the different types of root systems, necessary for the nursery level nurturing of plants, were ordered for supply. Organisation of other essential nursery facilities such as propagation shed, shade house etc are also under active consideration, which would be constructed in the immediate future.

Propagation of orchids

An action plan has been prepared to fast multiply orchid hybrid in the orchidarium. As a result, a good number of hybrid plants were produced. These surplus research materials were released for sale at nominal prices. The distribution of excess orchids to pre-registered applicants started in December, 1988. 105 hybrid plants belonging to eight hybrid varieties were sold to orchid lovers during this year to promote orchid cultivation among common people. A leaflet containing instructions for cultivation entitled 'Growing orchids at home' was also given to those people who purchased orchids from the garden.

PLANT BIOTECHNOLOGY

Some of the projects described in the previous report were worked out to a stage where meaningful inferences could be made out of the results obtained. Thus, with the addition of new information, rapid propagation schemes for Blue Vanda (*Vanda coerulea* Griff. ex. Lindl) and *Gloriosa superba* L. were finalised and the biochemical basis of protocorm formation in foliar tissues of *Cymbidium* was partially established. This was a source of encouragement to extend the *in vitro* techniques to some new botanicals and horticulturals. On the negative side was the terrible power shortage experienced in the first half of the year which made even simple maintenance of the cultures difficult.

Micropropagation of endangered orchids

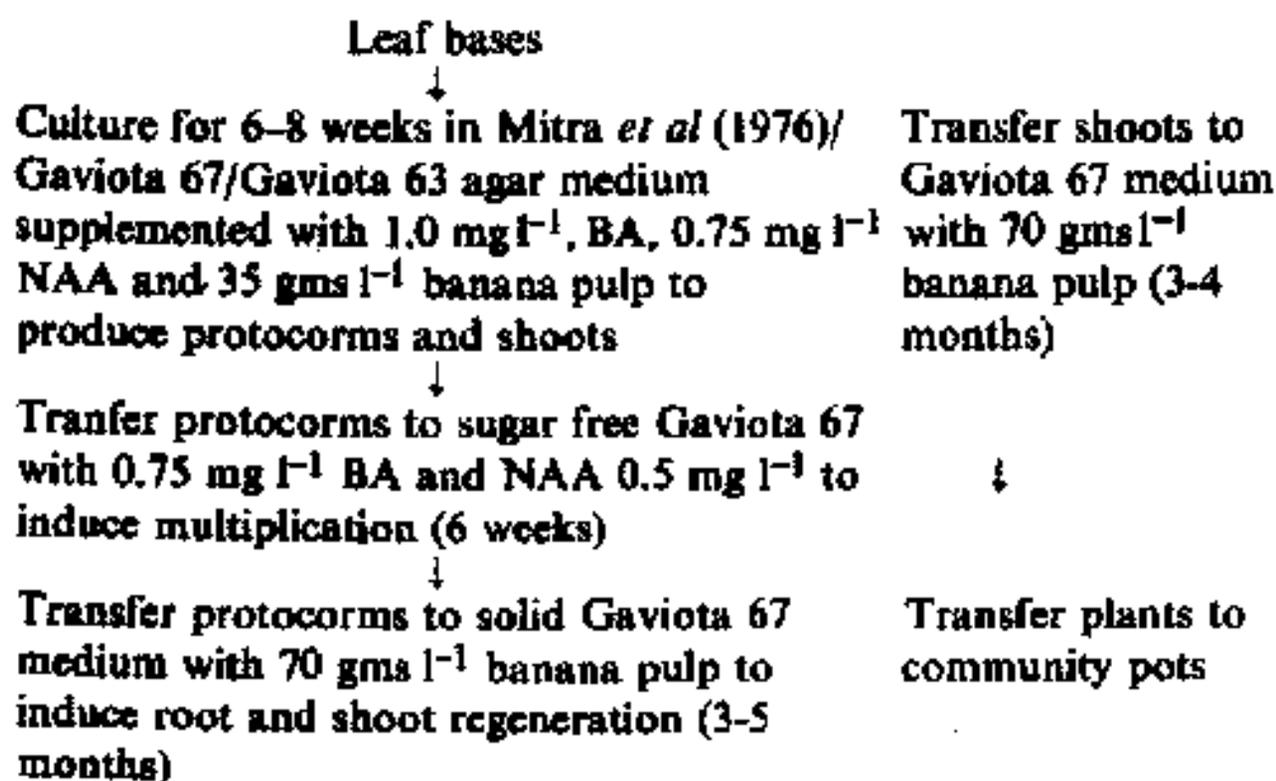
Liquid cultures of Blue Vanda leaf tissues were tried on nutrient medium consisting of the components of Mitra *et al.*, (1976). Casein hydrolysate 200 mg l^{-1} , BA 0.5 mg l^{-1} and NAA 1.0 mg l^{-1} induced maximum differentiation of protocorms. Tender leaves measuring less than 8 mm were by far the best source as protocorm formation occurred all over the surface of the leaf within 3 weeks. In leaves exceeding 1.5 cm length, excised leaf bases alone responded. If intact leaves were used, the distal chlorophyllous lamina gradually got disintegrated, plaguing the nutrient medium with debris and phenolics. Compared to tender leaf cultures, callusing was more pronounced than protocorms in leaf base cultures. However, when the calli were transferred to agar media, shoots were directly formed from the meristemoid zones without the intervention of protocorms.

