

# **JNTBGRI**

# **ANNUAL REPORT**

## **2022 - 2023**



**KSCSTE - JNTBGRI**  
**Jawaharlal Nehru Tropical Botanic Garden and Research Institute**  
**Pacha-Palode, Karimancode P.O., Thiruvananthapuram - 695 562,**  
**Kerala, India**  
**[www.jntbgri.res.in](http://www.jntbgri.res.in)**



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**KERALA STATE COUNCIL FOR SCIENCE TECHNOLOGY AND ENVIRONMENT -  
JAWAHARLAL NEHRU TROPICAL BOTANIC GARDEN AND RESEARCH INSTITUTE  
Karimancode P.O., Pacha-Palode, Thiruvananthapuram-695 562, Kerala, India**

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2022-2023

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Dr. R. Prakashkumar  
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**Design & Layout**

Dr. A. Nazarudeen

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Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Thiruvananthapuram –  
695562, Kerala, India

E-mail: [contact@jntbgri.res.in](mailto:contact@jntbgri.res.in)

Website: [www.jntbgri.res.in](http://www.jntbgri.res.in)



Cover photo: *Baccaurea courtallensis* (Wight) Muell.-Arg.  
Photo by Dr. A. Nazarudeen

## CONTENT

SN	Entry	Page No.
1	Introduction	7
2	Division of Garden Management, Education Information and Training	7
3	Aquatic Plants Conservatory	8
4	Arboretum	9
5	Palmetum	9
6	Fernery	12
7	Gymnosperms	13
8	Lesser-known fruit plants	13
9	Ornamental plants and landscapes	14
10	Central Nursery plant sales unit	14
11	RET species park	15
12	Compost unit	15
13	Visitor's Management Centre	15
14	Labour Management	16
15	Division of Plant Genetic Resources	20
16	Medicinal, aromatic and spice plants unit	20
17	Field Gene Bank and Conservatory Garden for Andaman Flora	21
18	Bamboo Biology unit	22
19	Orchid Biology unit and Carnivorous plants	22
20	Tissue Culture unit	23
21	Division of Biotechnology & Bioinformatics	23
22	Conservation biotechnology	24
23	Bioproduction	27
24	Molecular Biology	27
25	Bioinformatics centre	30
26	Saraswathy Thangavelu Extension Centre, Puthenthoppu	31
27	Division of Conservation Biology	34
28	Seed Bank, seed holding and maintenance	34
29	Documentation of Flowering Plants of India	35
30	Palynology Laboratory	35
31	Division of Phyto chemistry and Phytopharmacology	53
32	Division of Plant Systematics & Evolutionary Science	63
33	Herbarium (TBGT)	73
34	Red Data Book of Kerala Plants	73
35	Conserving RET species/ KSBB funded (Kudumbasree Project)	75
36	Division of Ethnomedicine & Ethnopharmacology	79
37	Division of Microbiology	83
38	Extension & Training unit	87
39	Products/ plants for sale	87
40	Tissue culture plants for sale	98
41	Library and Information Science	98
42	Exhibitions	101
43	Major and unique facilities created	101
44	Honours, Awards & Recognitions	102

45	MoU & Research Collaborations	105
46	Hybrids registered	106
47	Ph.D. awarded	106
48	Ph.D. programmes ongoing	107
49	Students Programme	111
50	Final Technical Reports	112
51	Research Publications	114
52	Chapters in book	121
53	Book published	124
54	Seminars/Symposia Papers	126
55	Invited Talks	137
56	Outreach Programmes	139
57	Workshop/Training/Webinars organized / attended	140
58	Popular articles	146
59	Significant assignments and consultations	147
60	Trainings conducted	149
61	Patents granted	151
62	VIP Visits	152
63	Special talks organized	153
64	Plan funded research and infrastructure programmes	157
65	Externally funded programmes	159
66	Research Council	166
67	Management Committee	167
68	Staff List	167
69	List of retired/ departed staff	172
70	Expenditure Statement	173
71	Balance Sheet	174



## From the Director's Desk

I joined as the 9th director of JNTBGRI on 1st June 2018 and I feel immensely happy in presenting this report as a testimony of the exciting performances and productive efficiency of the committed and enthusiastic researchers in recuperating the Garden system as well as the connected R & D activities performed during the period 2022-2023. I hope that this report may provide useful leads to our activities and objectives fulfilled so far and I am fully confident that with the continued support of the Government of Kerala, guidance from the members of the Management Committee, Executive Committee and Research Advisory Committee, continued dedication of the members of the staff and generous funding from various National and International agencies, JNTBGRI can accomplish its cherished goals with very many promising research and development activities that can go a long way in the service of mankind. We are indebted to the Kerala State Council for Science, Technology and Environment and the Government of Kerala for financial support and advice meted out from time to time. Setting up of a conservatory botanic garden has reached with more than 50,000 live accessions belonging to nearly 5000 species. Assemblage and maintenance of such vast plant diversity at JNTBGRI was made possible only because of the constant and wholehearted efforts of the staff and the vision set by the former Directors. I am grateful to the present and former staff and Directors of this Institute, who have rendered expertise and professional assistance in the transformation of the Conservatory Botanic Garden in the present state. The memory of the legendary Late Prof (Dr.) A. Abraham, the founder Director and visionary of this Institute is gratefully acknowledged. Scientists, researchers, teachers, and professionals from different walks of life including the tribal people who have generously shared their knowledge and skills during the evolutionary process of this Institute is honoured.

Dr. R. Prakashkumar

Director

## **INTRODUCTION**

KSCSTE-Jawaharlal Nehru Tropical Botanic Garden and Research Institute (KSCSTE – JNTBGRI) is a conservatory botanic garden and research institution established by the Government of Kerala which functions under the umbrella of the Kerala State Council for Science, Technology and Environment (KSCSTE). JNTBGRI is a premier autonomous R & D Centre of the Government of Kerala, established on 17 November 1979 with a broadened mission of conserving the waning tropical plant resources and species of India. Currently the Institute focusses conservation, evaluation, and sustainable utilization of India's tropical plant diversity. The Institute now works on in the thrust areas viz., Establishment of *ex situ* conservatories and Garden development, Integrated taxonomy and Conservation Biology, Sustainable Utilization, Biotechnology and Bioinformatics and Capacity Building and Training. The idea of establishing conservatory botanic garden and research institute was conceived after the first United Nations Conference on Human Environment, held in Stockholm in 1972. It was under the committed efforts by late Professor A. Abraham, the Founder Director, the Garden became a reality. It was established as an autonomous R&D organization The Kew Botanic Gardens played a significant role in the designing and lay-out of the garden in its initial stages.

## **DIVISION OF GARDEN MANAGEMENT, EDUCATION INFORMATION AND TRAINING**

The Division of Garden Management, Education, Extension and Training of JNTBGRI, mainly deals with the development and maintenance of plant conservatories, landscapes, and displays of conservation, education and aesthetic interest. Conservation gardens mainly focus on indigenous plants especially endemics and IUCN Red listed species, while the aesthetic and educational collections incorporate curious exotic species also. The plant germ plasm collections are enriched mainly through field explorations, purchase, and exchange with other conservatory gardens.

The Division is involved in developing conventional propagation protocols for species facing conservation threats and subsequent multiplication for eco-restoration of degraded natural habitats particularly in the Western Ghats, declining sacred groves and for the construction of new bio parks.

The Division remarkably contributes to income generation through plant sales and by promoting garden visits. It is also involved with other outreach programmes like exhibitions, consultancy in developing Bio-parks/ Botanical gardens for educational institutions and other government organization.

On par with the Plant Genetic Resource division, the garden Management Division maintains different thematic collections of conservation, educational and aesthetic interests. The twelve different themes/function-based units in the division are (i) Aquatic plants conservatory, (ii) Arboretum, (iii) Palmetum, (iv) Fernery, (v) Gymnosperms, (vi) Fruit Plants including lesser exploited indigenous species, (vii) Ornamental plants & landscapes (viii) Central nursery, sales & distribution, (ix) RET species park (x) Compost management (xi) Public relations, visitor's management & Extension activities (xii) Labour management.

**(i) Aquatic Plants Conservatory**

The Aquatic plant conservatory preserves plants of conservational, educational, and aesthetic interests grown in water and bogland ecosystems. During the report period about 130 species/cultivars were added to the collection through field explorations, purchase, and exchange. The cultivars of Lotus and Waterlilies were multiplied by splitting suckers and sold out to add in income generation. Twenty-nine among them are new to the collection. The educational collection of Aquatic species specially adapted with diverse type modifications for the life in water sorted out to display in the Gallery style display steps.



Fig. 1. Gallery style display steps Aquatic plant conservatory

**(ii) Arboretum**

The Arboretum that spread over 50 acres of the total 300-acre garden, preserves over 800 species of trees including many endemics with IUCN conservation status. During the report period 2 new additions were made through explorations. As in previous years, during in the given period also the Arboretum section could contribute significantly to eco-restoration extension programmes, particularly in restoring mangroves and constructing Bio-parks as well as plant sales through the multiplication of endemic/ indigenous trees stock. As a part of landscape alteration, a traditional village face is given to the Arboretum entrance from the biotech lab side by constructing antique style earthen compound walls, ancient style gate, traditional shops etc. in KTDC funding.

**(iii) Palmetum**

Reflexology Pathway, the landscape footpath constructed based on the ancient Egyptian traditional medical massage system, done in the Palmetum was the most noticeable landscape creation invited visitors' attraction during the period. The 50m long cobble stone paved Reflexology Pathway (1.5m broad) coupled with the parallel alternative Eurocon tile path in same breadth (for non-users to walk through) connects the Palmetum to the 'Lake shore

leisure trail' surrounding the reservoir. The traditional 'Kottiyambalam' style arch and the explanatory boards on the theory of Reflexology at the path entry add to the attraction. One giant spider web model done in the Palmetum raise curiosity of children. Rubble walled granite topped tree ring cum visitors seating, done surrounding the Bamboo clump at the entrance of the Palmetum is a shade relief for garden visitors. The granite sheet paved foot path in about 100 m length in the Palmetum was restructured in attractive curvy line and provided with a homogenous avenue of *Bentinckia nicobarica* (20nos) at one side. Many topiaries including the 3 ft. high 'PALMETUM' letters done of *Ehretia microphylla* make the entrance layman enthusiastic.



Fig. 2. Palmetum topiary with *Ehretia*



Fig. 3. Reflexology pathway in the Palmetum



Fig. 4. Dr. E. Sreekumar, Director, IAV, inaugurating the newly constructed Reflexology Pathway in the Palmetum on 10 January 2023.



Fig. 5. Giant spider web model, Palmetum

#### **(iv) Fernery**

The JNTBGRI Fernery, the largest collection of its kind in the country, maintains a well saturated collection of Indian Ferns and Lycophytes of 272 species comprising primitive species like *Psilotum nudum*, *Equisetum arvense*, *Huperzia squarrosa*, *Huperzia phlegmaria* etc., plant curiosities like *Ophioglossum reticulatum*, *Gymnosphaera gigantea*, *Helminthostachy szeylanica* etc. In the report period 4 accessions were done out of which one species is a new addition. Many species were multiplied by the splitting up of suckers as well as through spore germination. A good flourish in growth and sucker sprout has been achieved this year by the replacement of the algae faded roof sheet with clear sheets permitting more light entry.



Fig. 6. Fernery fencing

#### **(v) Gymnosperms**

Individual physical protection was given to all the cycads in the precious collection comprising 7 genera as well as to the sole endemic conifer species *Nageia wallichiana* to protect them from wild boar attack. A good number of *Cycas* spp. *Dioon spinulosum*, and *Zamia* were propagated by splitting suckers for selling.

#### **(vi) Lesser-known fruit plants**

The section concentrates on identifying indigenous fruits traditionally used by the ethnic and other local people of the region and their popularisation in the general community. In collaboration with the research divisions like ethnopharmacology and phytochemistry of the Institute, selected species were subjected to toxicity and nutritive value studies to evaluate the possibilities of promoting them as edible fruits. During the report period 30 new accessions were added to the mother plant stock of most demanded variants. Thousands of stock plants for grafting were propagated by collecting seeds locally. Many numbers of grafts and buds of quality guaranteed variants were sold out, contributing much to the income generation. Plan is submitted and initiative taken to pave the rocky guttered entry of the road to Fruit section with interlocks.

### **(vii) Ornamental plants and landscapes**

The unit is responsible for developing aesthetic landscapes and displays focusing main entrance, sides of roads and pathways and premises of major buildings. It is also assigned with developing curious ornamental group collections for aesthetic and educational displays. The unit is also bound to identify and popularise the wild less-exploited horticultural potential of the indigenous flora. The major landscape works done during the report period are the two carpet beds in the frontage garden: (i) Emblem carpet bed: The carpet bed of 225m<sup>2</sup> comprising of the institute logo and the letters JNTBGRI; the shrub flexible to be trained into desirable shapes *Ehretia microphylla* is used to depict the substance; background is constructed of rubble and bricks fixed with cement mortar. (ii) 'Gandhiji' carpet bed: The carpet bed of 165m<sup>2</sup> comprising of the nature conservation quote of Mahatma Gandhi 'The Earth has enough for man's needs but not for his greed' (the word synonymous with the vision of botanical gardens, 'the sustainable utilization of nature'). The substance matter done of *Alternanthera ficoidea* 'Green' is encircled by an outline of Gandhiji silhouette done of *Alternanthera ficoidea* 'Yellow'; here also the background is done of rubble and bricks fixed in cement mortar. A total number of 58 accessions of ornamental plants including indigenous wild species is added to the collection during the report period. Plan and estimate submitted for the relandscaping of the old Rose Garden plot and the road in front of it included of the newly done 'Ficus Arch' to be paved with interlock bordered with kerb stones. Three collection trips were conducted and added 58 new accessions in the wild ornamental plant germplasm. More than 5000 foliage and flowering pot plant display alterations in both interior and exterior were done with plants developed in the unit and in the Central Nursery. The huge *Ficus benjamina* tree planted by former Chief Minister Sri K. Karunakaran in 1992 which later caused blockage of the drainage pipes in the office building was uprooted using earth excavator. To honour the legacy of planter one clone sapling grafted out from the mother tree was arranged to plan in the frontage garden by his son and Member of Parliament Sri. K. Muralidharan on 13/01/2023.

### **(viii) Central nursery and plant sales unit**

The central nursery is assigned to multiply and distribute plants to strengthen the existing conservatories, to reconstruct the degraded natural ecosystems and for sales to generate the income. The unit also concentrates on developing conventional propagation protocols for conservation required indigenous/endemic species. During the report period nearly 20,000 saplings were raised through seed propagation and vegetative means, so that approximately

*Begonia* (600), *Bougainvillea* (1150), *Coleus* (400), *Dracaena* (200), Dragon fruit (280), *Hamelia* (450), *Hibiscus* (750), *Pentas* (150), Hanging pot plants (650), *Ixora* (1200), Jasmine (1300), *Kopsia* (500), *Nepenthes* (20), *Peperomia* (600), *Pereskia* (200), *Philodendron* (400), Rambutan (1100), Rose (720), *Selaginella* (800), *Tabernaemontana* (2050), *Tecoma* (200), *Zinnia* (1,050) etc. were propagated. 20,000 sprouted cuttings of *Ehretia microphylla* for planting the carpet beds were given to the ornamental plant unit. The sales section could earn Rs.13, 54,419/- (Rupees Thirteen lakhs fifty-four thousand four hundred and nineteen) through the sales of 33,705 numbers of plants produced in the two garden divisions and in the commercial tissue culture unit during the financial year. The unit maintains the oldest and well flourished *Nepenthes khasiana* plant in the garden under net roof and supports the Bio-prospecting study initiatives from the Phytochemistry division.

#### **(ix) RET Species Park**

The park like conservatory garden done in the 'Lead Garden project' of MoEF&CC in 2009 spreads over seven-acre land comprises of nearly 160 spp. of IUCN Red listed indigenous/endemic trees in many multiples. Still the addition through field exploration continues and in the report period 87 new accessions were made through trips in the Western Ghats. Minor landscape alternations were made at the entrance. Two polyhouses were done in the site with funding of two different external projects supported to get the newly accessed saplings flourished well for field planting in the forthcoming south-west monsoon.

#### **(x) Compost unit**

The unit intended to recycle the garden generated plant waste, could produce enough compost used for summer mulching in the ornamental plant and other units of the garden management division.

#### **(xi) Visitors Management Centre**

The unit arranges garden visits for students and public, guided by graduate/post graduate staff, generating conservation awareness along with entertainment. During the report period an amount of Rs.9, 98,900/- (Rupees nine lakhs ninety-eight thousand and nine hundred) and was generated through entrance fee from 19,384 visits. The unit also co-ordinates the exhibitions and outreach programmes giving exposure to the institute. As it is in every year the unit has initiated about 6 exhibitions and outreach consultancies spreading fame of the Institute.

## (xii) Labour Management

The labour management unit arranges the daily required number of labourers and skilled workers for the garden works from the existing muster roll as well as from the local people arranged by the labour supervisor. The unit responsibly arranges workers for holiday watering, prepare and submit documents to the office for their payment. The crisis arisen in garden maintenance due to non-availability of sufficient members in the muster roll was overcome through arranging Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) workers through the panchayat. More than 2000 MGNREGA works were arranged in different garden units during the report period.