Multiplication of the protocorms originally obtained from leaf base cultures in solid media were tried in liquid cultures. Media containing sugars caused browning and eventual necrosis of the protocorms. Sugar-free nutrient medium consisting of Gaviota 67 salts, vitamins of Mitra *et al* (1976)., BA 0.7 mg l^{-1} and NAA 0.5 mg l^{-1} promoted rapid multiplication of protocorms within 5–7 weeks under agitated conditions. Nearly five fold increase in fresh weight and differentiation of 55–70 new protocorms occurred during this period. Prolonged culture of the protocorms in sugar-free media resulted in paling and gradual death of the tissues. However under still conditions, differentiation of shoots from the protocorms occurred in the spent medium. The protocorms, differentiated in liquid suspensions were more chlorophyllous than those grown on agar media. While root development was completely lacking in liquid cultures, both root and shoot development occurred simultaneously in agar media.

The origin of the foliar protocorms was traced using microtome sections of leaf bases cultured for varied periods. Mitotic divisions were first observed in the epidermal layers, especially in the upper epidermis within a week after culture with or without being followed by pronounced callus formation from subepidermal layers. The epidermal protuberances continued to grow in size leading to the formation of globular protocorms containing homogenous mass of parenchyma after 4–6 weeks. Formation of

meristemoids at the distal end of the protocorm and differentiation of shoot meristem and leaf primordium occurred after 8 weeks. Invariably shoot regeneration from the protocorms was in 1:1 ratio.

An overall analysis of the results obtained thus far enabled us to formulate a rapid propagation scheme for the leaf meristem of blue vanda.



Top cuttings of three red vanda (*Renanthera imachootiana* Rolfe) plants recently received from Shillong were used for shoot apex and leaf meristem cultures. Nearly 50% of the explants were lost due to contamination. Two of the remaining leaf base explants implanted in solid Mitra *et al* (1976) medium supplemented with 1.0 mg l⁻¹ NAA and 0.75 mg l⁻¹ BA have formed nodular type of callus. The formation of this callus has been rather slow, often plagued with browning which necessitated frequent transfer of the tissue to fresh nutrient media. In liquid media, one or two leaf bases were swollen and proliferated to produce 1-3 protocorm-like bodies (plbs). This experiment is now repeated with more explants to reproduce the results.

Different nutrient media and hormonal combinations of BA and NAA were tried for inducing protocorm differentiation and direct shoot initiation in scaly leaf and nodal explant cultures of

the otherwise aphyllous *Vanilla wightiana*. Though the cut ends of the stem and leaf base explants responded with rapid swelling apparently due to mitotic activity, pronounced callusing, protocorm differentiation or direct shooting did not occur. Instead, the swollen leaf bases gradually necrosed in prolonged cultures. In shoot explant cultures, mostly single shoots were obtained from the nodes. Interestingly the cytokinin, BA at concentrations exceeding 4 mg l^{-1} promoted the development of negatively geotropic roots in 40% of the nodal explants. Better regeneration of shoots in stem explants at the expense of roots occurred in different combinations of hormones in liquid cultures. However, differentiation of shoots in leaf base cultures and multiple shoot initiation in nodal cultures have not been obtained yet.

2. Clonal multiplication of orchid hybrids.

As part of our continuing effort to develop rapid multiplication schemes for isolated hybrids, *in vitro* culture of shoot and leaf meristems and other sources of tissues were attempted. While the standard shoot apical meristem culture in *Dendrobium* and *Cattleya* was developed with relative ease a potential new source of regeneration in the leaf and root cultures of *Phalaenopsis* and flower stalk internode cultures of *Renanthera* was established after a number of trial runs. The nucleus for a whole series of media that were tried for this purpose was the chance observation that an enriched nutrient medium originally prepared for foliar tissue cultures of *Nepenthes* elicited quick regenerative response in whole leaf cultures of *Phalaenopsis*. Yet another offshoot development of the systematic efforts to induce clonal multiplications was that minor modifications satisfied the requirements of efficient regeneration in a number of taxa.

Meristemology (i) *Dendrobium*:

In addition to shoot apical meristems, tender leaf bases derived from flask grown and compost seedlings produced plbs within a month of the culture. Among the various media tried, as many as 12 plbs per explant were obtained in Modified Mitra *et al* medium containing BA and NAA at 1 mg l^{-1} each. Plbs were subsequently transferred to media devoid of sugar where multiplication of plbs and differentiation of shoots occurred

simultaneously. The culture of the shoots for 2 months in VW medium containing 15% CW and 2 g l^{-1} Peptone resulted in the development of mature plants with healthy shoots and roots. Successful establishment of the mericloned plants in community pots occurred at a frequency of 78%.

(ii) *Cattleya*: Apical meristems and leaf explants of *Cattleya* Wine Festival were cultured in 7 different liquid media for comparative studies on growth and differentiation. Within a month after culture plbs were produced from apical meristem explants in 5 of them. Plbs were transferred to the respective solid media and roots were formed by the end of the second month. Mitra's nutrient formulation with BA and NAA at 1 mg l^{-1} each was the best producing 75% proliferation and an average of 8 shoots and 2 roots/ shoot.

Leaf base, leaf tip and whole leaf cultures did not respond favourably in the media tried. These explants remained green for a month without plbs formation and later necrosed in all the media except Mitra's where 25% of leaf base explants produced 2-3 shoots directly in 2 months. The rooted plants were separated for transplantation directly into community pots after 5 months.

(iii) *Aranda*:

Aranda Christine and *Aranda* Peter Evart collected from our Orchidarium have been used for regeneration experiments through tissue culture. Apical meristem nodes, leaf tips and leaf bases of potted plants were used for the experiments. Apical meristem and leaf base explants yielded nearly 100 plbs each within 2 months of culture, in modified liquid Mitra medium. However, leaf tips and remaining parts of leaf lamina showed no response. The apical meristem-derived plbs were to be transferred to solid media for subsequent development of shoots, otherwise they necrosed.