Fig. 7. 'Gandhiji' carpet bed- Frontage Garden



Fig. 8. Emblem carpet bed- Frontage Garden



Fig. 9. Emblem carpet bed- Frontage Garden, under construction



Fig. 10. Training on endemic plant propagation to 'Kudumbasree' people

New taxa described by Garden Management Division



Fig. 11. *Humboldtia ponmudiana* ESS Kumar, Shareef & Raj Vikraman (Top Left);  
*Buchanania abrahamiana* ESS Kumar & Shareef (Top Right);  
*Syzygium caryophyllatum* var. *abrahamianum* Shareef & ESS Kumar (Bottom)

## **DIVISION OF PLANT GENETIC RESOURCES**

The PGR Division undertakes diverse activities on taxonomic, biosystematic and phytochemical studies, breeding experiments to produce new hybrids, studies to utilize the resources in a sustainable manner and extension/awareness activities along with its chief mandate on enrichment of the genetic resources of Medicinal and Aromatic plants, Bamboos, Orchids, Carnivorous plants etc. and maintaining the existing resources in the garden.

### **Medicinal, Aromatic and Spice Plants Unit**

*Ex-situ* conservation of genetic resource of selected medicinal plants and assessment of intraspecific variability is an ongoing programme through which characterization of selected medicinal plants are being carried out. Exploration trips were conducted to Northeast states (Arunachal Pradesh, Assam, Meghalaya, and Sikkim), Dindigul and Palakkad and introduced 30 species. As part of propagation trials, seeds of *Myristica beddomei*, *Knema attenuata* and *Indigofera tinctoria* subjected for germination trial in the Germinator and nursery. Cuttings of *Adathoda vasica* and *Punica granatum* were planted in pots in the humidity chamber and in the nursery to observe the variation in the duration and germination percentage. Air layered on the lateral branches of *Clitoria arborea* and rooted cuttings were planted in pots. Planted *Rauvolfia serpentina*, *Aegle marmelos*, *Syzygium* sp. and *Cochlospermum religiosum* were planted in pots. Seeds of *Aegle marmelos* and *Bauhinia tomentosa* were sowed. Established seedlings of 5 spp. were issued to the Butterfly Garden and 30 seedlings of *Artabotrys odoratissimus* were given to the Plant Systematics and Evolutionary Science Division. Cuttings 40 spp. were planted in shallow pots and 2,381 seedlings belonging to 72 species were raised in the nursery.

Planted *Ricinus communis*, *Commiphora wightii*, *Pandanus tectorius*, *Psilanthus travancoricus*, *Clitoria arborea*, *Ixora coccinea*, *Nelumbo nucifera*, *Lagenandra keralensis*, *Nymphoides indica*, *Equisetum arvense*, *Ocimum sanctum*, *Adhatoda vasica* in Itty Achuthan Vaidyan's Garden; *Cereus pterogonus* in the Succulent Garden; *Cestrum nocturnum* and *Santalum album* in the Shrubbery; *Operculina turpethum*, *Tinospora cordifolia*, *Naravelia zeylanica* and *Asparagus racemosus* in the Vinery section. Replanted *Coleus amboinicus*, *Eryngium foetidum* in the Aromatic Garden. Prepared a new herbal bed for *Indigofera tinctoria* near the Aromatic Garden. Replanted *Vernonia cinerea*, *Emilia sonchifolia*, *Biophytum sensitivum*, *Emilia sonchifolia*, *Cyanthillium cinereum*, *Catharanthus roseus*, *Eclipta alba*, *Bacopa monnieri*, *Adhatoda beddomei*, *Oxalis corniculata*, *Rauvolfia*

*serpentina*, *Mentha piperita*, *Scoparia dulcis*, *Vernonia cinerea*, *Centrotherum intermedium*, *Boerhaavia diffusa* and *Emilia sonchifolia*.

*Equisetum arvens* was displayed beside the entrance of the special group. Planted *Curcuma longa* and *Murraya koenigii* in the spice garden. Planted *Gossypium herbaceum*, *Orthosiphon glomeratus*, *Adhatoda vasica*, *Strobilanthus ciliatus*, *Saraca asoka*, *Peperomia* sp., *Chlorophytum borivilianum*, *Glycosmis mauritiana*, and *Anaphyllum wightii* in the herbal garden. Pruned the profusely grown plants of the Special group Display, removed outdated plants and replanted seedlings of *Phyllanthus niruri*, *Scoparia dulcis* and *Eryngium foetidum*. Renovated the fencing along Chittar river at the entrance of Itty Achuthan Vaidyan's Garden. Shade Net was spread out over the Special Group display to avoid sun-scorch. Cleared around the rare plants like *Commiphora wightii* and *Pandanus tectorius* in the Itty Achuthan Vaidyan's Garden.

### **Field Gene Bank and Conservatory Garden for Andaman Flora**

Plant exploration was conducted to Assam, Meghalaya, Nagaland, and West Bengal, Munnar, Paithalmala and Peechi and 104 species were introduced. A total of 18 accessions, 19 species collected from Northeast India are additions new to JNTBGRI. Two species from Andaman & Nicobar Islands were procured from KFRI. Seeds of *Knema attenuata*, *Diospyros montana*, *Leea guineensis* and *Ardisia littoralis* were sowed. Established plants of *Adhatoda vasica*, *Vitex negundo*, *Piper nigrum* 'PMM' and 'PAJ', *P. betle*, *Geophila reniformis* and *Bacopa monnieri* were multiplied through vegetative propagation. Established accessions of *Asparagus racemosus* and *Plumbago zeylanica* repotted and maintained in the tub of the conservatory. A sum of 120 plants of 11 species and 103 RET plants were repotted. Nursery established plants of 22 species were planted into the Andaman field conservatory. New field beds were prepared around the restructured round hut at FGB and herbals such as *Centella asiatica*, *Hemigraphis colorata*, *Geophila reniformis*, *Elephantopus scaber*, *Trichopus zeylanicus* and *Kaempferia galanga* were planted. Prepared three seating benches in the renovated hut at FGB using mature stems of *Areca triandra* from Andaman collection. Undergrowth clearing, mulching, and pruning of trees were carried out in the Andaman field plot. Morphological characterization of 12 accessions of *Murraya koenigii*, 2 accessions of *Asparagus racemosus* was carried out. Six Andaman species were identified, and 123 herbarium specimens were processed.

## **Bamboo Biology Unit**

Conservation of Bamboos at JNTBGRI is an ongoing plan funded project through which the Bambusetum of the Institute is being developed and maintained. Five plant explorations were carried out to Nagaland, Assam, Meghalaya, West Bengal, and Kerala (Rose Mala, Charupara, Chullalam, Adimali, Vagamon, Poopara, Poonjar and Urumbikkara) and collected 32 bamboo species, of which 7 are new additions. Seeds of *Dendrocalamus longispathus* and *Bambusa tulda* purchased from Tripura and saplings of *Pseudoxytenanthera madhavii* and *Dendrocalamus somdevei* from Date Bambusetum, Nashik, Maharashtra and received *Gigantochloa apus* and *G. takserah* from Institute of Himalayan Bioresource Technology (IHBT), Palampur. The rhizome geometry of *Melocanna baccifera* was studied by exposing the underground rhizome system and doing scientific topographic survey. The data was analysed, and diagrams & reports were prepared in AutoCAD and SketchUp formats.

## **Orchid Biology/ Carnivorous Plant Unit**

The unit deals with germplasm of Orchids, Carnivorous Plants and Anthuriums. 'Establishment and Upkeep of a National Collection of Orchids' is an ongoing plan funded programme through which daily maintenance and upkeep of the orchidaria are continued. Conducted 20 days long plant exploration trip to Northeast India (Arunachal Pradesh, Assam, Meghalaya, and Sikkim) and about 50 orchid species were introduced/ reintroduced. Following plant species were newly introduced to the present collection : *Grammatophyllum speciosum* var. *flava*, *G. wallisii*, *Sedirea japonica*, *Drosera serpens*, *Tetramicra canaliculata*, *Catasetum pileatum* alba, *Calanthe biloba*, *C. discolor*, *C. plantaginea*, *C. puberula*, *Aerides ringens*, *Coelogyne breviscapa*, *Coelogyne* sp., *Vanda tessellata*, *Podochilus falcatus*, *Paphiopedilum insigne*, *P. hirsutissimum*, *P. villosum*, *Dendrobium ovatum*, *Aerides crispa*, *A. ringens*, *Rhynchostylis retusa*, *Acampe praemorsa*, *Smithsonia straminea*, *Cottonia peduncularis*, *Anthurium forgetii*, *A. papillilaminum*, *A. clarinervium*, *Renanthera* Kalsom, *Vanda* hybrid, Mokara Prapin white, Mokara Chark kuan orange, Mokara Dinah shore red, Mokara Chark kuan pink, Mokara Bankuthian gold, Mokara Jairak gold, *Spathoglottis* Big red star, *Spathoglottis* salmon dots. Three species added to the germplasm collection of Foliage Anthuriums and allied groups. A total of 3668 plants in 19 varieties (*Anthurium* hybrids, orchid hybrids, and carnivorous plants) were potted / re-potted. More than 2250 *Nepenthes* hybrid plants were raised from JNTBGRI hybrid-3 and made available for sale.

Orchid breeding is an important activity of the Unit. Forty-eight interspecific / intergeneric crosses were carried out. Five hybrid capsules were harvested, and establishment of cultures is in progress in the Tissue Culture lab. New hybrids *Phaiocalanthe* Pink Splash (*Phaius tankervilleae* X *Calanthe rubens*) and *Phalaenopsis* Tiger Stripes (*Phalaenopsis mannii* X *Phalaenopsis fasciata*) registered at Royal Horticultural Society, England.

### **Tissue Culture Unit**

The Tissue culture Unit of the Division is working on non-conventional propagation of selected commercially important plants as part of institute's Lab-to-Land Programme and generating income for the institute. Under mass multiplication programme for ornamentals, micropropagation is being carried out in 23 potential taxa comprising hybrids of *Anthurium* and Orchids such as Caesar Violet, Hawaii Orange, Dora and *Phalaenopsis* white, pink, *Dendrobium* New coyote, Airy hybrid, Burana splash, Bangkok fancy, Venus, Triple fantasy, fluorescent pink, white, Pink, *Spathoglottis*, and *Rhynchosstylis* (new).

Explants collected from Aluva, Vellayani, Munnar, Idukki, Kallara, Bangalore & JNTBGRI Campus subjected for Culture initiation. A total of 78,764 culture Bottles were inoculated aseptically through specific protocols including fresh culture and subculture. During the period, 1,47,811 tissue cultured ornamental plants and bananas were deflasked. A sum of 95,375 Plantlets established in the laboratory conditions were transplanted for field hardening. Inflorescence of Red banana, Banana rose, Nendran, Rasakadali were subjected for fresh culture and *Zingiber officinale* (Big Rhizome), a new variety from Hyderabad was introduced as new trial in the laboratory.

### **DIVISION OF BIOTECHNOLOGY AND BIOINFORMATICS**

The conservation and sustainable utilization of the nation's plant genetic resources are intricately achieved through a multifaceted approach, involving biotechnological interventions, knowledge discovery, and the promotion of lab-to-land programs. This comprehensive endeavour is orchestrated by five specialized units within the division. The first, Conservation Biotechnology, concentrates on developing *in vitro* protocols for the long-term conservation and large-scale multiplication of vital plant species, effectively reversing their rarity status. This unit also delves into seed physiology studies, crafting efficient germination protocols for conservation and economically significant species. The second unit, Bioproduction, focuses on devising protocols for secondary metabolite production

through cell, root, and hairy root cultures, as well as implementing hydroponics systems for optimal results. The Molecular Biology unit focussed on genetic variability and the identification of specific genes crucial to the preservation and utilization of plant genetic resources. The fourth unit, the Bioinformatic Centre, is dedicated to creating biodiversity databases, disseminating knowledge, and bioprospecting medicinal plants for lead molecule discovery against various diseases. Lastly, the Saraswathy Thangavelue Extension Centre plays a pivotal role in producing and supplying quality planting materials, conducting large-scale cultivation demonstrations of orchids and ornamental crops, translating research findings into practical applications, and fostering human skill development. Additionally, this centre extends its expertise to consultancy programs for garden development.

### **Conservation biotechnology**

**Establishment of a biorepository of the plants endemic to the Southern Western Ghats of India:** Established JNTBGRI as the first biorepository in India as part of the Global Genome Initiative in 2023. The programme was supported by BGCI GGI-Gardens Partnership Award. JNTBGRI was the first Institute to receive this award in South Asia. The biorepository developed has multiple accessions of 57 species (58 taxa) from 47 genera belonging to 28 families, which are endemic to the Western Ghats and not represented in the Global Genome Biodiversity Network (GGBN). The collection holds significance as it includes 41 endemic and 14 threatened species, of which three species are point endemics, not represented in any other biorepository.

**Species distribution modelling and bioprospecting of wild germplasm of *Salacia* species:** Accomplished germplasm collections (43 accessions of 13 species) of *Salacia* species from the different natural habitats of Kerala/ Karnataka/ Tamil Nadu regions of the Western Ghats. Accessions are maintained in the specially prepared conservatory/Field gene bank (RET garden of KSCSTE-JNTBGRI) with germplasm registration. Analyzed anti-diabetic and anti-lipidemic properties of all *Salacia* species and identified that *S. malabarica* and *S. beddomei* could be the most promising raw material for anti-diabetic drug formulations both of which are endemic to the Southern Western Ghats. Isolation and quantification of salacinol content is in progress. Genome analysis - DNA Bar-coding/Species specific markers for establishing the identity of raw material for ensuring the quality raw material/safe supply of traditional medicine derived from the genus is in ultimate stages. Targeted specific objectives not only provide comprehensive assessment of species of *Salacia* but also

guarantee the strategies for conservation/reinforcement of the existing wild population for sustainable utilization, as the plant is now being highly traded and extensively used in pharmaceutical industries.

**Habitat distribution modelling and reinforcement of *Buchanania barberi* and *Calophyllum apetalum*:** Accomplished inventory/ mapping/ accurate field data of the wild population of the two trees, *Buchanania barberi* and *Calophyllum apetalum* across the Western Ghats. The distribution map of two trees was developed with GIS. Zygotic embryo cryopreservation protocols are standardized for *B. barberi* and *C. apetalum*. A total of 8 accessions of *B. barberi* and 12 accessions of *C. apetalum* are maintained in the *in vitro* bank/ specially prepared conservatory/Field gene bank with germplasm registration.

**Analysis of species distribution and reinforcement of *Buchanania lanzan* var. *palodensis*:** Habitat study and germplasm collection of *Buchanania lanzan* var. *palodensis* a solo plant species identified and recorded in the Palode region. Seedlings were successfully raised with GA<sub>3</sub> treatment (with 100% germination rate). *in vitro* regeneration and zygotic embryo cryopreservation studies are in progress.

***Ex situ* conservation, chemical and molecular profiling of sweet flag (*Acorus calamus* L.) germplasm from the Western Ghats:** Accomplished the phytochemical and genetic characterization of the *A. calamus* germplasm across the Western ghats to identify the elite genotype(s) (WHO suggested that only the *A. calamus* with no  $\beta$ -asarone or having very low quantity of this compound should be used in the food as well as in the medicines due to the highly carcinogenic and toxic properties of the  $\beta$ -asarone compounds). The present study identified an elite accession of *A. calamus* with less  $\beta$ -asarone content (1.35 $\pm$ 0.00 mg/g) from the Western Ghats. Developed Species-Specific ISSR-Derived SCAR Marker for the identification of quality raw material.

**Utility of semiochemicals and exploitation of *Etilingera fenzlii*, an endemic plant species of the Andaman and Nicobar Islands in pest/insect management:** The plant under previous studies has been well established as a mosquito repellent. A repellent formula from the essential oil of the plant is processed and efficacy/reliability/CPT/Outdoor-Indoor field trials are in progress. The study also pertained to the development of a repellent gel that contains essential oil extracted from the leaf as an active ingredient. This plant can thereby be extended for the label of a potent mosquito repellent that can thwart a broad spectrum of these deleterious pests.

***Calophyllum apetalum* Willd. seed physiology:** The study focused on understanding seed physiology, growth parameters, and the expression of Late Embryogenesis Abundant (LEA) proteins in *C. apetalum*, an endemic tree of the Western Ghats. The objective was to establish an efficient protocol for seed germination, paving the way for large-scale conservation and commercial exploration of the species.

**Key aspects of the research include:**

*Seed Physiology:* Investigating the physiological aspects of the seeds, such as dormancy, viability, and factors influencing germination, to gain insights into the reproductive biology of *Calophyllum apetalum*.

*Growth Parameters:* Examining various growth parameters to understand the optimal conditions for the tree's development, including factors like light, temperature, and soil composition.

*LEA Proteins Expression:* Analysing the expression of Late Embryogenesis Abundant (LEA) proteins, which are known for their role in stress tolerance, particularly during seed development and germination. This provided information on the adaptive mechanisms of the species.

*Protocol Standardization:* Developing and refining a protocol for seed germination, ensuring that the process is efficient and reproducible. This standardized protocol serves as a basis for large-scale conservation efforts.

*Conservation and Commercial Exploration:* The goal of the study was to contribute to the conservation of *Calophyllum apetalum* by providing a reliable method for seed germination. Additionally, the research laid the foundation for potential commercial applications, exploring the economic potential of the species.

By combining insights into seed physiology, growth parameters, and molecular aspects such as LEA proteins expression, the study aimed to facilitate both conservation efforts and the sustainable utilization of *Calophyllum apetalum* in various applications, contributing to the understanding and management of this endemic tree species in the Western Ghats.

## **i. Bioproduction**

The unit is currently dedicated to enhancing the acceptability of plant-derived essential oils in the herbal drug, essential oil, and cosmetics industries, with a specific focus on *Plectranthus vettiveroides* (Jacob) N. P. Singh & B. D. Sharma. This medicinal plant, once endemic to South India, is now extinct in the wild. The plant's preference for specific agroclimatic conditions and the laborious process of root harvesting, where 40-50% of the roots are lost due to their thin and hairy nature, have prompted a shift toward alternative method of its oil production. At present, the unit is actively developing protocols for root-derived essential oil production through hydroponics, root, and hairy root cultures in *Plectranthus vettiveroides*.

Successful initiation of shoot cultures has been achieved, and ongoing efforts are directed towards the establishment of root cultures. In the hydroponics system, the unit has standardized the medium to optimize biomass yield, considering environmental factors such as light, moisture content, and temperature. Comparative phytochemical profiling of roots from field-grown plants and those cultivated in hydroponic systems has been conducted through GC-MS analysis of the oil. Although the phytochemical profiles of the roots were similar, the total oil yield in the hydroponic system was comparatively lower. Ongoing experiments are aimed at improving oil yield in the hydroponic system, addressing the challenges posed by the plant's specific growth requirements and root harvesting difficulties.

## **ii. Molecular Biology**

### **Temperature stress tolerance in small cardamom (*Elettaria cardamomum* Maton) upon root colonization by endophytic fungus *Piriformospora indica***

*Elettaria cardamomum* Maton, one of the most valuable and ancient spice crops, is generally vulnerable to abiotic stress factors. The major factor that contributes to this specificity of the plant is the temperature. *P. indica* symbiosis with cardamom reduced the negative effects of temperature stress. This study aimed to identify temperature stress tolerant genes in *Piriformospora indica* induced cardamom plants and evaluation of chlorophyll and mineral content.

More than one year old *P. indica* colonized cardamom plants already established in JNTBGRI experimental field were exposed to shade and temperature stress. The changes

in plant phenotypes, some biochemical parameters, and the expression of temperature tolerant genes in cardamom leaves under shade and stress condition were measured. Results obtained shows that colonization of roots by *P. indica* revealed significant variation in leaf number, leaf length and tiller number of temperature stressed plants with control ( $p < 0.05$ ).

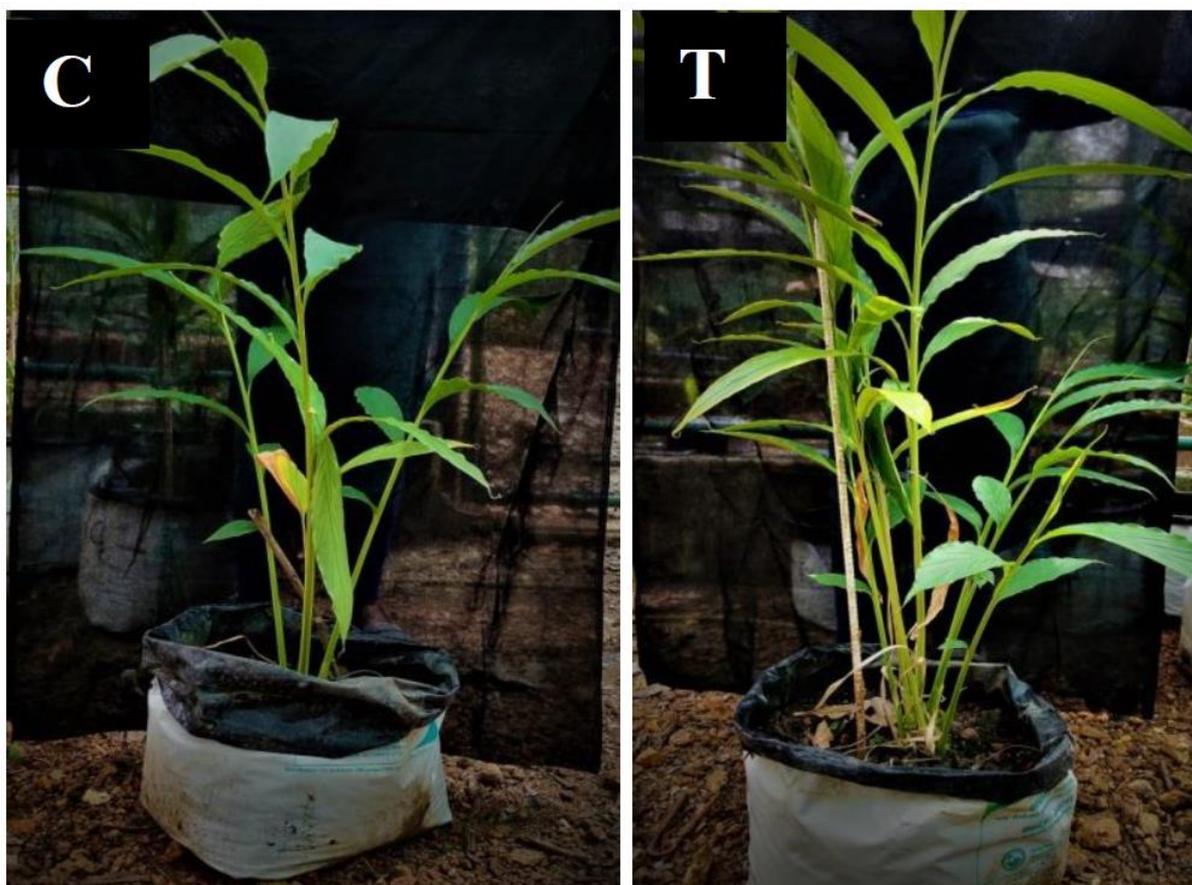


Fig. 12. Effect of *Piriformospora indica* on growth of cardamom plants after 6 months: (C- Control; T- Treated)

In addition, chlorophyll a, b, a + b and carotenoid contents were increased in the leaves of the colonized plants under stress conditions improving photosynthetic efficiency. Mineral estimation revealed that plants treated by *P. indica* had increased the accumulation of Ca and Mg elements. Furthermore, the expression of the antioxidant enzymes catalase, ascorbate peroxidase and superoxide dismutase were significantly up regulated in *P. indica* inoculated cardamom plants during temperature stress. This improvement in the transcripts of antioxidant enzyme genes (Catalase [CAT], Ascorbate Peroxidase [APX] and Superoxide dismutase [SOD]) could be correlated with a significant increment in antioxidant enzyme content. In conclusion, *P. indica* has the potential to enhance the cardamom growth under temperature stress and altering the activity levels of enzymatic

and non-enzymatic antioxidants and chlorophyll content which would help them to grow in high temperature zones of Kerala.

### **Analysis of genetic variability and molecular characterization of ABCDE genes in Palmyra palm**

Palmyra palm (*Borassus flabellifer* L.), the source of palm-sugar, is dioecious with a long juvenile period requiring at least 12 years to reach its maturity. To date, there is no reliable molecular marker for identifying sexes before the first bloom, limiting crop designs and utilization. Recent developments in plant molecular studies during the last two decades include robust methods for genetic variability and ABCDE gene-based analyses. Knowledge of genetic variation and ABCDE gene in a dioecious tree species are important for planning strategies for its successful crop improvement programmes. The first attempt of the present study was to examine the genetic variation in selected male and female palmyra palms using RAPD, ISSR, SCoT, and iPBS marker analysis and to identify molecular marker(s) linked to sex, if any.

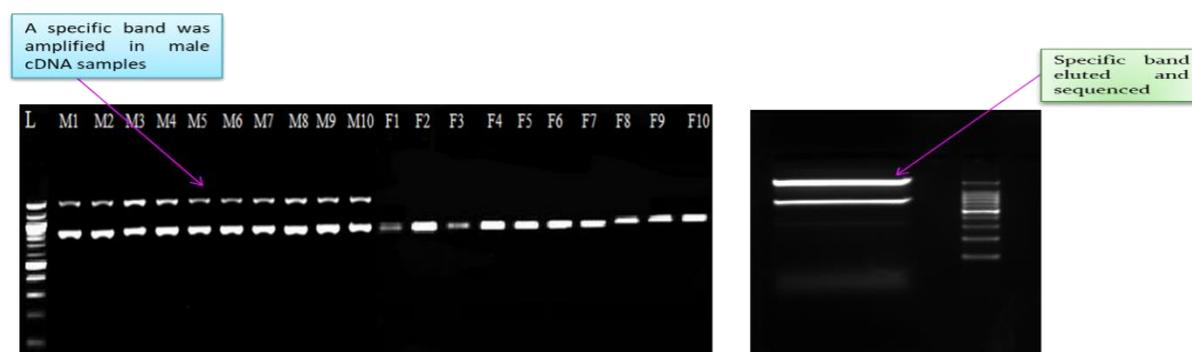


Fig. 13. cDNA SCoT analysis of ten each male and female palmyra palms

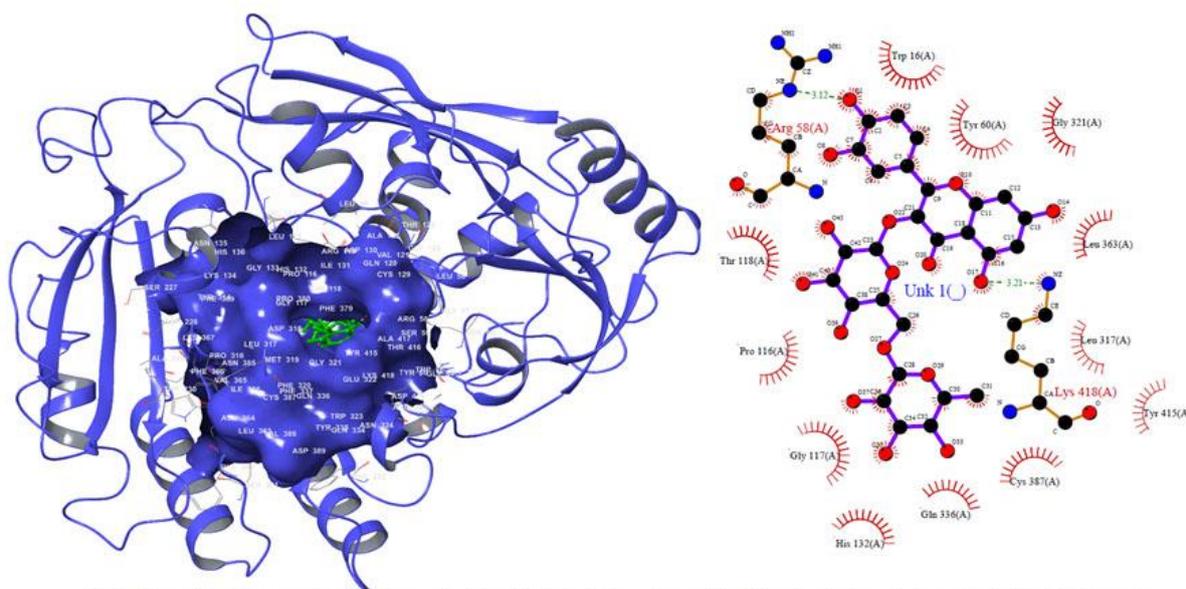
This attempt revealed that iPBS marker shows the highest efficacy among the four markers studied and the dendrogram generated using the un-weighted pair group method with arithmetic mean (UPGMA), placed the 20 samples into two major clusters based on sex. But the PCR analysis of the few selected sex-specific DNA bands did not produce any sex-linked markers despite thorough screening and testing. The second attempt was made on the ABCDE class genes that involved in the sex organ development. These research areas are currently very helpful for understanding evolutionary relationships and enhancing crop improvement programmes. The ABCDE model genes have been long considered as candidate genes for sex determination in monoecious and dioecious species. In the current work, we performed a detailed analysis of the spatial pattern of expression

of the ABCDE genes during the development of male and female inflorescence using real time PCR. Also, we identified the partial and full-length gene sequences of selected ABCDE class genes and deposited the sequence in NCBI GenBank. We have identified AGAMOUS, GLOBOSA, SHATTER PROOF and SEEDSTICK genes as key factors in both floral organ identity and sexual dimorphism in palmyra palm. Sex-specific and differentially expressed transcripts identified in the study would be beneficial to analyse sexual dimorphism in palmyra palm and related species.

### iii. Bioinformatics Centre

The major activities of the bioinformatics Centre include:

- Biodiversity database organisation,
- Identification of lead molecules against snake venom, SARS Co-V2, hepatitis B, dengue viruses, *Mycobacterium tuberculosis* and diabetes through bioprospecting of medicinal plants



Unlocking Inhibitory Potential: Investigating Rutin's Interaction with *Mycobacterium tuberculosis* DprE1 Target

Fig. 14. Unlocking Inhibitory Potential: Investigating Rutin's Interaction with *Mycobacterium tuberculosis* DprE1 Target

- Screened 2500 phytochemicals derived from ten medicinal plants against three targets of SARS CoV-2 namely Spike protein, M<sup>P</sup><sub>ro</sub>, RdRp and a human protein, ACE2 and identified potential lead molecules.
- A total of 400 phytochemicals from five plants namely *Solanum nigrum* L. (phytochemicals 40), *Syzygium aromaticum* (L.) Merr. & L. M. Perry (phytochemicals 70), *Tamarindus indica* L. (phytochemicals 105), *Tinospora*

*cordifolia* (Willd.) Miers (phytochemicals 43) and *Vitex negundo* L. (142) were screened against the targets of dengue virus DENV-NS5 & Human IMPDH2) and Hepatitis C virus targets HCV-NS3-4A & HCV-NS5-RdRp and identified potential lead molecules.

- Collected data from 25 anti-snake venom plants and incorporated it into the database.
- Developed a software application package and digitized 10500 herbarium specimens as part of a project sanctioned by the University of Kerala and generated Rs. 5.00 lakhs as the cost of software application
- **Visitors Management and Billing Tool-Version-1.5:** Application package for managing the data of visitors at JNTBGRI and entry fee billing purpose. It is a standalone package used by Visitors management Centre of JNTBGRI. The application package was developed and updating.
- The following databases developed as part of various Bioinformatics projects have been maintained on the web server installed at STEC-JNTBGRI, Puthenthope
  - ✓ Virtual Herbarium of JNTBGRI URL <http://www.jntbgri.in/tbgtherbarium>
  - ✓ Mushrooms of Wayanad URL <http://www.jntbgri.in/mushroom>
  - ✓ Fungal database Meliolales <http://www.jntbgri.in/fungi>
  - ✓ Wild Ornamental Plants <http://www.jntbgri.in/Ornamentalplants>
  - ✓ Endemic Plants of Western Ghats <http://www.jntbgri.in/endemicplants>
  - ✓ Germplasm of JNTBGRI <http://www.jntbgri.in/germplasm>
  - ✓ Foliicolous fungi of JNTBGRI <http://www.jntbgri.in/tbgrifungi>
  - ✓ Rice varieties/derivatives of Kerala <http://www.jntbgri.in/rice>
  - ✓ Sacred groves of Kerala (<http://jntbgri.in/SacredGroveonline>)

#### **iv. Saraswathy Thangavelu Extension Centre of JNTBGRI, Puthenthope**

The main activities of the Saraswathy Thangavelu Extension Centre of JNTBGRI are:

- Orchid cultivation, its genetic improvement through wild hybridization and embryo rescue.
- Germplasm collection and evaluation
- Production and supply of planting materials and vegetable seeds
- Undertaking consultancy programmes in landscaping, eco-restoration, and gardening
- Human resource development by imparting training in Bioinformatics and Cultivation practices.



Fig. 15. Hands on training to the UG students of NISH on the topic “Cultivation and Multiplication practices on ornamentals, vegetables and medicinal plants” 1-7 June 2022.

The major achievement during the reported period includes:

- Standardized the seed germination protocols for two wild orchids, *Rhynchostylis retusa* and *Vanda tessellata*.
- Produced over 20,000 saplings of different ornamental and fruit plants and over 21.3 kg different vegetable seeds for sale.
- Ten accessions of new plant species were introduced into the Puthenthope campus.
- Over 25000 orchid plants were maintained, and 8000 plantlets were raised through stem cutting and sucker splitting.
- Produced 18 different varieties of vegetable seeds and supplied to the farmers on nominal rate through Agro Bazaar, Kerala Agro Industrial Co-operation Ltd.
- Produced elite varieties of coconut seedlings and supplied to the farmers on nominal rate.
- Propagated different types of ornamental plants and generated income through its sale.
- All about 10000 different ornamental plants, 30000 different types of orchids, 2-acre area heliconia, ~50000 sq. ft area carpet grass lawn have been maintained in the Puthenthope campus. Besides economic crops like coconuts, mango and cashew nut are also well maintained. Delivered arranged flower vases to the Hon'ble Chief Ministers Office at weekly intervals and Government functions as and when required. The large-scale cultivation demonstration plots of orchids (over 35000 plants) 18 varieties of *Heliconia* (1 acre land area), *Spathiphyllum* (1500 plants), etc. are well maintained and propagated saplings for sale.
- A total of Rs. 5.0 lakhs were generated through product sale.
- Organised two training programmes on vegetable and orchid cultivation practices and trained 60 students.  
Organised one awareness programme on conservation and sustainable utilization of genetic resources.
- Provided training in Bioinformatics to 15 PG students.
- A statue of G.V. Raja (full size-12 feet height with proportionate size statue created on 4 ft x 4 ft width x 10 ft height basement) associated with aesthetic landscaping and garden (5000 m<sup>2</sup> area) was created at the G.V. Raja Sports School campus as part of a consultancy project programme.



Fig. 16. Sculpture of G.V. Raja created by V. Premkumar at G.V. Raja Sports School, Mylam, Thiruvananthapuram as part of landscaping and gardening undertaken by KSCSTE-JNTBGRI

## **DIVISION OF CONSERVATION BIOLOGY**

Conservation Biology Division is concerned with the biodiversity loss and working for scientific solutions based on research experience. In line with the guidelines and approval of the Research Advisory Committee, in-house projects are running on threatened plant species and ecosystems for a deeper understanding on the reproductive process, genetic makeup, gene flow systems, interaction with animals *etc.* to evaluate the reasons of rarity and extinction. Externally funded inter institutional projects are also going on for helping concerned biodiversity managers and policy makers to take appropriate actions to slow down the loss of native plants. Field observations are in support of *ex-situ* conservation as a concerted effort in the campus as well as with other designated areas base on published results. Altogether 14 number of Research Scholars are associated with the Division out of which 3 Ph. D.'s are produced, and 3 M. Sc. students completed their dissertation with theme on biodiversity conservation. Total number of research publications reaching 44 highlights testimony to the analysed data acceptable to national and international domain. Efforts are also going on in the division to conserve the germplasm through Palynology and Seed Banking.