(iv) *Phalaenopsis*:

En masse production of plbs and plantlets of *Phalaenopsis* Mab x Eagle was obtained from the roots and leaves of seedling cultures as well as isolated leaf and root cultures. The seedlings and organs were cultured on Knudson C medium supplemented

with minor elements of Mitra *et al.*, 20% CW, 2% sucrose, 500 mg l⁻¹ Peptone, 500 mg l⁻¹ casein hydrolysate, 1% agar and factorial combinations of BA and NAA. The frequency (50-70%) and the number of plbs (22-45) produced from roots and leaves were significantly high when a combination of 10 mg l⁻¹ BA and 1 mg l⁻¹ NAA was employed. Plb formation was largely asynchronous as it was first noticed near the tip of the organ and then spread all over the surface and plbs of various sizes and developmental stages were formed on the same organ. Shoots regenerated from plbs were subcultured to produce plantlets of uniform genotype. As is revealed from mitotic studies, 80% of the flower stalk nodes of *Phalaenopsis* 'Alice Gloria' and *Phalaenopsis* 'Barbara Moller' in culture were found to be regenerative on modified Knudson C with BA 10 mg l⁻¹ and NAA 2 mg l⁻¹ each. Invariably all of them produced 3-5 shoots/node. These shoots later produced roots and complete plantlets could be separated out by 4 months. Besides, the leaf sections of the flower stalk derived plants proved to be highly regenerative and were used for bulking up of the propagules in *Phalaenopsis* 'Alice Gloria'. The regenerated plants are being screened for genotypic uniformity. *Renanthera* Alex Hawkes flower stalk internodes 5-8 mm long, cultured on modified Mitra medium with BA 5 mg l⁻¹ produced plbs. Plb formation followed a definite pattern as they were arranged in rows one after another around the first formed ones. About 50 plbs/explant have been produced in 2 months, which are subcultured in a multiplication medium to induce shoot regeneration.

3. Protoplast culture in Orchids

Previous experiments suggested that protoplasts derived from achlorophyllous or less chlorophyllous parts of *in vitro* grown plants may be desirable for culture purposes. Therefore, protoplasts isolated from the leaf bases of *Vanda coerulea*, *Dendrobium* Ng Eng Cheow and *Vanda tessellata* x *Vandopsis* Twinkle seedlings were used. The aggregation of plastids in nearly 75% of the protoplasts was one of the serious problems encountered during the isolation and purification steps. Though per cent viability of the protoplasts remained as high as 90% at the post purification stage, the aggregated plastids were not redispersed in the cytoplasm during culture. There was a progressive decline in FDA

staining, leading to complete loss of viability of such protoplasts after 10 weeks. Addition of fresh nutrient medium at biweekly intervals and exposure of the cultures to light/dark conditions did not stop the eventual degeneration of these protoplasts. The following were some of the encouraging results obtained.

- (a) A population of less dense and less pigmented protoplasts from the leaves of different taxa was easily harvested (without purification step involving sucrose cushion) by spinning the maceration mixture at 40 g for 10 minutes.
- (b) Nearly 40% of these protoplasts isolated from the leaf bases of Blue Vanda and subsequently cultured in suitable nutrient media supplemented with additives such as PVP, coconut water, casein hydrolysate and MES were mitotically competent. These protoplasts presumably derived from the colourless palisade parenchyma, vascular parenchyma and epidermal layers were found to gradually increase in size and divide after two weeks. Formation of distinct cytoplasmic strands and streaming of the cytoplasm were characteristic of the dividing protoplasts. A combination of 2 mg l^{-1} NAA, 1 mg l^{-1} BA and 0.2 mg l^{-1} zeatin was found satisfactory to induce divisions. The successive mitotic divisions resulted in the formation of cell clusters or less frequently, a linear array of 6–16 cells in 5 weeks. Thus, the evidence for the true mitotic divisions of orchid protoplasts presented for the first time in this study, provided clues as to the desirability of using leaf bases as the source of protoplasts for future experiments.

4. Tissue culture of *Anthurium*, *Philodendron* and *Diefenbachia*

As part of the research proposal already submitted to State DSTE, (Department of Science, Technology and Environment) some attempts were made to induce regeneration in shoot tip, nodal and leaf explant cultures of these plants. Among the seedling and sucker derived explants of *Anthurium andraeanum* (red crinkled) prolific callusing followed, by the formation of 6–8 meristemoids and shoot initials was obtained in stem explants cultured on Nitsch medium supplemented with appropriate combinations of BA and IAA. Leaf explants remained unresponding

except in media containing low levels of BA ($0.2 - 1.0 \text{ mg l}^{-1}$) where marginal callusing was observed in 50% of the cultures. Higher concentrations of BA (2 mg l^{-1}) inhibited callus formation.

Preliminary trials on the *in vitro* germination of *Anthurium andraeanum* and *Anthurium clarinereum* seeds indicated maximum germination of the seeds in half strength MS basal medium supplemented with 0.5% sucrose. Vigorous growth of the seedlings with 3-5 leaves was observed in 4-5 weeks. However, the leaves unlike those of the seedlings raised on media devoid of sugar was small and thin.

Stem explants of *Philodendron* differed markedly from those of *Diefenbachia* and *Anthurium* in their response to ammonium level in the medium. Most of the explants of *Philodendron* 'Caesar', *Philodendron* 'Blue mistic', *Philodendron* 'Black cardinal' and *Philodendron* 'Spider' released phenolic oxidates and then perished in full strength MS medium. Direct initiation of 4-6 shoots occurred in Nitsch (1959) medium supplemented with low ammonium (200 mg l^{-1}). A combination of BA (1.0 mg l^{-1}) and 2, 4-D (0.2 mg l^{-1}) produced highly regenerative callus in different hybrids of *Philodendron*. Shoot meristems of *Diefenbachia* 'Peppermint' were regenerative in both MS and Nitsch nutrient media with standard concentrations of ammonium.

5. Experiments on potting and nutrient requirements of cultured plants

Experiments were conducted to determine the appropriate potting medium and nutrient requirements of the plants transferred from the flasks, by the Biotechnology section.

It was evident that pretreatment of plants, pots and potting media with Diethane M-45 which was routinely followed earlier was no more required as even otherwise 90-100% survival of seedlings could be ensured.

Among the various potting media tried for *Phalaenopsis*, dried stem cuttings of Cassava, outer shells of rubber seeds and broken tiles supported maximum growth of shoots and roots. Foliar sprays of different commercial fertilizers and their mixtures revealed that Factorfos (FACT Always) and a combination of

DAP (Spic, Tuticorin) and KNO_3 are the best and inexpensive sources of nutrition for seedling growth. Foliar application of dilute solutions of these fertilizers at alternate day intervals resulted in equally impressive growth of *Cattleya* 'Wine Festival' and *Dendrobium* 'Ng Eng Cheow' seedlings.

Yet another experiment conducted during this year was to study the effect of 11 different fertilizer mixtures (made of laboratory chemicals/commercial fertilizers/conventional cheap organic manures) on the growth of hybrid orchid cuttings of *Aranthera* 'Anne black' and *Holttumara* 'Loke Tuck Yip'.

The cuttings subjected to the fertilizer schedule showed signs of fresh shoot growth and initiation of axillary buds within a month after fertilizer application. Among the individual nitrogen sources tried, urea and nitrate, were the least to promote growth. In fact, urea as the only source of nitrogen not only retarded fresh root and shoot growth, but also caused leaf fall and browning and burning of existing root tips after two months of treatment. Ammonium was a better source of inorganic nitrogen than nitrate. Regular sprays of dilute solutions of diammonium phosphate and potash mixture yielded results comparable to those obtained with standard formation of NPK. Similar or even better rates of growth were noticed when inexpensive and easily available organic manures were used. It should be mentioned that a mixture of dry cowdung and poultry manure is better than the use of cowdung alone. An overlay of the mixture on the potting medium coupled with monthly sprays of filtrates of the mixture promoted optimal growth of the cuttings. These organic manures also induced the development of more than one axillary shoot especially in *Holttumara* cuttings without shoot tips. Plants grown in organic manure were healthy with profuse rooting and dark green leaves. Presumably such manures contain necessary trace elements and marginal amounts of inorganic nitrogen as well in addition to organic nitrogen. It is recommended therefore that these conventional manures could be safely employed by the amateur orchid growers and other interested orchid fanciers, for cultivating orchids. It may be possible, however, to improve the result, if occasional sprays of a mixture of urea, nitrate and ammonium supplemented to the cuttings which are otherwise grown in an overlay of cowdung and chicken manure.

Variations in the response of different hybrids to the same source of nutrition are usually encountered in cultivation trials with orchids. As mentioned earlier, while *Holttumara* cuttings without shoot apices produced atleast two healthy lateral shoots in organic manure, *Aranthera* cuttings produced only one. Besides, root formation was conspicuous in *Aranthera* in most of the nutrient mixtures tried. Significant difference in the rate of growth was not observed between the cuttings with shoot tips and newly formed axillary shoots on the cuttings without shoot tips. Therefore, it may not be desirable to show any preference towards cuttings with shoot apices for orchid cultivation purposes. As additional shoots are not formed on such cuttings of both *Aranthera* and *Holttumara*, cuttings without shoot apex may be a better choice to get more number of shoots.

6. *Protocorm differentiation in foliar tissues of Cymbidium*

Free hand sections of the protocorm-forming leaf tissues of *Cymbidium* stained in KI-I₂ reagent revealed the near absence of starch in tender leaf bases (inoculum) as well as mature plbs formed after 50 days of culture. However, 20-22 day old developing protocorms were fully loaded with starch. This additional evidence obtained during this year enabled us to summarise the results on this system for the purpose of preparing a manuscript as follows:

Relative changes in the endogenous levels of starch, soluble sugars and isoforms and activity of α -amylase were determined during protocorm development in leaf base segments of *Cymbidium* 'Bergundian Chateau' cultured in the dark. A large pool of sugars formed after two days of culture, disappeared at the initiation of tissue growth (10 days). Maximum accumulation of starch occurred when the growth centres were already formed and the protocorms were emerging (20-22 days). Rapid depletion of the starch reserve, consequent rise and then fall in free sugars, and high α -amylolytic activity characterized the rapid phase (20-30 days) of development of the protocorms. Evidences for the early appearance of a highly persistent isozyme of α -amylase, a_1 , and a transient, probably a marker isozyme, a_2 , confined to the period of high intensity metabolism (15-30 days) during the initiation and rapid development of the protocorms were obtained.

Mature protocorms contained negligible levels of starch and lacked the latter isozyme.

7. Tissue culture of medicinal plants

After standardising culture conditions for mass multiplication attention was focussed on the establishments of biosynthetically active cell suspension cultures preferably chlorophyllous ones in selected plants.