## **Important Programmes**

### **1) Studies on Conservation biological aspects of selected flowering plant wealth of Kerala, Seed biology of selected flowering plants and maintenance of seed bank.**

Seed research and seed banking of endemic species and infrastructure development

#### **Seed Bank, seed holding and maintenance.**

*Active collection:* During the period 138 accessions were added to the active collection of seed bank, which include 103 genera comprising 112 species of 89 families from different localities and from JNTBGRI campus.

Carried out germination study of 20 species belonging to 15 families, desiccation study of 4 species, dormancy study of 3 species, storage study of 8 species and viability study of 6 species were completed.

*Seedlings given for field enrichment:* During the period 378 seedlings of 27 species were given to various sections of JBTBGRI for field enrichment.

## **Documentation of Flowering Plants of India**

A rough estimate showed that India harbours 22,108 species of flowering plants (Plant Discoveries 2022). Even though numerous publications dealing with regional, district and local floras appeared, a comprehensive account on flowering plants of India yet to be come out. As 7,402 species has already been worked out for the preparation of Flowering Plants of the Western Ghats, India (Nayar et al., 2014), Flowering Plants of India is a logical extension.

During the period, 1,006 species were newly added to the database and revised relevant characteristics of 13,624 species referring to states, districts and regional Floras of Uttarakhand, Punjab, Uttar Pradesh, Haryana, West Bengal, and Himachal Pradesh. Collected 365 scientific papers, by online, related to new species, new records, rediscoveries, revisionary studies, and nomenclature from 56 plant taxonomic journals. The Bibliography was updated by adding 174 references.

## **Palynology Laboratory**

A Palynology unit is attached to the Division of Conservation Biology. The laboratory focuses on the applications of pollen morphology in areas of taxonomy (systematic

palynology), identification of drug adulteration (pharmaco-palynology), pollen in honeys (mellisso-palynology), in criminal investigation (forensic palynology) and plant animal interaction. It maintains a sporotheca which carry 12000 pollen and spore slides of 1100 species of angiosperms, 60 species of Pteridophytes, 300 honey samples and 6 animal fur samples. The following works are done/were completed during the period under report.

**Pollen morphology of the variants of *Pellionia heyneana* Wedd.:** This investigation was in collaboration with Dr Mathew Dan, Scientist and Murugesan, JRF of the Division of garden management, education, information, and training as part of the variability study of *Pellionia heyneana* variants in the Western Ghats. The aim was to study the pollen morphology of the variants of *Pellionia heyneana*. Twenty variants were selected for the study. Pollen grains were acetolysed following for the study. Out of the 20 variants selected pollen morphology of six variants were studied in 2019 and rest of the 14 variants were studied in the year under report. Light microscopic observations were carried out using Nikon Eclipse 80i model light microscope. Quantitative and qualitative morphological characters: polar outline, equatorial outline, pollen size, aperture type and size, ornamentation, exine thickness, apocolpium, mesocolpium etc. were analysed. About 140 light micrographs of pollen grains were exposed using Nikon DXM1200F digital camera attached to the light microscope. At least 50 pollen grains from each variant, thus a total of 700 pollen grains, were studied.

Pollen grains were generally very small, less < 15  $\mu\text{m}$ , tri or tetraporate with psilate tectum. The study found no morphological differences among the variants under light microscope. Observations using Scanning Electron Microscope under high magnification is needed to know the difference in the ornamentation among the varieties.

**Pollen Morphology of the Family Arecaceae of Kerala with Special Emphasis on Forensic Science (MSC dissertation program):** Forensic palynology is the utilization of pollen grains and spores in the investigation of crimes. Pollen analysis is an important avenue of forensic research because pollen grains can prevail for millions of years in soil and other sources. Forensic palynology is applied to relate items and materials left at crime scenes, which can connect a scene to a suspect, relate a suspect to the scene of a crime or discovery scene, relate a thing at the disclosure scene to the crime scene, demonstrate or discredit conceivable explanations, reduce the list of potential suspects, determine the movement history of things including drugs, provide data related to the condition from which a material evidence originated, provide information concerning the condition that a material evidence started from, give information with respect to the geographic area of a crime or material, help

police in their lines of questioning, help find secret graves and human remains, help decide the perimortem destiny of an unfortunate casualty, help to determine the age of human remains etc. Despite all the advantages forensic palynology is an ignored branch of palynology because of the ignorance in the techniques, lack of trained specialists and lack of academic centres that provide training in forensic palynology.

Pollen grains are little used in forensic investigations in India, for that matter in Kerala also. The present work 'Pollen Morphology of the Family Arecaceae of Kerala with Special Emphasis on Forensic Science' is taken up against this backdrop as part of an MSc dissertation of Forensic Science course, at Police Academy, Thrissur, Kerala taken up by the Palynology laboratory in the division of Conservation Biology. The study is expected to help identifying the pollen grains of different taxa of Arecaceae family among the pollen grains associated with the materials associated in a crime investigation to use them as geographical markers. Pollen grains of 10 species were studied. They were *Arenga wightii* Griffith, *Areca catechu* L., *Bentinckia condapanna* A. Berry ex Roxb., *Borassus flabellifer* L., *Calamus travancoricus* Bedd. ex Becc. & Hook. f., *Cocos nucifera* L., *Caryota urens* L., *Elaeis guaneensis* Jacq., *Phoenix pusilla* Gaertner and *Phoenix sylvestris* (L.) Roxb.

Polliniferous materials of all the candidate species were collected either from herbarium specimens or directly from the field. Sixty pollen slides, six pollen slides for each species, were prepared following acetolysis method. Pollen morphology was studied under light microscope. Morphology of at least 20 pollen grains was studied for each species. Quantitative and qualitative characters like polar and equatorial axes, number, position, and characters of apertures, exine structure and stratification and exine ornamentation were studied. More than 100 Light microscopic photographs, at least 10 photomicrographs for each species, were exposed in Nikon light photomicrography system.

Definite geographic identity can be attributed a forensic sample when it carries any of the Arecaceae species studied. For example, *Areca catechu* and *Cocos nucifera* are cultivated throughout Kerala. But the associated plant crops or weeds seen in combination with *Areca catechu* and *Cocos nucifera* may vary according to altitudinal variation and soil characteristics. For example, *Areca catechu* and *Cocos nucifera* are never seen in combination with Piper cultivation in coastal areas. *Borassus flabellifer* is seen in dry areas of Kerala in abundance. *Arenga wightii*, *Bentinckia condapanna*, *Phoenix pusilla* and *Phoenix sylvestris* are generally seen in forest areas only. Among them *Arenga wightii* and *Bentinckia condapanna* are seen in evergreen forests only. *Phoenix pusilla* is seen in

Thiruvananthapuram District only whereas *Phoenix sylvestris* is distributed in Kozhikkode, Palakkad, Thrissur, and Thiruvananthapuram Districts. *Elaeis guaneensis* is in cultivation only in restricted areas in Kerala like Palode in Thiruvananthapuram District and Kulathupuzha in Kollam District. *Calamus travancoricus* has its distribution in evergreen forests as well as in the sacred groves of Kerala. *Caryota urens* is seen throughout Kerala naturally and often planted. But the associated plant species in naturally occurring areas and cultivated areas will be different. All the pollen grains studied here are produced in plenty and there are chances of their presence being in air. The presence of pollen grains of species like *Areca catechu* and *Cocos nucifera* are reported in air. So, there is all likelihood of these pollen grains getting deposited on fabrics from air. But the concentration would be much lesser when compared to direct contact. Pollen grains provide information of the blooming plants in a habitat at a particular time. Here all the species except *Bentinckia condapanna* and *Calamus travancoricus* flower throughout the year. But *Bentinckia condapanna* flowers in September and October and *Calamus travancoricus* flowers during November to January. This is an important clue about the season of pollen grains seen associated with the evidence. Further, the seasonality of flowering of the associated species of the Arecaceae family can also give confirmatory leads. So, the distributional pattern of Arecaceae members along with their associated species can function well as a geographical marker system in investigations.

**Pollen analysis of fur of Nilgiri Langur:** A dead body of Nilgiri Langur (NL) [*Semnopithecus johnii* (J. Fischer)] was received from Silent valley National Park during the exploration in relation to plant animal interaction and population study of *Cullenia exarillata*, a key food plant of arboreal vertebrates in the tropical evergreen forest ecosystem in the Western Ghats. A study was designed to analyse the pollen in the fur of Nilgiri Langur to identify the plants visited by this animal through pollen grains to understand its feeding habits and movement pattern if any. More than 100 pollen slides were prepared from the body washings. Identified pollen grains of 42 species of flowering plants consulting the sporotheca of JNTBGRI and pollen literature. The frequent species identified through pollen grains were *Cullenia exarillata*, *Palquium ellipticum*, *Olea dioica*, *dimocarpus longan*, *Turpinia malabarica* and *Syzygium leatum*. Further interpretations are in progress.

**Identification of the pollen in the honey of *Trigona tetragonula*:** *Trigona tetragonula* is a small stingless bee seen throughout Kerala. Though it produces only small quantity of honey, it costs more than 3000 INR in the market. This study was undertaken in association with the Kerala Agriculture University, Mannuthi with the broad aim to identify the major pollen

grains in the honey to understand the most preferred plants by honeybees for collecting nectar. This would help the beekeepers to increase the production of honey through planting more bee preferred plant species or keeping the beehives near to bee preferred plant species. Identification of pollen grains in honey samples collected from all the districts of Kerala was the task entrusted with our laboratory. Fifty slides were read and pollen grains of 60 angiosperm species were identified referring to the sporotheca maintained in the laboratory and pollen literature. The major pollen grains identified were *Cocos nucifera*, *Areca catechu*, *Caryota urens*, *Tridax procumbens*, *Chromolaena odorata*, *Stachytarpheta indica*, *Syzygium cumini* etc.

**Conservation of *Dialium travancoricum* Bourd. (Leguminosae: Dialioideae), a critically endangered and endemic tree in the Western Ghats:**

*Dialium travancoricum*, locally known as ‘Malam Puli’ is an endemic and endangered species occurring in Kerala. It is reported only from two different localities, Kallar-Ponmudi hills in Thiruvananthapuram district and Aryankavu forests in Kollam district in Kerala. It is an evergreen tree reaching 30 m height. A recent survey found that the species now survives with only one individual in Ponmudi forest in Thiruvananthapuram district and deserves immediate conservation attention. So, a programme was initiated in the year 2019 with the leadership of Dr. Anurag Dhyani, Scientist of the Division of Conservation Biology, where I am a team member. The main aim of the programme is to develop as many as seedlings to establish more plants in both its habitat and in JNTBGRI campus. The programme also aims to conduct detailed surveys in the forest to locate more individuals of the species, phenological studies, pollination, seed set, seed dispersal, seed germination studies, seedling demography, environmental issues related to the long-term survival of the species.

Five field trips to Ponmudi were conducted to study phenology, pollination, and seed set and to survey the nearby localities to find out more individuals. Flowering was observed in November 2022. But no fruiting was observed. The observations are in progress.

**Wildflowers of Silent Valley National Park:** This is an auxiliary outcome of many years field work in Silent Valley forests in connection with different project works done in Silent Valley National Park. The work aims to bring out a coffee table book on the wildflowers with photographs and popular description to develop conservation awareness among common man. The work tries to explore the beauty of the flowers of about 100 species occurring in mid elevation forests of Silent Valley. Identification of the selected 60 species was done with

the help of local floras, flowers of Sahyadri (three volumes by Srikant Ingalhalikar), The plant list and other Internet Resources. Confirmation of identification, preparation of descriptions, correction of photographs and layout of the pages are in progress.

### *External projects*

#### **Population biology of *Humboldtia unijuga* var. *trijuga*, an endemic and endangered tree species of the southern Western Ghats and its conservation.**

*Humboldtia unijuga* Bedd. var. *trijuga* J. Joseph & V. Chandras. is a small tree of Leguminosae (Ceasalpinioidea) family, highly restricted to the southern Western Ghats region and is of medicinally and potentially important ornamental tree. The main objectives of this SERB, Govt of India sponsored project are to study the spatial distribution, population structure and dynamics, study the genetic variation among and within populations employing molecular markers and to address the conservation issues related to seed set, recruitment, biotic and abiotic interactions, and seed biology. During the period, nine field trips were conducted to study sites of Agasthyamala biosphere reserves. Molecular characterisation of the species was carried out. Fresh and young Leaf samples from three different populations were collected. Each sample comprises one focal candidate tree and ten surrounding trees separated by a minimum distance of one metre. From one population a total of 33 samples were collected. DNA from leaf samples were isolated following CTAB method. For PCR amplification, 10 ISSR and 10 SCoT primers were selected, which gives clear, more polymorphic and reproducible fragments, and were used for the total analysis. PCR reaction mixtures were prepared to a total volume of 15  $\mu$ L (containing 2  $\mu$ L of DNA sample, 7.5  $\mu$ L PCR mix, 3.5  $\mu$ L double distilled water and 2  $\mu$ L of primer). The amplification was performed by using Eppendorf Thermocycler with a cycle start at 94°C for 2 minutes; followed by denaturing at 94°C for 15 seconds by 35 cycles; annealing for 15 seconds at 37°C; and product extension for 5 minutes at 72°C. The products of PCR after primer amplification were subjected to gel electrophoresis (3 gm Agarose in 200 ml TE buffer and 4  $\mu$ L Ethidium Bromide) and visualised under Gel documentation system.

Ten ISSR primers generated 121 fragments in 33 accessions. The size of the amplified products ranged from 100 to 1500 bp. Total number of fragments amplified ranged from 6 to 19. Maximum numbers of amplicons were generated by primer ISSR 817 (19) and least by ISSR 820 (6). The ten ISSR primers generated 101 polymorphic bands and 20 monomorphic

bands. The number of polymorphic fragments ranged from 3 to 18. Maximum numbers of polymorphic fragments (18) were observed in ISSR 817 (94.7%) least (3) by ISSR 820 (50%). The number of monomorphic fragments ranged from 1 to 3. Maximum number of monomorphic fragments (3) was observed in ISSR 820 (50%) and least (1) by ISSR 857 (12.5%), ISSR 817 (5.3%). The average percentage of polymorphism was 83.5%. The similarity coefficients generated from the ISSR data were used to construct the dendrogram based on the Jaccards coefficient. UPGMA clustering algorithm grouped the accessions into 2 clusters. Further molecular characterisation and statistical analysis are progressing.

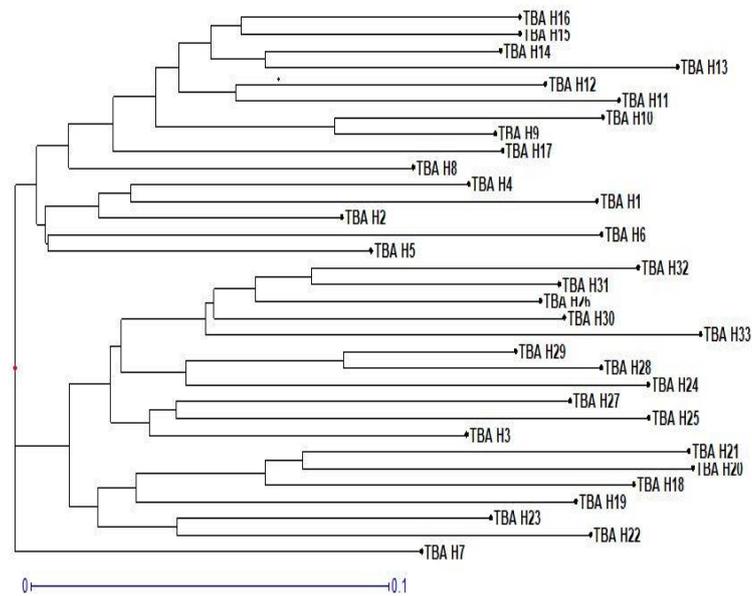


Fig. 17. UPGMA clustering algorithm.

### **Triparty action plan for the reintroduction of red plants of Kerala - Kerala Forest Department**

Targeted surveys were conducted for locating the populations of *Hopea racophloea*, based on the reports on species documented in regional flora, herbaria, and other publications. During the period, Kollam, and Thiruvananthapuram districts were explored. Mature 20 individuals of *Hopea racophloea* from Pallivasal forest in Rosemala were selected as plus trees and 175 seedlings kept in the nursery for planting purpose. For the reintroduction of the species and to increase the population of the species by establish a field Gene bank of targeted species in situ, a discussion was made with Forest officials on 19th September 2023 including DFO, Wildlife Warden and foresters of Shenduruny Wildlife Sanctuary. Subsequently, it was

decided to establish a field gene bank at Rosemala Forest area with 25 seedlings each planted in 3 plots on 4<sup>th</sup> October 2023 (Plot 1 – Pallivasal Starting area- Pathekar, GPS Points-N 08°54'48.95"E 077°10'58.59", Ht-268m; Plot 2 – S Valavu, GPS Points-N 08°54.648' E 077°10.870'; Plot 3 – Near Dam Site area-Urulyar, GPS Points-N 08°54.043' E077°10.689'. The areas of planting were marked using paints for continued evaluation.

Field trips are made to Bonacaud and Chemunji areas for locating and collecting the fruits of *Garcinia imberti* and *Betinckia condappana*. Around 500 seeds of both the species were collected and seed studies are going on. As these two species are endemic to Southern Western Ghats and IUCN red listed, conservation measures are necessary for the future survival of the species.

**Nutritional analysis and development of nutraceuticals/food supplements based on ‘Arogyapacha’ (*Trichopus zeylanicus* subsp. *travancoricus* Burkill ex K. Narayanan): an ethnomedically important plant**

Population aspects of *Trichopus zeylanicus* subsp. *travancoricus* were studied to assess the existing structure and dynamics of populations. Observed eco-physiological and edaphic parameters in *in-situ* variables prevailing along with the elevation range of 100-1000 m asl. These factors are playing key role in the growth, reproduction, and distribution of the species. *Trichopus zeylanicus* subsp. *travancoricus* populations are found to be spatially separated among spaces of identical altitudinal specificity. Significant annual variations were noted in population size, percentage of species existence with respect to natural stochastic disturbances. The age distribution pattern of the species revealed that seedling, sapling, and mature individuals significantly varied among populations. The reproductively able groups of plants along with good rate of seedlings were identified in Kulathupuzha and Aryankavu forests. Field observations in Bonacaud, Kallar, Kottur, Neyyar and Cheenikkala forest patches and particularly of Kulathupuzha forest range revealed less content of phosphorous and more zinc in rhizosphere favourable mycorrhizal fungi association favouring plant growth. In the light of these observation, Kulathupuzha population is selected as the elite population for nutritional analysis. Detailed nutritional analyses were carried out and identified that the plant has potent nutritional value. The analysis revealed that the energy sources like carbohydrate, crude fibre, vitamins B1, B2, B3, B6 and C are remarkably high in value. The plant also contains Phosphorous, Calcium, Zinc, Manganese, Iron and Sodium. Based on these results, development of nutritional supplement is in progress.



Fig. 18. Tzfldexprmntlplotl bld 27-9-22

### **Conservation of Vulnerable sandalwood (*Santalum album* L.) through propagation and reintroduction**

*Santalum album* is the second most expensive wood in the world (Rs. 300,000/kg). It is included under vulnerable status in IUCN Red List (IUCN 2018). The project involves seed storage and germination experiments with raising quality planting material of *Santalum album* and transplantation of these seedlings to the natural habitat.

Seeds pre-treated with GA3 500 ppm overcome seed dormancy and germinated faster with high germination percentage. Irrespective of treatments, room temperature ( $30\pm 2^{\circ}\text{C}$ ) was the best condition for sandal seed germination. So, GA3 500 ppm pre-treated seeds placed in petri dishes lined with Whatman no. 1 filter paper at room temperature ( $30\pm 2^{\circ}\text{C}$ ) is observed as the best condition for the seed germination. Potting media containing soil, sand, and cow dung in 1:1:1 ratio was the best medium for propagation. *Cajanus cajan* or *Crotalaria retusa* were found to be the best host plants for the seedling growth and development. Conservatory shed is the better condition for keeping the transplanted seedlings.

## **Study on ecology conservation and utilization of *Diospyros crumenata* Thw. in Kerala – an endangered tree of Western Ghats:**

Population survey of *Diospyros crumenata* was continued in the Kerala region of the Western Ghats. During this period, populations were surveyed at Peruvannamuzhi forest (Calicut Division), Kakkayam forests (Malabar WLS) and Achenkovil forests (Kollam District). So far, three populations of the species were identified which are in Thrissur District viz. Vazhachal/ Poringalkuth (Vazhachal Forest Range/ Vazhachal Division), Chakkapara and Vellani Mala (Pattikad Forest Range/ Thrissur Division). Population details viz. GPS coordinates, number of mature individuals, area of occupancy, extent of occurrence, natural regeneration, habitat threats etc. were collected from each site.

The Extent of Occurrence and Area of Occupancy of the species in Kerala were calculated as per IUCN criteria (Geo Cat app.). The extent of occurrence is observed as 228.072 km<sup>2</sup>, the Area of Occupancy as 36.000km<sup>2</sup> and number of mature individuals is less than 100.

**Population structure:** The population structural study was already completed within sampled and non-sampled areas at three population sites by recording GBH, basal area, basal cover, age phase and height of each individual @  $\geq 30$  cm.

**Population diversity:** Population diversity analysis at three population areas was already completed. Five quadrates (50m $\times$ 20m each) were selected at each site and all the individuals  $\geq 30$  cm was enumerated in terms of relative frequency, relative density, relative dominance, and Importance Value Index (IVI). The IVI of each species was worked out and relative dominance/abundance were calculated.

Among the 49 species enumerated in 5,000 sq. m area at Vazhachal forests, *D. cruminata* attained 17<sup>th</sup> position with an IVI value of 0.069187. Species such as *Vateria indica*, *Kingiodendron pinnatum* and *Dipterocarpus indicus* are dominant species with IVI values 0.219093, 0.1942010 and 1.68606 respectively in this forest area.

Among the 43 species enumerated in 5,000 sq. m area at Chakkapara forests, *D. cruminata* attained 26<sup>th</sup> position with an IVI value of 0.042715. Species such as *Tetrameles nudiflora*, *Cedrela toona* and *Polyalthia fragrans* attained dominant species with IVI values 0.249393, 0.226465 and 0.157038 respectively in the forest area.

Among the 60 species enumerated in a 5,000 sq. m area at Vellanimala forests, *D. crumenata* attained 10<sup>th</sup> position with an IVI value of 0.082055. Species such as *Xanthophyllum arnottianum*, *Spondias pinnata* and *Artocarpus hirsutus* were attained dominant species with IVI values 0.162915, 0.136813, 0.135555 respectively in the forest area.

The ripe fruits of *D. crumenata* were collected from the population located in Poringalkuth forests for nutritional analysis. The nutritional elements such as Total Mineral Contents (%), Carbohydrate (g/100g), Protein (g/100g), Total sugars (%), Ascorbic Acid (mg/100g), Sodium (mg/100g) and Potassium (mg/100g) were evaluated as per the methods suggested (Sadasivan and Manickam, 2009). The ripe fruits of the species are rich in nutritional elements. The elements identified were compared and were found more promising than other cultivated fruits. The Total Mineral Contents, Total sugars, Ascorbic Acid and Sodium were higher than the ripe jackfruits. The elements such as Protein, Sodium and Potassium were higher than those of ripe mango fruits. The protein content was higher than the ripe Pineapple fruits.

#### **Seed physiology of *Gymnacranthera canarica* (King) Warb., a rare endemic tree species of southern Western Ghats**

Myristica swamps are ancient freshwater swamp forests, which are endemic to the Western Ghats below 15.5°N latitude and occur in areas with an average annual rain fall of 3000mm. *Gymnacranthera canarica* is dioecious mangrove tree and is classified as Vulnerable by the IUCN. The main threats to their natural habitat are poor seed germination, habitat destruction and over-exploitation for aril and seeds. As a result, there is an urgent need for *insitu* conservation of *G. canarica* and, as a result, the critically endangered Myristica swamp ecosystems.

The present investigation has thus been focused on the following objectives: 1) To characterize the phenology and seed development of *Gymnacranthera canarica* 2) To understand seed storage behaviour through seed desiccation and storage studies 3) Biochemical characterization of seeds from different stages of development, desiccation and germination and metabolite profiling of seeds with effect on seed desiccation 4) Identifying the seed dormancy type through different priming treatments and phytohormonal analysis 5) Ecology study and conservation through large-scale restoration practices in to their natural habitat.

The phenology study of *G. canarica* exhibits high phenological synchrony and seasonality in the Myristica swamp habitat, indicating that no phenological shifts occurred in this endemic habitat specialist dioecious tree. *G. canarica* flowers for a short period but with great intensity where in; female flowers are more significant than male flowers. The average number of male flowers per tree outnumbered the number of female flowers per tree. Flowering in *G. canarica* is more synchronised among individuals of Myristica swamp forests and between male and female trees, resulting in tremendous fruiting success in this species. Fruit development took 160 days to complete maturity, with physiologically mature dark seeds shed in September with a high moisture content (28%). The higher dry matter accumulation and seed moisture content at the end of seed development indicating the lack of maturation drying stage. Absence of maturation drying is a characteristic feature of recalcitrant seeds. The biochemical study during seed development reveals that *G. canarica* remains metabolically active throughout the stages of development indicating that these tropical tree species do not dry out during maturation. Further seed desiccation and seed storage studies confirm the absence of maturation drying as recalcitrant seed storage behaviour.

The ideal desiccation for testing recalcitrance in this species is air-dried slow desiccation at ambient laboratory conditions ( $28 \pm 2^\circ\text{C}$ ,  $60 \pm 2\%$  RH). Fresh seeds with a moisture content of 28.86% began to lose viability after two days of drying, and after five days of desiccation, the seed moisture content was decreased to 19.37%. When fresh seeds were tested for germination, they showed poor seed germination (34%), while seeds dehydrated to 19.37% moisture content showed gain in germination to 80%, and after that, germination decreased to below 50%, and germination became zero by 10.72% seed moisture content (15 days of desiccation). Based on the results, the seed moisture content 19.37% is considered critical, and the moisture content of 10.72% is considered as lethal. Desiccation-induced seed viability loss has been linked to a loss of cell membrane integrity and ROS accumulation. Increased ROS accumulation in the seeds can inhibit metabolic processes and cause early viability loss. Desiccation impacts the biochemical and metabolic changes in *G. canarica* seeds. Desiccation of *G. canarica* seeds resulted in an increase in soluble sugars, which could be due to starch breakdown. Lipid, as a primary compound may help the seeds to float on water-flooded swamp forests. Protein depletion was accelerated by desiccation via protease enzyme activity. The transition from reserve accumulation to seed desiccation was associated with an increase in the levels of several free amino acids except for proline,

as well as several organic acids and sugars except for higher oligosaccharides, raffinose, according to metabolite profiling. Flavonoids are the most abundant class of compounds in *G. canarica*, with Genistein being the most prominent. According to seed storage studies, the ideal storage temperature is 20°C in a polyethene storage medium, which can retain seed viability for up to 75 days and increase germination percentage to a maximum of 50% through gibberellic acid seed pretreatment. *G. canarica* seeds show hypogeal germination, and fresh seeds germinate after more than 50 days, indicate seed dormancy. Seed germination in *G. canarica* is associated with embryonic length enhancement so that; fresh seeds show poor germination due to immature embryos. The warm stratification improves germination percentage but, this alone does not break seed dormancy in *G. canarica* seeds for their requirement for pretreatment. According to the findings of this study, a low concentration of GA<sub>3</sub> had a significant effect on breaking seed dormancy by reducing mean germination time and increasing germination percentage. However, increasing GA<sub>3</sub> concentrations may inhibit germination due to excess hormone content, resulting in GA<sub>3</sub> toxicity. *G. canarica* seeds contain both a morphological component (embryo growth) and a physiological block as if having morpho-physiological dormancy.

The important value index (2.61), basal area (548.30), and relative dominance (1.08) of *G. canarica* in the entire swamp ecosystem were higher than those of other species, confirming *G. canarica* dominance status in this swamp ecosystem. The floristic analysis revealed that the Myristica swamp ecosystem has a low species richness, which can be attributed to edaphic conditions and swampy species ecological requirements. The floristic diversity - Simpson's diversity index - was higher in this forest than in other Western Ghats Forest ecosystems, indicating a higher concentration of dominance. The dominance of a few trees and lower diversity within the swamps are the causes of low floristic diversity. Mature trees outnumber saplings and seedlings in the *G. canarica* distribution pattern, and the disturbance index and regeneration status of *G. canarica* trees indicate disturbed nature and lower generation. After one year of in-stipulating, restoration of one-year-old *G. canarica* seedlings in the Myristica swamp ecosystem showed 63% survival with low height increment. Due to edaphic conditions and flooded forest ground, the growth performance of *G. canarica* seedlings during *in situ* conservation is lower. Another major cause of seedling growth arrest is apical bud abortion and wilting caused by low light intensity or insect predation of leaves. In the advanced stage, the main threats are wild animal feeding and

anthropogenic activities. Because *G. canarica* has recalcitrant seeds and seeds are the primary sources of multiplication, *in situ* conservation and restoration of this endemic threatened tree species is the most secure long-term conservation and establishment method.

**Regulation mechanism of seed germination in selected species of *Myristica* Gronov. (Myristicaceae) in Kerala.**

*Myristica malabarica* Lam., *M. magnifica* Bedd. and *M. beddomei* King of the family Myristicaceae face severe threats in their natural habitats, particularly of the Western Ghat's evergreen forests and Myristica swamps. Human activities, climate change, invasive alien plants and overexploitation for medicinal purposes pose substantial risks to their survival. Poor regeneration of their recalcitrant seeds also gives way their endangered status. To address this challenge, a comprehensive study was focused on the genus *Myristica* as a model to unravel the mechanisms of seed recalcitrance. This understanding becomes crucial for devising effective conservation strategies to prevent their extinction. Seeds of the four *Myristica* species, including that of the cultivated *M. fragrans* Houtt. revealed high moisture content during shedding which is typical to recalcitrant seeds. Notably, though the small embryo and comparatively large ruminant endosperm coexist and contribute optimal moisture and nutrient levels, viability loss occurs when desiccated due to the absence of natural protective mechanisms. The critical moisture content (CMC) of each species was identified below which viability was significantly decreased. Desiccation-induced loss of viability was further confirmed through electrolyte and solute leakage measurements and the formation of triphenyl formazan in embryonic tissues.

The developmental changes in *Myristica* seeds including *M. malabarica*, *M. magnifica*, *M. beddomei*, and *M. fragrans* reveal dynamic biomolecular shifts. The embryo predominantly comprises proteins, amino acids, and soluble sugars for fuelling germination. elevated starch and lipid levels in the endosperm support energy demands during maturation. Desiccation amplifies starch and lipid concentrations, indicating heightened metabolic activity. Total soluble sugars in the embryo decrease due to dehydration, while free amino acids, notably proline accumulate as abiotic stress protectants. Phenolic compounds increase under water stress, benefiting both endosperm and embryo, but insufficient phenol-protein aggregates in the embryonic tissues lead to diminished seed viability.

The dynamics of plant growth regulators (PGRs) during the seed lifecycle in *Myristica* species revealed distinct patterns. In late embryogeny, low concentrations of auxins, gibberellins, and cytokinins are observed, contrasting with notably higher levels of abscisic acid (ABA). As germination initiates, there's a significant rise in auxins, gibberellins, and cytokinins, accompanied by a decrease in ABA and salicylic acid (SA), indicating the need for a balance between these antagonistic PGRs for successful seed germination. Pre-sowing treatments with PGRs like IAA, GA<sub>4</sub> and Panchagavya enhance seed germination metrics, while ABA exhibited an adverse effect. Such insights guided for opting recommended approach in augmenting seed germination and seedling growth of *Myristica* species.

Due to their recalcitrant nature, the seeds of *Myristica* species quickly lose their ability to germinate shortly after being shed. The seeds are particularly sensitive to desiccation and exposure to colder temperatures, making it challenging to store them for extended durations. However, it is possible to prolong the viability period by maintaining optimal storage conditions as exemplified in the case of *M. malabarica* seeds stored as long as 90 days at 18 ± 2°C and a relative humidity of 50 ± 2%.

Scientific validation of traditional knowledge related to seed sorting in the Palakkad district confirmed the efficacy of three sayings: "*Parum vithu mulakkilla*" (Floating seeds fail to sprout), "*Kulungum vithu mulakkilla*" (Shaky seeds fail to sprout), and "*Vilartha vithu mulakkilla*" (Seeds pale with coloured seed coat fail to sprout). Observations substantiated those viable seeds exhibited deeper grooves on their seed coat surface, while non-viable seeds display shallow grooves, in line with the traditional knowledge practices of agricultural communities.

Comprehensive investigations into various aspect of *Myristica* seed biology, including development, maturation, desiccation, germination, changes in plant growth regulators, biomolecules and cellular membrane integrity contributes significantly to our understanding of tropical seeds, especially recalcitrant ones. Ultimately, these research findings advance our knowledge on endangered *Myristica* species and aid in formulating measures to ensure long-term species survival through seed-oriented conservation strategies.

### **Seed Physiological studies of *Bentinckia condapanna* Berry ex Roxb., a rare endemic tree palm of Southern Western Ghats**

Seed germination of *B. condapanna* was studied extensively for ensuring the restoration and conservation of this ecologically significant red listed species. Physiologically mature- 12

MAA pyrenes were used for the germination study. The hard endocarp and seed coat of the pyrene extended impermeability to water. The control pyrenes exhibited 20% germination with the germination period spanning from 2 to 8 months. The germination pattern exhibited is hypogeal and adjacent ligular. A small portion of the cotyledon emerges from the pyrene as a button like structure subtending the plumular and radicular axis from the top and bottom of the button respectively. The pyrenes remain horizontal, neither above nor below the plumular-radicular node. The admotive ligular germination pattern indicates that *B. condapanna* might belong to the phylogenetically advanced members among the Areaceae (Saakov, 1954). Even though the radicular and plumular propagule initiates to emerge simultaneously, the first to emerge out physically is the radicle with the primary root. This was followed by the ligule emergence from the plumular axis. The primary roots soon get replaced by adventitious roots at the plumular-radicular node and later develops secondary roots on the adventitious roots. Three ligules emerge prior to eophyll emission.

Among the various priming studies conducted, scarification yielded the better result. But removing the endocarp *lid* and operculum of the seed coat exposing embryo and endosperm lead to either decay of the endosperm and embryo or deformed the button which delayed plumular-radicular emergence. Removing the endocarp *lid* and carefully thinning the operculum without removing the structure accelerated the germination speed and germination percentage. This proves the hindrance extended by envelopes of the pyrene on its germination. The then comparable result was yielded by least concentration of gibberellic acid (100ppm) for 48 hours. Hence, the scarification protocol could be employed while raising seedling for restoration purposes.

To check whether the absence of De husking agents of the pyrene in the natural habitat could have any impact on the germination, allelopathic impact of pericarp on germination was checked. Seeds with pericarp yielded germination which indicates the absence of allelopathic impact of pericarp on seed germination.