(i) *Sida rhombifolia*:

Friable calli were easily raised from leaf, stem and most explant cultures in MS medium supplemented with $1-5 \text{ mg l}^{-1}$ 2,4-D. Friability and rate of growth of the calli increased considerably in subcultures but invariably the cultures got bleached successively.

(ii) *Gloriosa superba* L.

Extensive studies undertaken on this system showed that growing tips of the underground corms are the only source of tissue best suited for regeneration, producing 2-4 shoots and a number of roots. Shoot regeneration was obtained in mixture of varying proportions of auxin (2, 4-D and NAA) and Cytokinin (BA and Kinetin). While roots were readily formed, shoot emergence in these media was a delayed process, usually after a period of 4-6 weeks and always preceded by at least a rudimentary callus formation. None of the explants derived from other parts of the corm produced shoots while profuse rooting was a common phenomenon. The roots originated mostly from the epidermal and subepidermal zones rather than from the starch loaded central cortical zone. Root cultures were easily established in dark in both solid and liquid nutrient media supplemented with 0.2 mg l^{-1} NAA or IAA. Slow growing, golden yellow callus cultures which were essentially non-friable type were also obtained in hormonal supplement of NAA 2.5 mg l^{-1} and BA 0.5 mg l^{-1} . It was concluded that corm explants may serve as a better source of root and shoot cultures rather than callus/cell suspension cultures for studies on product (colchicine) synthesis.

8. *Studies on haploid induction in cassava*

Previous results indicated that mixaploid calli were routinely obtained in anthers of cassava cultured in MB medium supplemented with 2, 4-D, NAA and Kinetin 2 mg l^{-1} each, coconut water and casein hydrolysate. Rhizogenesis was of common occurrence whereas shoot differentiation could not be induced in these calli. Realising an apparent set back in this project, diverse sources of inoculum including pollen, ovule and ovary, and induction of embryogenesis in anther cultures was attempted during the year.

(i) *Anther and Pollen cultures*

Anthers were cultured in solid and liquid media supplemented with different concentration of 2, 4-D. Irrespective of the concentrations, 2, 4-D was found to be toxic to the anthers. Per cent viability of the pollen decreased as the 2,4-D concentration increased. In higher concentrations ($12-16 \text{ mg l}^{-1}$) browning of the anther occurred within 10 days. Cytological observations revealed that the unicellular pollens remained as such and did not undergo mitosis in any of these treatments. Addition of BA (0.5 mg l^{-1}) to medium supplemented with 2 mg l^{-1} 2,4-D stimulated callus formation in at least 40% of the anthers. Microscopic observations revealed no presumptive embryo initials present in these calli. Besides the transfer of the calli to embryo differentiating media devoid of auxins or with low levels of auxins did not lead to any structural differentiation. Instead the calli got browned in due course.

Anther-derived calli were generally of compact type in liquid media supplemented with 2, 4-D. However, somewhat friable calli were obtained in combinations of 2 mg l^{-1} BAP, 1 mg l^{-1} NAA, 1 mg l^{-1} 2i P and 500 mg l^{-1} CH. Though morphological symptoms of embryo formation are not observed in these calli, masses of cells already separated and dispersed into the medium are being cultured in the solid media to study their further differentiation.

Fresh pollen released from the anthers as well as those derived from anthers cultured for 7 days, were subjected to various culture media and treatments. Isolated cases of karyokinesis were observed in Nitsch's medium supplemented with 2 mg l^{-1} BAP, 2 mg l^{-1} GA₃

2 mg l⁻¹, 15% CW and 500 mg l CH. The results are yet to be finalised.

(ii) *Ovule culture*

Unfertilized ovules dissected out from the ovaries were cultured in different media. Profuse callus formation was observed in Nitsch's medium supplemented with 2 mg l⁻¹ BAP, 1 mg l⁻¹, NAA and 500 mg l⁻¹ CH. Cytological studies of the proliferating callus revealed that the callus cells were derived from the integuments rather than embryosac. Evaluation of a number of ovule-derived calli with reference to possible mitotic divisions from the cells making up the embryosac is being done.

(iii) *Ovary culture*

In order to obtain pre-treated ovules, ovaries of different size and age were cultured in Nitsch's medium containing various concentrations of phytohormones. Nearly 90% of the ovaries which continue to remain after 10 days in a combination 2 mg l⁻¹ BAP, 1 mg l⁻¹ NAA and 15% CW produced callus. Attempts are being made to dissect out ovules from such ovaries and culture them in various media.

9. *Miscellaneous*

In vitro culture of *Nepenthes khasiana*:

Seeds of this endemic and endangered insectivorous plant of N. Eastern India were surface sterilized and sown on MS medium devoid of sugar. Germination took place within 6 weeks of culture. These were transferred to fresh media with 3% sugar where they formed leaves and roots.

When transferred to modified Knudson medium with suitable concentrations of BA and NAA the buds in the axils of leaves produced vigorous new shoots. Though these observations of multiple shoot formation were encouraging, isolated explants like leaf, base, lamina and nodes did not respond favourably.

METEOROLOGICAL DATA-1988

<i>Month</i>	<i>Precipitation*</i> (mm)	<i>Evaporation*</i> (mm)	<i>Maximum temperature**</i> (°C)	<i>Minimum temperature</i> (°C)	<i>Relative humidity**</i> (%)
January	—	125.6	33.6	17.9	68.0
February	160.8	130.5	34.5	20.1	73.0
March	86.2	132.1	33.9	22.5	78.0
April	473.2	112.3	33.0	22.7	84.0
May	101.6	108.9	32.3	23.6	82.0
June	453.8	72.3	30.2	22.3	86.0
July	333.0	88.5	30.1	21.7	82.0
August	289.0	82.5	30.0	21.9	85.0
September	396.8	75.4	29.8	21.5	86.0
October	105.9	107.9	31.8	21.1	82.0
November	120.4	98.0	31.8	20.3	81.0
December	111.8	112.6	32.1	19.2	78.0
Total	2632.5				

* Total of the month

** Monthly average

LIBRARY

Books and Periodicals

In 1988, 157 books were procured and added to the collection raising the total number of volumes to 3552. At present the library is supplied with 85 national and international journals.