Wet storage of pyrenes under room temperature in closed Ziplock bags (filling only 25% volume of the bags and the rest inflated with air) was found to be the best storage protocol to store the viable propagules for a minimum period of 8 months. The results obtained during the germination and storage studies could be extensively used while generating large number of seedlings for restoration purposes in the future endeavours.

### **Reproductive biology of *Goniothalamus keralensis* E.S.S. Kumar *et al.***

*Goniothalamus keralensis* is an endemic species of Annonaceae family. It is restricted to three sites of Idukki district and survived with less than 200 plants. It is a wild relative of medicinally important *Goniothalamus* species. During the period under report, we studied the population structure and seed dispersal and germination studies. Population of this species is found in Valara and Mankulam. The habit analysis showed that they are growing adjacent to rivers and rivulets. The plants are shrubby nature attaining a height of 5 meters. The population at Valara is spread in area of 7 square kilometre and found as three sub population. The subpopulation 1 is near a rivulet with 9 adult plants and three seedlings/ saplings. Major tree associates were *Vateria indica*, *Elaeocarpus* sp. and *Leea* sp. The second subpopulation is composed of 14 adult individuals and 11 saplings spread on two sides of the rivulet. The major associate was *Humboldtia vahliana* and *Ochlandra travancorica*. The third subpopulation is larger one with more than 25 adult plants and 18 saplings. In this area, the major associates were *Vateria indica*, *Humboldtia vahliana* and *Ochlandra travancorica*, *Zingiber* sp. at Mankulam, only a single large population was found near the river. It consists of more than 50 adult plants and 21 saplings. Flower buds initiated in mid-October and continue up to January. A flower bud took about 45 to 50 days to become a flower. Fruit set was recorded from December to April. Fruits are berry and are green, which change to orange on ripening. Each fruit contain a single seed. Seed dispersal was mainly carried out by water. Seeds took 46 days for germination in the normal condition. Further studies are progressing.

### **Systematics and conservation of natural populations of *Phyllanthus emblica* L. (Amla) in the southern Western Ghats**

The Indian gooseberry or amla (*Phyllanthus emblica* L.) has several culinary and medicinal uses. They are the treasure trove of ascorbic acid – the vitamin C. Naturally there are different variants, differ in terms of taste, size, colour differences, and texture of flesh. Even though, we use many hybrid varieties for culinary purpose, traditional medicinal sector rely heavily on our wild fruits. Due to habitat destruction coupled with over exploitation in an unscientific manner, this highly sought medicinal tree is facing a constant threat of extinction. The present research programme aims to characterize different forms of Indian gooseberry

growing naturally in the southern Western Ghats through morphological, phytochemical and molecular techniques and to find plus trees and their conservation and popularisation. During the period under report, 13 field trips were conducted to different forest areas such as Bonacquad, Kallar and Ponmudi in Thiruvananthapuram district, Marayoor in Idukki District, Nedumkayam in Malappuram District, and Rosemala in Kollam District. A total of 32 accessions were collected during the trip. Samples of leaves from these accessions were also collected for molecular characterisation. Details such as size of fruit, colour, weight, number of fruits in one kilogram were recorded, following standard methods, for calculating average fruit production, taste, moisture content and total soluble sugar concentration. Further collection of samples and chemical characterisation such as determination of lipid, protein, vitamin content etc are in progress.

### **Propagation and conservation of selected *Garcinia* species**

*Garcinia*, belongs to the family Clusiaceae, has 250 species distributed globally. It is the largest genus of the Clusiaceae, usually found in evergreen to semi-evergreen forest of tropical and sub-tropical region. In India the genus is represented by 43 species and 5 varieties, among them 38 species are found in the wild and rests are introduced. The Western Ghats hold nine species, two varieties and four of them are endemic to Agasthyamala biosphere reserve. These species have been placed under different categories in the IUCN Red List of Threatened species. Present project targets to conduct field surveys to identify populations of *Garcinia* species, study their phenology, develop propagation methods and conservation strategies.

To identify population of *Garcinia gamblei*, surveys were conducted in forest areas of Kerala part of the Western Ghats. The species was found in Ponmudi hills, the only known locality of the species, in Thiruvananthapuram district of Kerala. We have located 31 trees within an area of <1 Km<sup>2</sup>, with girths of 20-150 cm at breast height. Only three female and one male tree was located at an altitude of 964-1097 m. The trees produce small number of flowers during November to February and fruiting is observed during June to September. Some potential threat to this species is low number of reproductively active trees, rarity of seedlings, increased number of tourists and occasional forest fires and high seed predation.

## **DIVISION OF PHYTOCHEMISTRY AND PHYTOPHARMACOLOGY**

### **Areas of Research**

- Phytochemistry, new molecules, biological activities
- Essential oils, chemical profiling, biological activities
- Search for elite lines of medicinal plants.
- Secondary metabolite-based nanoparticles, their biology
- Chemical ecology
- Chemical profiling of fats and oils

### **Important Highlights of Major Programmes**

**[A] Centre of Excellence in Phytochemical-Nanotechnology (CEP) is established at KSCSTE-JNTBGRI. It is a 200 Lakhs programme granted to KSCSTE-JNTBGRI:** Excellence in Phytochemical-Nanotechnology is a niche area in the advanced nanotechnology where great attention is needed for the development of useful products to the society as well as to create scientifically trained manpower in the concerned area of nanotechnology for the development of our State/Nation. Based on the necessity to fill up the lacuna in the above said points, KSCSTE put forward the idea of establishing a centre of excellence in nanotechnology under the SHRESTA scheme. For this purpose, KSCSTE invited proposal from its constituent R&D institutions in Kerala to award the establishment of a centre of excellence in nanotechnology. In this regard we submitted a detailed proposal for the establishment of a Centre Excellence in Phytochemical-Nanotechnology (CEP) at KSCSTE-JNTBGRI for the above-mentioned scheme. Based on the merit of the proposals received, and after detailed evaluation and presentation of the proposals KSCSTE granted the establishment of Centre of Excellence in Phytochemical-Nanotechnology at KSCSTE-JNTBGRI only. Thus, among our sister R&D organizations we only received the centre of excellence in Nanotechnology area with a total budgetary provision of 200 lakhs for five years. KSCSTE-JNTBGRI previously received centre of excellence in Conservation area from Ministry of Environment and Forest, Govt. of India. After this It is for the first time KSCSTE-JNTBGRI received a state level centre of excellence, which is not awarded to any of our sister concerns in Nanotechnology. The centre will be nurtured by the KSCSTE-SHRESTA for five years, and after five years it will become a permanent establishment of JNTBGRI. Through the CEP in phase one (1 and 2 years) and Phase II (3,4 and 5<sup>th</sup>years) deliverables like wound healing phytochemical embedded nano-pads and nano encapsulated essential oil for food grain pest management are envisaged. In human resource development

the programme envisages training to researchers, industrial collaborations, collaborations with national and international R&D centres (in I and II phases, SCTIMST Trivandrum is the national collaborator and University of Oklahoma Health Science Centre, Oklahoma City, USA is the international collaborator). The CEP also provides a platform for researchers and industries for the onsite synthesis of nanomaterial from phytochemicals. The patents and training fee, royalties are focused in the II phase of the programme, which will enhance the CEP as a self-sustainable entity. In a nutshell the programme of establishing Centre of Excellence in Phytochemical-Nanotechnology at KSCSTE-JNTBGRI is a novel initiative and an asset to our institute in the future.

**[B] Detection of coconut oil adulteration with palm oil through NMR spectroscopic**

**method:** Food adulteration is a serious threat to human health, and a major issue in the food market, and several innovative analytical techniques were applied to address the problem. As part of the ongoing studies on oils and fats, we have evaluated the application of <sup>1</sup>H NMR spectroscopy in checking the authenticity of coconut oil and monitoring its adulteration with the cheap substitute palm oil. Various parameters such as average chain length (14.25), saponification index (244.66 mg KOH/100 g), molecular weight (652.12), iodine value (8.27 mg/100 g), peroxide value (0.02 meq/kg) and percentage of unsaturation (7.81%) were calculated through NMR technique and were found to be in concurrence with the values obtained from wet lab experiments. The extent of palm oil adulteration can be detected through NMR by evaluating the chemical shift values of olefinic protons at  $\delta$  5.4, 2.8 and 2.0 ppm. The results suggested NMR spectroscopy as a reliable, easy, and non-destructive method for assessing the purity of coconut oil.

**[C] Chemistry of floral volatiles in *Nymphaea* species - Headspace analysis:**

*Nymphaea* (Family: Nymphaeaceae) is one among the fascinating aquatic plant groups with both economic and cultural values and has a significant role in wetland ecology. Though few of the *Nymphaea* species have been explored for their phytochemicals through conventional techniques, the floral volatiles are least investigated, especially the headspace (HS) volatiles. Headspace volatiles has a key role as the floral sensory stimuli that mediate flower visitation and has significant role in chemical ecology. Plant volatile organic compound (VOCs) profiling has wide applications in chemical ecology, biosystematics, aromatherapy, perfume and food industries. The present work reports the HS-VOCs from the flowers of seven different *Nymphaea* species. A total of 36 VOCs were identified, and the major finding of the

study is the remarkable variation of HS volatiles among the day blooming and night blooming species. The day bloomers *N. capensis*, *N. micrantha* and *N. nouchali* have benzyl alcohol and 6,9-heptadecadiene as common characteristic compounds, while 2-hydroxyisocaproic acid methyl ether methyl ester and 2-methoxy 3-methyl butyric acid methyl ester predominated the night bloomers *N. omarana*, *N. pubescens* and *N. rubra*. The role of the identified HS-VOCs in pollinator selection and attraction and any other possible chemical ecological interferences need to be investigated in detail.

**[D] Search for Potential Biologically Active Constituents from the Indian Pitcher Plant, *Nepenthes khasiana*:** This is the first phytochemical investigation on the Indian pitcher plant, *N. khasiana*. Thirty compounds were isolated from the extracts of *N. khasiana* (whole plant) and nine compounds were isolated from the extracts of its pitchers. This study demonstrated the anti-inflammatory effects of cis-isoshinanolone (10 µg/mL) and 2,4-di-tert-butylphenol (25 µg/mL), mediated by suppression of the production of pro-inflammatory cytokines (IL-6, IL-18) and subsequent elevation of anti-inflammatory chemokine/cytokine (IL-10, INF-γ) in LPS induced RAW 264.7 cells. This study also showed the reversal of inflammation induced by LPS on RAW 264.7 cells by cis-isoshinanolone (10 µg/mL) and 2,4-di-tert-butyl phenol (25 µg/mL) through annexin V assay, which clearly proved that these compounds reduce the necrotic and apoptotic cells which are prominent in LPS induced RAW 264.7 cells.

Nevertheless, ROS assay showed that necropsy of LPS induced RAW 264.7 cells was by scavenging of cells which was observed in the DCFDA assay where cis-isoshinanolone (10 µg/mL) and 2,4-di-tert-butyl phenol (25 µg/mL) showed an increase in ROS<sup>+ve</sup> cells denoted as fluorescent peaks (P5). Likewise, short term acute toxicity also substantiated the non-toxic nature of cis-isoshinanolone (10 µg/mL) in mice. Biochemical parameters like liver enzymes ALP, SGOT and SGPT were normal in the compound as compared with the control.

Overall, the study clearly depicts that cis-isoshinanolone and 2,4-di-tert-butyl phenol reverse the inflammation induced by LPS on RAW cells. Also, acute toxicity study revealed antioxidant potential of cis-isoshinanolone on mice liver and brain tissues which may lead to mutations and alter protein synthesis in due course of time. It is of interest to note that cis-isoshinanolone has a protective action on the inflammation caused by LPS by protecting the expression of cytokines and oxidative stress. Hence cis-isoshinanolone can be used as a therapeutic agent against inflammation. This is the first study reporting anti-inflammatory activity of secondary compounds isolated from *N. khasiana*.

**[E] Chemical ecology: ‘Sharpshooter’ in Botanic Garden: The tale of a rare plant-insect interaction:** In this study, we unravelled a unique plant-insect interaction between the leafhopper *Aloka depressa* (tribe Phlogisini) and the host liana, *Diploclisia glaucescens*, from a Botanic Garden located at the southern edge of Western Ghats in India. Field observations and SEM micrographs were employed to derive evidence on this rare plant-insect interaction. 20-Hydroxyecdysone (20E), insect moulting hormone, was detected and quantified in the host plant *D. glaucescens* using HPTLC-densitometry. 20E was isolated and characterized from *D. glaucescens* using column chromatography, <sup>1</sup>H-, <sup>13</sup>C-NMR and HR-MS. 20E was also detected in *A. depressa* excrement using HPTLC-densitometry.

The leafhopper *A. depressa* is functioning as a ‘sharpshooter’ drawing nutrients from the host liana, *D. glaucescens*, and flinging the waste fluid as droplets through their tail ends. SEM micrographs of *A. depressa* revealed its external morphological features, characteristic of a sharpshooter. We quantified 20E (0.44-1.44%, dry wt.) in various parts of *D. glaucescens*. 20E (1.47%, dry wt.) was also detected in the excrement of *A. depressa*. This plant (*D. glaucescens*)-insect (*A. depressa*) association crucially is not damaging the host liana. Considering the diseases caused by sharpshooting leafhoppers in the Americas, this association, and the survival of the host plant (*D. glaucescens*) is illustrating a unique plant-insect interaction.

**[F] Insecticidal properties of *Clausena austroindica* leaf essential oil and its major constituent, trans-anethole, against two stored product pests, *Sitophilus oryzae* and *Tribolium castaneum*:** In this study, the chemical profile of the leaf essential oil of hitherto uninvestigated shrub *Clausena austroindica* B. C. Stone & K. K. N. Nair and its insecticidal potential against two stored product pests, *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst) are being investigated. Essential oils from the leaves of *C. austroindica* collected from two locations in south India were isolated by hydro distillation and analysed by gas chromatography-flame ionization detector (GC-FID) and gas chromatography-mass spectrometry (GC-MS). Six to eight compounds comprising 99.41-99.44% were characterized with trans-anethole (phenyl propanoid) as the major component (95.12-97.44%) in leaf essential oils. Trans-anethole was isolated from the leaf oil by column chromatography, characterized by Fourier Transform Infrared (FT-IR), ultraviolet-visible (UV-Vis), <sup>1</sup>H-, <sup>13</sup>C- and distortion less enhancement by polarization transfer (DEPT 135) nuclear magnetic resonance (NMR) spectroscopy, and quantified by external standardization. Insecticidal activity of *C. austroindica* leaf oil and trans-anethole were assessed against the

rice weevil (*S. oryzae*) and red flour beetle (*T. castaneum*) by contact and fumigant toxicity assays. The mammalian cell toxicity of *C. austroindica* leaf oil and trans-anethole was also tested against L929 cell lines using (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) MTT assay and quantification of reactive oxygen species (ROS). *C. austroindica* leaf oil and trans-anethole demonstrated superior contact and fumigant toxicities against adult beetles of *S. oryzae* and *T. castaneum*. *C. austroindica* leaf oil and trans-anethole showed potential fumigant toxicity against *S. oryzae* (lethal concentration 50 (LC50) 38.80 & 76.98  $\mu\text{L/L}$ ) and *T. castaneum* (LC50 35.65 & 29.10  $\mu\text{L/L}$ ). Relatively less prominent *viz.*, *S. oryzae*: LC50 leaf oil 469.70  $\mu\text{L/L}$ , trans-anethole 2543.20  $\mu\text{L/L}$ ; *T. castaneum*: LC50 leaf oil, 1090.70  $\mu\text{L/L}$ , trans-anethole 2050.84  $\mu\text{L/L}$ , but significant contact toxicities were displayed by the leaf oil and trans-anethole against the two stored product pests. Both *C. austroindica* leaf oil and trans-anethole ( $< 2.0 \mu\text{g/mL}$ ) have not demonstrated any mammalian cell (L929 cell line) toxicity. Our study demonstrates the potential *C. austroindica* leaf essential oil as a new botanical insecticide for controlling stored product pests. Its major component, trans-anethole, also showed prominent insecticidal activity.

**[G] Assessment of major centelloside ratios in *Centella asiatica* accessions grown under identical ecological conditions, bioconversion clues and identification of elite lines:**

Centellosides *viz.*, asiatic acid, madecassic acid, asiaticoside, madecassoside, are the major bioactive molecules in *Centella asiatica*. In this study madecassic acid:asiatic acid, madecassoside:asiaticoside (C6-hydroxylation *versus* non-hydroxylation) and asiaticoside:asiatic acid, madecassoside:madecassic acid (C28-glycoside *versus* aglycone) ratios in 50 *C. asiatica* accessions originally collected from their natural habitats in south India and grown under identical ecological conditions for six generations were determined using validated HPTLC-densitometry protocols. Asiatic acid, madecassic acid, asiaticoside and madecassoside contents ranged from 0.00-0.29% (average  $0.03 \pm 0.06\%$ ; 28 accessions recorded asiatic acid content as zero), 0.02-0.72% ( $0.12 \pm 0.13\%$ ), 0.04-2.41% ( $0.44 \pm 0.52\%$ ) and 0.15-5.27% ( $1.59 \pm 1.26\%$ ), respectively. Distinctly, C6-hydroxylated (madecassic acid:asiatic acid 4.00, madecassoside:asiaticoside 3.61) and C28-glycosylated (asiaticoside:asiatic acid 14.67, madecassoside: madecassic acid 13.25) centellosides dominated over the respective non-derivatized entities. Our results infer that both C6-hydroxylation by CYP450-dependent monooxygenases and C28-glycosylation by UDP-Glc glucosyltransferases are dominant bioconversion steps in *C. asiatica*.