Services

The library is used as a reference centre by research students from other institutions. Photocopying machine was extensively used this year also for the preparation of materials necessary for the horticultural training programme conducted during the year. Photocopying machine was made available to research workers from other institutions for copying research papers and other articles from the library.

Special Collection

The special collection of books, journals, articles, guide books, and other transparencies of Botanic Gardens which started in 1987 was enriched further with new collections. More photographs and slides showing different stages of the development of the garden was also added to the existing collection.

Other activities

Sale and distribution of publications of the Institute are done through the library.

Staff training programme in horticulture

(i) *Training at TBGRI, Palode*

After the successful completion of the training course in basic horticulture under Mr. Roy Bee in 1987, it was proposed to conduct a follow up course for the participants in the year 1988.

British Council and the Royal Botanic Gardens, Kew in a combined effort identified Mr. Mark Flanagan, Supervisor, Royal Botanic Gardens, Kew to conduct the follow up course.

Mr. Flanagan arrived at the garden on 6th April, 1988. After having a preliminary discussion with the participants a programme was chalked out. The programme was mainly practical oriented and was centered round the main sections of the garden.

Soil erosion, (both gully and sheet) was a serious problem in the lower slopes of the garden especially in the Arboretum and Medicinal Garden. The problem was solved by the construction of channels and by the establishment of grasses covering the slopes.

Suitable natural materials were used to cover the slopes to prevent soil erosion till the ground cover is getting established.

A small succulent garden was planned and the work executed in the medicinal garden with rocks pulled out from the river.

Annual beds and island beds were planned and executed. For the production of bedding plants a seed sowing chart was prepared. This will ensure the prompt supply of seedlings throughout the year as ready replacement for the beds.

Safety measures for the storage and use of pesticides and other chemicals were also discussed and put into practice.

A good number of suggestions were made for the improvement of the general functioning of the garden in the detailed report submitted.

This follow up course has helped the participants in gaining self confidence and to have a scientific approach towards the development and management of the garden.

(ii) *Training at Royal Botanic Gardens, Kew*

Mr. Jacob Thomas, Senior Scientific Assistant returned from U. K. and rejoined duty in September after completing an year's deputation to the Royal Botanic Gardens, Kew for training in Horticulture and Seed Banking, under the sponsorship of the British Council.

During his time at Kew, he obtained valuable practical experience in the different aspects of modern horticulture and allied fields and in the different activities of a seed bank; testing seed viability and their storage life, moisture content determination, etc., by working in the following major sections of the Kew gardens, viz., the arboretum, the temperate department, the Jodrell Seed Physiology Laboratory and the Seed Bank. Mr. Jacob Thomas also attended classes and passed the respective examinations for Arboriculture, Landscaping and Management and obtained the International Trainee's Certificate from the School of Horticulture, Royal Botanic Gardens, Kew, and the B.T.E.C. Certificate of Achievement in Management & Administration.

He visited over 20 notable botanic gardens in Scotland and U. K., the International Garden Festival at Glasgow and the famous Chelsea flower show. He also attended a number of flower shows conducted by the Royal Horticultural Society in London and served as steward in different judging committees. Above all, he made valuable contacts with important persons and organisations in and around Kew and London, on behalf of our garden. Also he was able to enrich our collection of exotics by negotiating with the Kew authorities to send a good number of very important living plants and a large number of seeds/spores to our garden including cycads, palms, trees, ferns and other endangered species.

PAPERS PUBLISHED

1. Krishnan, P. N. and Y. D. Singh 1988. Endosperm amylase activity in pearl millet seedlings in relation to dwarfism. *Curr. Sci.* 57: 1302-1304.
2. Koshy, K. C. and G. L. Shah 1987. A contribution to the Angiospermic flora and vegetation of Mandvi and Gokhirva Forest ranges in Maharashtra. *J. Econ. Tax. Bot.* 10(1): 79-124.

SEMINARS AND SYMPOSIA

SEMINARS ARRANGED BY TROPGARDEN FORUM

<i>Date</i>	<i>Speaker</i>	<i>Title of seminar</i>
6-1-1988	Dr P. N. Krishnan	In vitro production of haploids
20-1-1988	Sri. C. Sathishkumar	'Carnivorous plants--a prologue'
10-2-1988	Dr T. S. Nayar	Plant Nomenclature
16-5-1988	Dr S. Seeni	Photosynthetic properties of photoheterotrophic cells of peanut.

Other Seminars, Symposia, Workshop and Training

1. Dr T. K. Abraham, attended the XXVIII annual conference and golden jubilee celebrations of the Association of Microbiologists of India, held at Pune from January 16-18, 1988 and presented a paper entitled "Accumulation of citric acid in the culture filtrates of *Aspergillus niger* 6N3 and its mutant strains"
2. Dr T. K. Abraham, participated in the National Symposium on "New Trends in Biotechnology" held from June 3-4, 1988 at RRL, Trivandrum and presented a paper entitled "Biodegradation and utilization of Agricultural Wastes by Thermophilic fungi"
3. Dr K.C. Koshy, attended the International Bamboo Workshop organised by KFRI and sponsored by International Developmental Research Centre, Canada-held at Cochin, Kerala from 14-18 November 1988
4. Sri P. J. Mathew, attended an eight day training programme on Ethnobotany conducted by the society of Ethnobotanists at Lucknow and presented a poster on 'Ethnobotanic information on plants used by Kanikars for the treatment of snake bite and inflammations'.
5. Sri P. J. Mathew, attended one day seminar on 'Cultivation of medicinal plants as inter-crop in Rubber plantation', conducted by Rubber Board at Kottayam, Kerala.
6. Sri P. J. Mathew, attended 14 days training programme at Regional Research Laboratory (CSIR), Pappanamcode, Trivandrum from 21st November to 14th December 1988 on basic techniques of extraction and isolation of biologically active compounds.
7. Shri. P. J. Mathew participated in a scientific seminar organised by Kerala Pharmacy Graduates Association, Trivandrum on 28-10-1988 at the College of Pharmaceutical Sciences, Trivandrum and delivered a lecture on 'Endangered medicinal plants of Kerala'.
8. Shri. Jacob Thomas attended the International Conference

on Advances in Seed Biology held at Royal Botanic Gardens, Kew, U. K. on 14th and 15th of April 1988.

9. Dr P. N. Krishnan presented a paper on 'Androgenesis in anther cultures of cassava', by Krishnan, P. N., S. Seeni and A. Abraham, at the National Symposium on New Trends in Biotechnology, on June 3-4, 1988 held at Trivandrum.
10. Dr S. Seeni, presented a paper entitled 'Excretion of Photosynthates by cell suspension cultures of peanut', at the National Symposium on New Trends in Biotechnology on June 3-4, 1988 held at Trivandrum.
11. Smt. P. G. Latha, presented a paper entitled 'Mericloning in *Dendrobium* hybrids', at the National Symposium on New Trends in Biotechnology on June 3-4, 1988 held at Trivandrum.

CIVIL WORKS

(a) Laboratory and Library Complex

Construction work of the laboratory and library complex which began in December, 1986 is almost complete. Eighty percent of the electrical and plumbing work also completed during this year.

(b) Staff Quarters

The construction work of the staff quarters which started in September, 1986 was completed during this year.

(c) Ancillary facilities

Estimates were prepared for the main gate of the garden and the guard house. Estimates were also prepared for the construction of an overhead water tank to supply water to the Laboratory and Library complex.

(d) Roads and Miscellaneous work

1. Construction of an approach road to the Laboratory and library complex was completed.

2. The Road leading to the Arboretum was mettalled and then black topped.
3. Mettaling and black topping of the road at the quarters site was completed during this year.

(e) Landscaping

Landscaping of the rear area of the main building (Laboratory and Library Complex) was started during this year and the work is in progress.

ADMINISTRATION

Staff changes

Sri. P. Govindan Nair, Accounts Officer returned to his parent department (Accountant General's Office) in August 1988 and Sri. M. P. Sadasivan Nair took charge as Accounts Officer in October, 1988 from the same department.

Sri. K. P. Vijayakumar, Assistant Librarian, left TBGRI in July 1988 to join the Kerala University Library Science Dept. as Lecturer.

Sri. Jacob Thomas, S. S. A., rejoined duty in September 1988 after an year's deputation to the Royal Botanic Gardens, Kew, U. K. for the training programme in Horticulture.

Staff of the Institute

Director

Professor A. N. Namboodiri

Deputy Director

Dr. G. Bhadrn Nair

Scientist-in-charge

Dr. T. K. Abraham

Research and Development

Plant Taxonomy Division

Dr. T. S. Nayar

Dr. K. C. Koshy

Sri C. Sathish Kumar

Sri N. Mohanan

Sr. Scientific Assistant

Jr. Scientific Assistant

Jr. Scientific Assistant

Jr. Scientific Assistant

Herbarium Section

Sri. S. Mukuntha Kumar Assistant Herbarium Keeper

Plant Biotechnology Division

Dr. S. Seeni Scientist
 Dr. G. Gopalan Scientist (on leave)
 Dr. P. N. Krishnan Scientist
 Smt. P. G. Latha Scientist
 Sri P. K. Suresh Kumar Technical Assistant
 Smt. C. G. Sudha Technical Assistant

Medicinal Plant Division

Sri P. J. Mathew Sr. Scientific Assistant
 Sri A. E. Shanavaskhan Field Assistant

Germplasm Centre and Seed Bank

Sri Jacob Thomas Sr. Scientific Assistant

Horticulture and Garden Development

Sri Bejoy Mathew Field Assistant (on leave)
 Sri C. Anil Kumar Garden Assistant
 Sri P. C. Binoy Garden Assistant
 Sri P. A. Jose Garden Assistant
 Sri Mathew Dan Garden Assistant
 Sri R. Rajvikraman Garden Assistant

Library

Sri K. P. Vijayakumar Assistant Librarian (up to July 1988)
 Smt. V. Sujatha Jr. Library Assistant

Artist

Sri K. P. Pradeep Kumar

Administrative Division

Sri P. Govindan Nair Accounts Officer (upto to August 1988)
 Sri M. P. Sadasivan Nair Accounts Officer (from September 1988)
 Sri K. G. Ajithkumar P. A. to the Director
 Smt S. Radhalekshmi Ammal P. A. to the Accounts Officer
 Sri R. Muralidharan Nair Section Officer
 Sri Suresh Chandran Assistant Gr. I
 Smt C. Syamala Accountant
 Smt V. Jayasree Assistant Gr. II
 Smt A. Santha Typist Gr. II
 Smt G. Subhadra Typist Gr. II
 Smt C. Gracy Stenographer Gr. II

Other Staff

Sri Lazer Joseph	Night Watchman
Sri M. Bhuvanachandran	Night Watchman
Smt R. Valsala Devi	Part-time sweeper

Projects

Mr. K. Satheshkumar	Research Associate (From September 1988) ICAR Project — 'In vitro culture of anthers and production of haploids in cassava'.
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Important Visitors

Justice K. Sukumaran, High Court of Kerala, Cochin.