Besides, this study discovered six elite lines of *C. asiatica*, with their (asiaticoside+madecassoside) contents above the industrial benchmark ( $\geq 4\%$ ) from south India. Two elite clones with asiaticoside contents  $\geq 2\%$  were also identified. Standardization of the agrotechniques of these elite lines could lead to their industrial applications. Besides, this study emphasizes the need for standardizing all four centellosides as biomarkers in *C. asiatica* raw drugs, pharmaceutical and cosmetic products.

**[H] Ethyl palmitate, an anti-chikungunya virus principle from *Sauropus androgynus*, a medicinal plant used to alleviate fever in ethnomedicine:** *Sauropus androgynus* is a medicinal shrub used for the treatment of fever in ethnomedical traditions in various Southeast Asian countries. This study was aimed to identify antiviral principles from *S. androgynus* against Chikungunya virus (CHIKV), a major mosquito-borne pathogen that re-emerged in the last decade, and to unravel their mechanism of action. Hydroalcoholic extract of *S. androgynus* leaves was screened for anti-CHIKV activity using cytopathic effect (CPE) reduction assay. The extract was subjected to activity guided isolation and the resultant pure molecule was characterized by GC-MS, Co-GC and Co-HPTLC. The isolated molecule was further evaluated for its effect by plaque reduction assay, Western blot, and immunofluorescence assays. *In silico* docking with CHIKV envelope proteins and molecular dynamics simulation (MD) analyses were used to elucidate its possible mechanism of action. *S. androgynus* hydroalcoholic extract showed promising anti-CHIKV activity and its active component, obtained by activity guided isolation, was identified as ethyl palmitate (EP), a fatty acid ester. At 1  $\mu\text{g/mL}$ , EP led to 100% inhibition of CPE and a significant 3-log<sub>10</sub> reduction in CHIKV replication in Vero cells at 48 h postinfection. EP was highly potent with an EC<sub>50</sub> of 0.0019  $\mu\text{g/mL}$  (0.0068  $\mu\text{M}$ ) and a very high selectivity index. EP treatment significantly reduced viral protein expression, and time of addition studies revealed that it acts at the stage of viral entry. A strong binding to the viral envelope protein E1 homotrimer during entry, thus preventing viral fusion, was identified as a possible mechanism by which EP imparts its antiviral effect. *S. androgynus* contains EP as a potent antiviral principle against CHIKV. This justifies the use of the plant against febrile infections, possibly caused by viruses, in various ethnomedical systems. Our results also prompt more studies on fatty acids and their derivatives against viral diseases.

**[I] Antiproliferative activity of secondary metabolites isolated from *Humboldtia unijuga* Bedd.:** *Humboldtia unijuga* Bedd. (Fabaceae), a tree species endemic to southern region of Western Ghats in India, is least explored for its chemical constituents and biological

activities. Phytochemical analysis of *H. unijuga* roots and stems resulted in the isolation of twenty-nine secondary metabolites with four new molecules, viz., methyl 3-(tetradecanoyloxy) olean-12-en-28-oate, lup-20(29)-en-3-yl 3-hydroxyheptadecanoate, methyl 3-(dodecanoyloxy) olean-12-en-28-oate, 28-oxoolean-12-en-3-yl myristate. Antiproliferative (cytotoxicity) activity of the twenty-nine isolated compounds was evaluated by MTT assay in five cancer cell lines, viz., C6, Hepa 1-6, RIN-5F, DLA and PC-12. These *in vitro* screening assays revealed promising anticancer activity of oleanolic acid-3-acetate and (2S)-1-*O*-palmitoyl-2-*O*-(9Z)-octadecenoyl-3-*O*-(6'-sulfo- $\alpha$ -D-quinovopyranosyl) glycerol. The mechanism of anticancer activity of these two molecules was elucidated by phase contrast and fluorescent microscopy, caspase 3 activity assay and flow cytometric cell cycle/apoptotic analyses. These compounds demonstrated anticancer activity on C6 and DLA cells by inducing cell specific apoptosis. Briefly, this study led to the isolation of twenty-nine secondary metabolites, with four new ones, from *H. unijuga*, and two of the isolated molecules demonstrated promising anticancer activity.

**[J] *Elettaria cardamomum* leaves, an underutilized resource: Chemical profile of its essential oil and insecticidal activity:** *Elettaria cardamomum* is known as the 'Queen of spices'; its leaf essential oil (EO) is least investigated and barely utilized. Here we report the chemical composition of *E. cardamomum* leaf EOs collected from five locations in the southern Western Ghats in India. EOs of fresh and dry capsules were also analysed for comparison of their chemical profiles. The major constituents in cardamom leaf EOs were  $\beta$ -pinene (35.6-51.9%) and coronarin E (17.7-34.2%). In fumigant toxicity assays against two stored product pests, lowest LC<sub>50</sub> against *Tribolium castaneum* was recorded in EO of fresh capsules (124.05  $\mu$ L/L), followed by dry capsules (LC<sub>50</sub> 128.21  $\mu$ L/L) and leaves (LC<sub>50</sub> 148.00  $\mu$ L/L); LC<sub>50</sub>s of fresh, dry capsule and leaf EOs against *Sitophilus oryzae* were 30.24, 35.33 and 89.42  $\mu$ L/L, respectively. This study demonstrates cardamom leaves as a source of untapped bioactive principles which can be viably utilized to produce botanical pesticides.

**[K] Dammarane-type triterpenoid saponin-rich elite genotypes of *Bacopa monnieri* from south India and their edaphic-ecological preferences:** High domestic and export demands are prompting the uncontrolled collection of the nootropic herb *Bacopa monnieri* (L.) Wettst. (BM) from its natural habitats in India; therefore, selection and cultivation of elite genotypes is one of the priorities for generating its quality biomass for industrial purposes. Here sixty BM accessions collected from diverse geographical regions of south India were screened for the two major bioactive dammarane-type triterpenoid saponins, bacoside A (BA) and

bacopaside I (BI), by HPTLC-densitometry. Among these sixty accessions, BA, BI and (BA+BI) contents ranged from  $0.36 \pm 0.05$  to  $5.68 \pm 0.18\%$ ,  $0.00 \pm 0.00$  to  $1.53 \pm 0.12\%$  and  $0.41 \pm 0.13$  to  $7.17 \pm 0.35\%$ , respectively. Industries consider BM accessions with (BA+BI)  $\geq 5.5\%$  as elite lines; this study identified eight elite accessions (1/Bm-11, 2/Bm-55, 3/Bm-57, 11/Bm-68, 19/Bm-76, 33/Bm-90, 36/Bm-93, 44/Bm-102) of BM, satisfying this benchmark. In bi-location trials, six BM elite genotypes were cultivated at two geographical locations (plot 1, low altitude and plot 2, high altitude). In Plot 1, highest (BA+BI) contents and biomass yields were observed in 2/Bm-55 ( $6.60 \pm 0.09\%$ ) and 19/Bm-76 (4090.28 Kg/ha, fresh wt.), respectively. Elite accession 2/Bm-55 was subjected to agrotechnology standardization trails at Plot 1 with 10 combinations of nitrogen-phosphorous-potassium (N-P-K), cow dung, cocopeat and soil (only) treatments. Two treatments, N:P: K 150:90:90 and soil (only), gave elite contents of BA+BI ( $\geq 5.5\%$ ) (5.89%, 6.62%) and high biomass yields (64152.84 Kg/ha, fresh wt., 63076.45 Kg/ha, fresh wt.). Significantly, five of the eight elite BM accessions identified viz., 1/Bm-11, 3/Bm-57, 44/Bm-102, 36/Bm-93, 19/Bm-76, were collected from  $\leq 10$  m altitude locations; this study provides experimental evidence to the preference of BM to low altitude, wet and marshy habitats. Briefly, this study provides conservation, sustainable utilization and edaphic-ecological preferences of the natural resources of this high value memory enhancing herb.

**[L] Mechanical superiority of *Pseudoxytenanthera* bamboo for sustainable engineering solutions:**

The advancement in natural fibre composites has replaced synthetic fibres in various commercial sectors. Bamboo species possess high mechanical properties due to their lignocellulosic fibre content, which makes them suitable for engineering applications and potential alternatives to solid wood. However, despite Bamboo being composed of 130 genera and 1700 different species, out of which many remains underexplored. In this study, we investigated the Lignocellulosic profiling, fibre strength, and mechanical characterization of two species of *Pseudoxytenanthera* Bamboo: *Pseudoxytenanthera ritchiei*, *Pseudopxytenanthera stocksii*, and the results obtained were compared with *Bambusa balcooa*, one of the priority species of bamboo identified by The International Plant Genetic Resources Institute (IPGRI). BET (Brunauer–Emmett–Teller) was used to quantify the samples' density, while SEM–EDX and FTIR spectroscopy were used for elemental analysis. The samples were then subjected to tensile test in addition, thermogravimetric analysis and water absorption test were carried out for the three species. The results showed that *Pseudoxytenanthera* species possessed superior chemical and

mechanical characteristics compared to the priority species of bamboo used for composites. Out of the two *Pseudoxytenanthera* species studied, *Pseudoxytenanthera stocksii* exhibited the highest values of cellulose, hemicellulose, lignin, pectin, ash, carbon, and silicon, indicating its chemical superiority. Moreover, *Pseudoxytenanthera stocksii* also showed higher mechanical values for tensile strength, making it suitable for a variety of engineering applications. The TGA values also indicated that *Pseudoxytenanthera stocksii* is stable at high temperatures when compared with other natural fibres.



Fig. 19. *Melocanna baccifera* fruits, predators. A. Fruits, B-L fruit predators, B-D. Slugs and snails, B. *M. dussumieri*, C. *C. bistrialis*, D. *Macrochlamys* sp., E. Millipede *S. colosseus*, F-G Fruit borers, F. Larvae of *A. grisella*, G. Larvae of *B. germanica*, H-L Mammals, H. Bonnet macaque, *M. radiata*, I. Fruit bitten by rats *R. rattus*, J. Quill of porcupine *H. indica*, K. Seedlings spoilage by wild boars *S. scrofa*, L. Soil rooting by *S. scrofa*

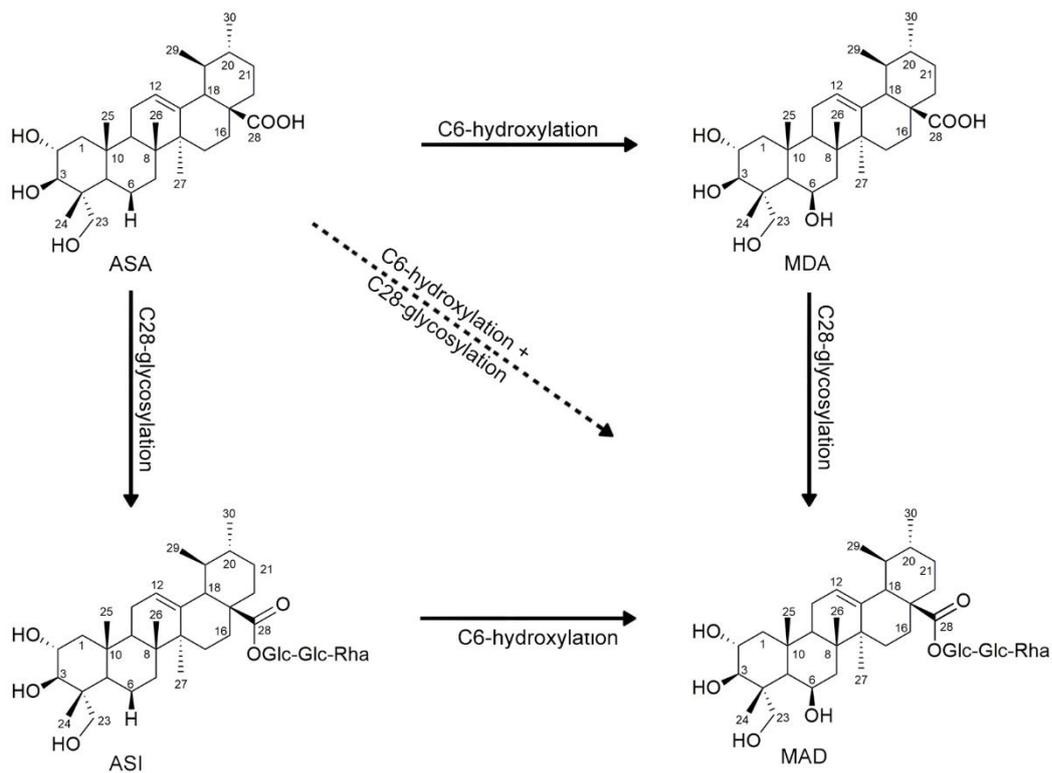


Fig. 20. Four major centellosides in *C. asiatica*, asiatic acid (ASA), madecassic acid (MDA), asiaticoside (ASI) and madecassoside (MAD), and their bioconversions through C6-hydroxylation and C28-glycosylation reactions

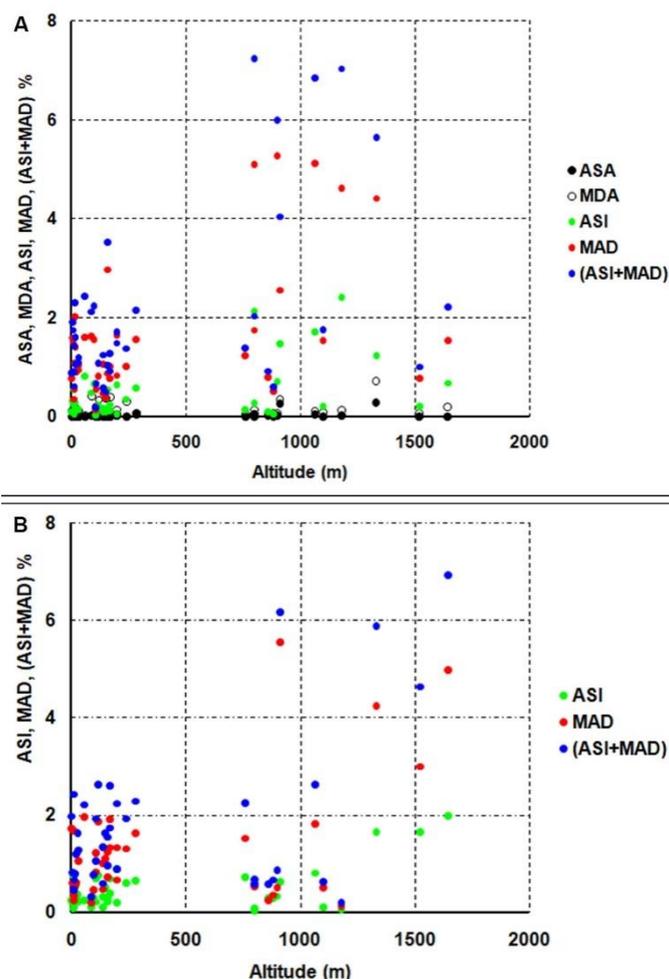


Fig. 21. (A) ASA, MDA, ASI, MAD and (ASI+MAD) contents *versus* altitude of the original collection locations of 41 accessions (out of the 106 in previous fig.) grown under identical ecological conditions for six generations (Kunjumon et al., 2022c\*); (B) ASI, MAD and (ASI+MAD) contents *versus* altitude of the collection locations of the same 41 accessions.

## DIVISION OF PLANT SYSTEMATICS AND EVOLUTIONARY SCIENCE

The research activities of Plant Systematics and Evolutionary Science Division mainly focuses on themes such as (i) Taxonomic studies, herbarium management and development, ecosystem assessment, rescue, and restoration of RET species. The Division is also devoted to the plant systematics in the broadest sense, encompassing phylogenetic, evolutionary, and biogeographical studies at the family, population, specific and higher taxonomic levels. Exploration trips were carried out for the documentation of the plant resources of the state which include species of economically important genus *Cinnamomum*, *Sonerila*, *Ceropegia* ornamentally potential climbers and species of the family Annonaceae. Attention was also paid to enumerate the floristic richness of laterites with emphasis on endemics and threat category species. Upkeep and maintenance of *Myristica* swamps also have been undertaken

due to its importance in protecting water regime and ecology of the area. Established a field gene bank of 126 local mango varieties in the campus ensuring its conservation and base resource for further breeding programmes. The herbarium TBGT is the inevitable part of the division which holds 43504 specimens, 3821 species under 1431 genera. During the period, 2 new species had been published.



Fig. 22. Taxonomy Lab at Plant Systematics and Evolutionary Science Division, JNTBGRI

### **Inventory Systematics and Conservation of family Annonaceae of Southern Western Ghats with emphasis on Endemic, RET species.**

#### **Establishment of Custard Apple Park**

Annonaceae is of considerable economic importance throughout the tropics of the world as a source of edible fruits. Locally called as ‘Aathaka’, a delicious fruit to enrich the fruit basket. In tropical region, large fleshy fruits of various species of *Annona* viz. *A. muricata* (Sour soup), *A. squamosa* (Sweet soup, Custard apple, Sugar apple, Sitaphal) *A. reticulata* (Bullock’s Heart, West Indian Custard apple) are juicy and edible. Sour soup is cultivated widely for its fruits which yield a sap used as beverage and in the preparation of jellies and the juice pulp is used as dessert. *Polyalthia longifolia* is planted as ornamental especially for

its fine foliage. It is also used as a potential plant for green fencing. *Uavria zeylanica* and *Miliusa paithalmalayana* were newly added to the collection.

***Vegetational and Ecological Assessment of Lateritic Zones of Northern Kerala: Endemism, Phytogeography, Evolution and Adaptive traits***

During this period Final Technical report of the Plan project entitled *Vegetational and Ecological Assessment of Lateritic Zones of Northern Kerala: Endemism, Phytogeography, Evolution and Adaptive traits*' preparing and progressing the preparation of a book based on *Endemism, Phytogeography, Evolution and Adaptive traits*.