Dr. S. Sharma and Dr. C. Thankam, School of Ecology.

Mr. Kevin and Lisa Barron, I.N. Lane, Londonville, N. Y. 12211, U.S.A.

Mr Gudruss Vogel, Council General of the Federal Republic of Germany in Madras.

Dr. Hari Eswaran, Soil Management Support Services, Washington D. C. 20013, U.S.A.

Mr. Mark Flanagan, Royal Botanic Garden, Wakehurst Place, Sussex, U.K.

Sri T.M. Rai, Minister of Agriculture and Co-operation, Govt. of Sikkim, Gangtok.

Dr. Leela Raman, Deputy Director, National Institute of Nutrition, Hyderabad.

Ms. Jane Phillips, The British Council, 10, Spring Gardens, London, U.K.

Mr. G. Nicholson, 617 Glenn Avenue, Lenigh Acres, Fl, 33934, U.S.A.

Sri M. Vijayanunni, Secretary to the Chief Minister of Kerala, Trivandrum.

Prof. N. Balakrishnan Nair, Chairman, State Committee on Science, Technology and Environment, Govt. of Kerala, Trivandrum.

Sri. V. Krishnamurthy, Planning Secretary, Govt. of Kerala, Trivandrum.

Sri. K. Jacob Ninan, Chairman, Pollution Control Board, Cochin.

Dr. K.S.S. Nair, Director, K.F.R.J., Trichur.

Dr. P. Basak, Executive Director, C.W.R.D.M., Calicut.

Dr. M.P. Parameswaran, K.S.S.P., Trivandrum.

Prof. M.K. Prasad, Pro Vice-chancellor, Calicut University.

Dr. V. Balakrishnan, Professor, Medical College, Trivandrum.
 Prof. C.G. Ramachandran Nair, Editor, Malayalam Encyclopaedia,
 Trivandrum.

Prof. T. Thiruvikraman, Head of the Department of Mathematics,
 University of Cochin.

Prof. R.V.G. Menon, Director, ANERT, Trivandrum.

Sri C.J. Johny, Department of Science, Technology and Environment,
 New Delhi.

Hon. Sri. E.K. Nayanar, Chief Minister of Kerala

Hon. Sri. A. C. Shanmukhadass, Minister of Health, Govt. of Kerala

Mr. Andrew Picken, British Council Division, British Deputy High Commis-
 sion, Madras.

Sri T. Balakrishnan, District Collector, Trivandrum.

Dr. E.G. Silas, Vice-Chancellor, Kerala Agricultural University,
 Vellanikkara, Trichur.

Sri V.M.C. Narayanan Namboodiri, Vaidyamadham, Mezhatthur, Trithala.

EDUCATIONAL TOURS FROM INSTITUTIONS TO THE GARDEN

Yuvajana Sakhyam, Pathanamthitta

Govt. H.S. Kozhenchery

Ayurveda College, Trivandrum

M.C.U.P.S., Chethakkal, Ranni

Forest Department, Govt. of Kerala

Stella Mary L.P. School, Nellimoodu, Trivandrum

N.S.S. Unit, Iqbal College, Peringamala

Botany Department, Kerala University

Govt. Boys H.S., Karamana, Trivandrum

Govt. Hospital, Palode

University of Agriculture, Vellanikkara, Trichur.

Janakiammal College, Sivakasi

College of Agriculture, Trivandrum

Institute of Management in Government, Trivandrum

Medical College, Trivandrum

Govt. U.P.S. Kattayikkonam
 Nirmalambika L.P.S., Kottarakkara
 Engineering College, Trivandrum
 Mar Theophilos Training College, Trivandrum
 Water Authority, Govt. of Kerala, Trivandrum
 Regional Research Laboratory, Trivandrum
 C. S. I. English Medium School, Attingal
 Vivekananda Memorial Public School, Balarampapuram
 Range Officers undergoing training at Agricultural College; Vellayani
 Science Club, R. K. D. N. S. H. S., Sasthamangalam
 Ayyappa College, Nagercoil
 Muslim High School for Girls, Kaniyapuram
 Academic Staff and Lecturers from Kerala University and Mahathma Gandhi
 University
 Y. W. C. A., Changanassery
 S. V. R. N. S. S. College, Vazhoor, Theerdhapadapuram P. O.
 Govt. H. S. Indinjar
 Govt. H. S. Vellanad
 Custon Hill High School, Trivandrum
 Department of Botany, Sri Parasakthi College, Courtalam
 CPCRI, Palode
 State Bank of India, Regional Office, Trivandrum
 P. W. D. Office, Palode
 Ayurveda College, Tripunithura
 Kerala Sastra Sahithya Parishad, Karunagappally
 Ayurveda Institute, Pujappura, Trivandrum
 Mahatma Gandhi College, Trivandrum
 State Bank of Travancore, Palode
 Bharat Scouts and Guides Training Centre, Palode
 All India Radio, Trivandrum



Butea parviflora, a woody climber, spreading over magnificent trees in our Arboretum - painting by Shri Pradeep Kumar (see inner cover)