During this period frequent exploration trips have been conducted to different lateritic areas of Malappuram, Kozhikode, Kannur and Kasaragod districts, especially dry grassland areas resulted 3 new species, 43 endemic taxa including two recently reported species; one recollection after 20 years (exclusive endemic to Kerala); one regional endemic and 3 IUCN Red List Category species; *Syzygium chavaran* (Bourd.) Gamble and *Mammea suriga* (Buch.-Ham. ex Roxb.) Kosterm. are two phytogeographically and medicinally interesting, rare species collected from the sacred groves of lateritic hillocks; 450 herbarium sheets were prepared. 16 rare plant taxa including red list category spices were collected from the micro-niches of these special habitats for *ex-situ* conservation programme. During this period an exploration trip conducted to Ponmudi hills, Agasthyamala Biosphere Reserve (ABR), Thiruvananthapuram district, resulted a new *Eriocaulon* species, *Eriocaulon ravii* Shaju *et al.* and observed extended distribution of *Eriocaulon periyarensis* Sunil *et al.* an exclusive endemic species of Kerala, so far reported only from Periyar river basin of Ernakulam district, now collected from Chittar riparian belt in JNTBGRI campus.



Fig. 23. *Eriocaulon ravii* Shaju et al, sp. nov.

## Dry grasslands of lateritic zones with special reference to endemism

Grass dominated ecosystems form an important constituent of Kerala vegetation which comprise over 250 sq. km of the State's geographical area. It harbours immensely rich plant diversity with high degree of endemism. Based on the degree of endemism and species diversity, the two criteria for recognising hotspots of the State, there is sufficient justification for treating the grass dominated ecosystems as a distinctive hotspot of the State.

The seasonal cycles of intense wetness and dryness give rise to a distinctive ecological scenario, fostering a unique flora in the lateritic hills of north Kerala. The dry grasslands of these lateritic hillocks provide a habitat for numerous species of seasonal herbaceous plants and grasses that thrive in extreme stressful conditions. Preserving endemic grasses protect the delicate balance of ecosystems. Most of the endemic grass genera are of phytogeographical importance and retracting to small ecological niches without any indications of active evolution. Endemic grasses form a major constituent of lateritic hillocks, during this season we were mainly focused on the collection and documentation of maximum number of endemic grass taxa from these special habitats, which results 36 endemic species of the genera *Ischaemum*, *Dimeria*, *Arundinella*, *Glyphochloa*, *Bhidea*, *Nanoorvia*, *Isachne*, *Chrysopogon* and monotypic genus *Danthonidium* etc. Important endemic species are:

*Arthraxon meeboldii* Stapf, *Arundinella kannanorica* V. J. Nair, Sreek. & N. C. Nair, *Arundinella ciliata* (Roxb.) Nees ex Miq., *Arundinella leptochloa* (Nees ex Steud.) Hook.f., *Arundinella mesophylla* Nees ex Steud, *Arundinella purpurea* Hochst. ex Steud.; *Ischaemum malabaricum* Sreek. et al., *I. jayachandranii* Ansari et al., *I. nairii* V. J. Nair et al., *I. fischerii* Ravi et al., *I. abrahamii* Ravi et al., *I. pappiniseriensis* Ravi et al., *I. lanatum* Ravi et al., *Ischaemum tumidum* Stapf ex Bor var. *calicutensis* Sreek. et al; *Dimeria jainii*, *Dimeria hohenackeri* Hochst. ex Miq. Subsp. *kodaguensis* Kiran Raj, Sivad. & Dileep, *Dimeria hohenackeri* Hochst. ex Miq. subsp. *hohenackeri*, *Dimeria ornithopoda* Trin., *Dimeria raizadae* V. J. Nair, Sreek. & N.C. Nair, *Dimeria bialata* C. E. C. Fisch, *Bhidea burnsiana* Bor, *Bhidea fischeri* Sreek. & B. V. Shetty, *Chrysopogon narayanii* Sunil et al. *Chrysopogon tadulingamii* Sreek., V. J. Nair & N. C. Nair, *Danthonidium gummiei* (Bhide) C. E. Hubb., *Nanooravia kayyurensis* Shaju, Rajendraprasad, Rijuraj & Ratheesh Narayanan, *Nanooravia santapau* (M. R. Almeida) Kiran Raj & Sivad., *Isachne bhatii* Biju et al. *Isachne gracilis* C. E. Hubb., *Isachne kannurensis* Sunil et al., *Isachne veldkampii* K. G. Bhat & Nagendran, *Glyphochloa acuminata* (Hack.) Clayton var. *acuminata*, *Glyphochloa acuminata* var.

*stocksii* (Hook.f) Clayton and *Sehima nervosum* (Rottler) Stapf, *Lepturus repens* (G. Fost.) R.Br. (New record for Kerala) also collected.

Along with this some interesting endemic sedge species were also collected. They are *Fimbristylis pokkudaniana* Sunil *et al.*, *Fimbristylis stigmatotecta* Govind, *Fimbristylis jaleeliana* Ratheesh, Shaju & Sunil

*Fimbristylis jaleeliana* Ratheesh, Shaju & Sunil (Recently published new species) and *Fuirena simpsonii* Ravi, N. Mohanan & Shaju.

Another important work progressing during this period is the data compilation of Fragile Ecosystems of Kerala, based on some case studies over a decade of intensive and extensive field work.

1. **Riparian Ecosystem:** Achankovil river basin
2. **Wetlands:** Kuttanad- below sea level farming system within Vembanad Lake, one of the Ramsar sites in Kerala, India
3. **Mangroves:** Puthuvypeen, Largest single stretch of mangrove vegetation in Kerala (101 ha), Vembanad wetland (Ramsar site), Ernakulam District
4. **Myristica swamp: Kulathupuzha-** southern Western Ghats region of Kerala
5. **High altitude grass land:** Hamilton plateau (Eravikulam National Park area and surroundings) Idukki District
6. **Dry grasslands:** Lateritic zones of northern Kerala
7. **Sacred groves:** Selected Sacred groves (Madayi Kavu, Vallikkattu Kavu, Eringol Kavu and Vandanam Kavu)

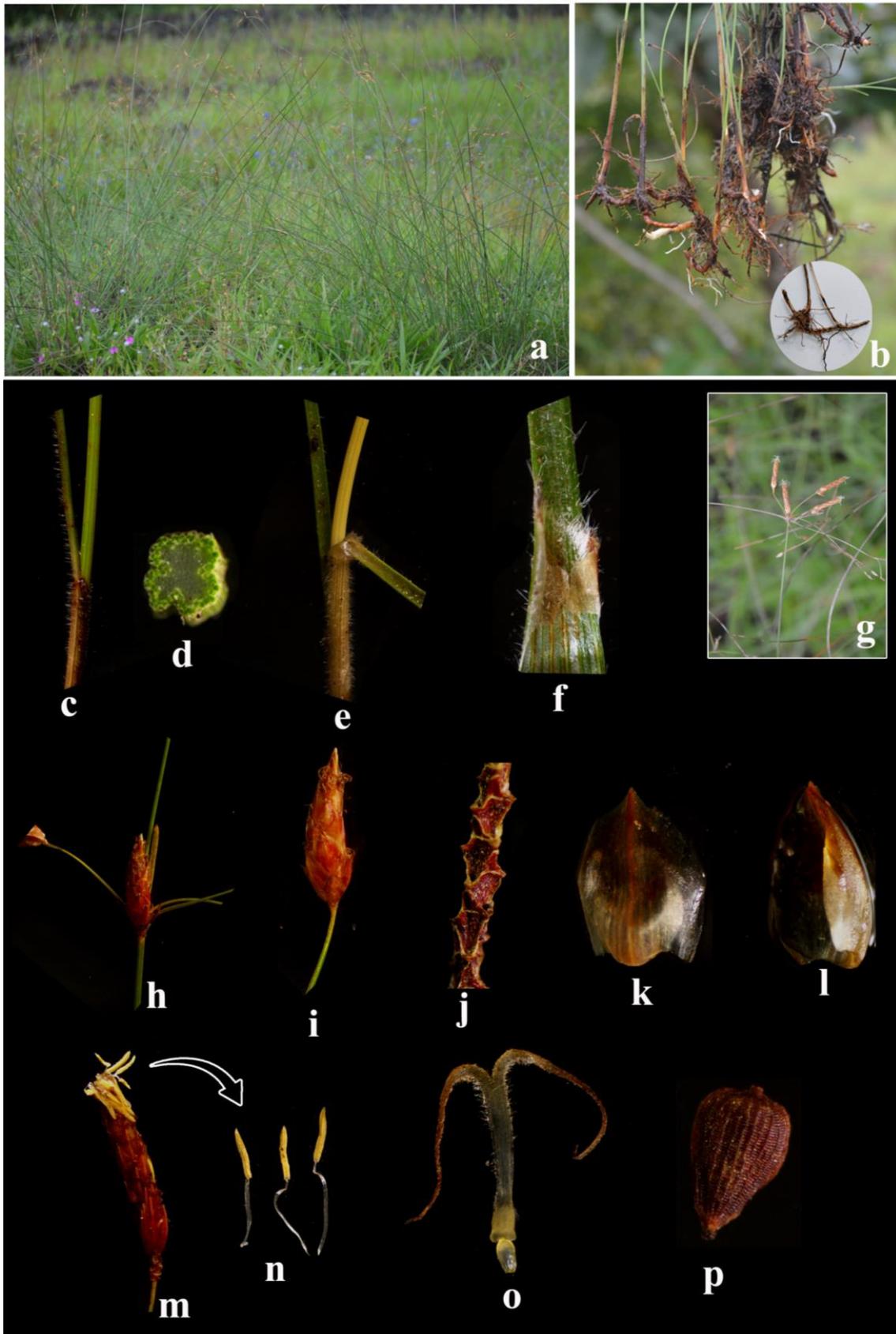


Fig. 24. *Fimbristylis jaleeliana* Ratheesh, Shaju & Sunil sp. nov.

**Taxonomic studies of the family Gentianaceae and the genus *Cinnamomum* in the Western Ghats:** The Western Ghats is one of the centres of diversity for the family Gentianaceae and genus *Cinnamomum* Schaeffer in India. During the period under report, 52 specimens from the family Gentianaceae and 201 specimens of *Cinnamomum* from the previous collection were processed, identified, labelled, and incorporated into the existing collection. Critically studied the *Exacum courtallense* and its varieties and based on the observations *E. courtallense* var. *laxiflorum* erected to the rank of species as *E. laxiflorum* and synonymized *E. courtallense* var. *bonaccordense* with *E. laxiflorum*. The article has been published in *Phytotaxa*.

**Establishment of a Biorepository of the plants in the Southern Western Ghats of India with particular emphasis on endemics:** The Global Genome Initiative (GGI) is a collaborative science-based endeavour to collect the Earth's genomic biodiversity, preserve it in the world's biorepositories and make it available to researchers everywhere. Under this programme, JNTBGRI received a seed grant from GGBN and was secured to establish a genomic resource biorepository and, with it, began a new genome-quality tissue sample collection, the "INTBGB". Before this, there were no Biorepositories in India as part of the Global Genome Initiative, and through this programme, JNTBGRI became part of the Global Genome Biodiversity Network (GGBN). The priority was to develop a collection of species in the Western Ghats. Through this award, developed a biorepository of taxa do not present in other biorepositories, with a priority on plants which are endemic to the Western Ghats, India, and are not well represented in the conservatories.

Various field exploration trips were undertaken and collected genetic samples and voucher specimens of 58 taxa (57 species) belonging to 47 genera under 28 families. All those taxa were new to the GGBN portal. The collection holds significance as it includes 41 endemic and 14 threatened species, of which two species are point endemics. Among the INTBGB specimens new to GGBN, *Nothopegia aureo-fulva* Bedd. ex Hook.f. (Anacardiaceae) is critically endangered, *Symplocos macrophylla* ssp. *rosea* (Bedd.) Noot. (Symplocaceae), *Cinnamomum chemungianum* M. Mohanan & Henry (Lauraceae), and *Tabernaemontana gamblei* Subram. & Henry (Apocynaceae) is endangered. Nine species fall under the vulnerable category viz. *Belosynopsis vivipara* (Dalz.) C.E.C. Fisch. (Commelinaceae), *Exacuma tropurpureum* Bedd. (Gentianaceae), *Gluta travancorica* Bedd. (Anacardiaceae), *Hedyotis pruinosa* Wight & Arn. (Rubiaceae), *Kunstleria keralensis* C. N. Mohanan & N. C.

Nair (Fabaceae), *Lasianthus jackianus* Wight (Rubiaceae), *Palaquium bourdillonii* Brandis (Sapotaceae), *Phaeanthus malabaricus* Bedd. (Annonaceae), and *Sonerila versicolor* var. *axillaris* (Wight) Gamble (Melastomataceae). Twenty-eight species have narrow distribution found only in the southern Western Ghats. Three species in this collection are point endemics *Cinnamomum mohananii* Gangapr., S.P. Mathew & Jagad. (Lauraceae), *Thottea ponmudiana* (Gamble) Ding Hou (Aristolochiaceae) and *Silentvalleya nairii* V. J. Nair, Sreek., Vajr. & Bhargavan (Poaceae). The collections were incorporated into the database of GGBN and accessed at the GGBN data portal. The project was completed by May 2022, and the progress report has been submitted.

**Reverse The Red: Assessing the population trends and developing a Recovery programme for two Cinnamomum species Endemic to the Western Ghats:** This programme is funded by BGCI under Small Grants Programme. The study aims to describe and document the current population of the selected species, its habitat, and any plausible threats to the known population, to serve as the basis for monitoring and formulating measures to protect the population. Under this programme 4 field trips were conducted to document the size and trends of their populations, the conservation status of the species by assessing their distribution, as well as the threats affecting them and developing effective species recovery programmes. Studies are being carried out to develop propagules through vegetative propagation for effective restocking of these endangered taxa.

### **Inventory, Systematics and Conservation of *Ixora* L. (Rubiaceae) of Kerala**

The genus *Ixora* L. of the family Rubiaceae is one of the wild ornamentally potential groups among flowering plants and forms an integral part of any garden landscape. *Ixora* is a part of any garden landscape from time immemorial. It is popularly called as West Indian Jasmine, Flame of the woods, Jungle geranium. It comprises of about 400 species and largely pantropical in distribution with the greatest diversity of species occurring in the SE Asian region. *Ixora* species are well known for their ornamental potential and forms an integral part of any garden. Due to their peculiar floral attraction and habits, they can be easily recognised by a common man. With their fine foliage and curious and variously coloured flowers, cultivars are preferred for topiaries, borders, green fencing etc. Flowers are numerous and showy and possess horticultural potential. They are also attractive to butterflies making the garden most attractive. All these attributes for its preferential selection during the designing

of a garden. *Ixora coccinea* is widely distributed and enrich open landscapes adjacent to forests with its red coloured blossoms.

In India, about 45 species occur and chiefly confined to mountains regions of Himalayas, hills of Northeastern states and Western Ghats. In India there are about 45 species of which W. Ghats inhabits 19 with 8 endemics. There are 18 species in Kerala with two endemics *I agasthyamalayana* and *I. sivarajiana*. There are 5 species falling under IUCN category. Altogether, 12 plant collection trips were conducted mainly in the Southern districts of Kerala and collected Stem cuttings and root cuttings for propagation During the reporting period, 8 species had been recorded viz., *Ixora coccinea*, *I. nigricans*, *I. brachiata*, *I. malabarica*, *I. agasthyamalayana*, *I. johnsonii*, *I. polyantha* and *I. elongata*. These are economically important species other than ornamental value. *Ixora coccinea* is medicinally used as a curative of diarrhoea, dysentery, leucorrhoea with astringent. Prepared herbarium voucher specimens too.



Fig. 25. a) *Ixora nigricans*; b) *Ixora johnsonii*



Fig. 26. a) *Ixora johnsonii* Variegated; b) *Ixora coccinea*

### **Herbarium (TBGT)**

Herbarium acts as the base for all taxonomy research. JNTBGRI Herbarium (TBGT) is a cross section of plant wealth especially of W. Ghats with 3821 species under 1431 genera and 43504 specimens. Digitalization was carried out for 549 specimens. There were 711 visitors during the period that include students and researchers.

**Conservatories:** 1. Custard apple Garden, a repository of the family Annonaceae of Western Ghats with 44 species, 2. Mango germplasm, a resource hub of 126 varieties of local native mango varieties of Kerala. 3. Myristica swamp in the campus, 4. Acanthaceae consists of 40 species 5. *Strobilanthes* Garden with 14 species is maintained.

### **Red Data Book of Kerala Plants**

This Red Data List covers species coming under plant groups namely Bryophytes, Pteridophytes, Gymnosperms and Angiosperms. The present project was officially started on 21-08-2020 and successfully completed by 31-03-2022. The primary objective of the project was to compile the threatened plant components to bring out the Rare Plant Register for the State of Kerala. The project was successful in identifying all the threatened species by going through all available literature and based on field surveys. The target species were recorded

and the data processed opening up chances and pointing necessities to afford some protection to the species until this uncertainty is resolved.



Fig. 27. Report on Red Data Book of Kerala Plants, The Hindu Daily 1 July 2022

The findings were quite alarming, because among 4694 species of Angiosperms inhabiting in Kerala, 4050 species are indigenous, and 616 species are exotic, naturalized or cultivated. Out of the total floristic wealth of Kerala, 1226 Angiosperm species were evaluated following IUCN criteria, of which a total of 297 species are threatened with extinction, 37 species are Near Threatened, 36 species are Data Deficient and a great majority of them (856 species) falls in the Least Concern (LC) category. Among Bryophytes, Pteridophytes and Gymnosperms, out of a total of 47 species evaluated based on IUCN criteria, 8 species are counted in the Threatened category and the remaining 39 species are included either in the NT or LC categories. This Red List of threatened plants includes many endemic species exclusively distributed in the state. These findings would serve as the baseline for the development and implementation of suitable policies and actions to conserve the threatened species reported from the state of Kerala.

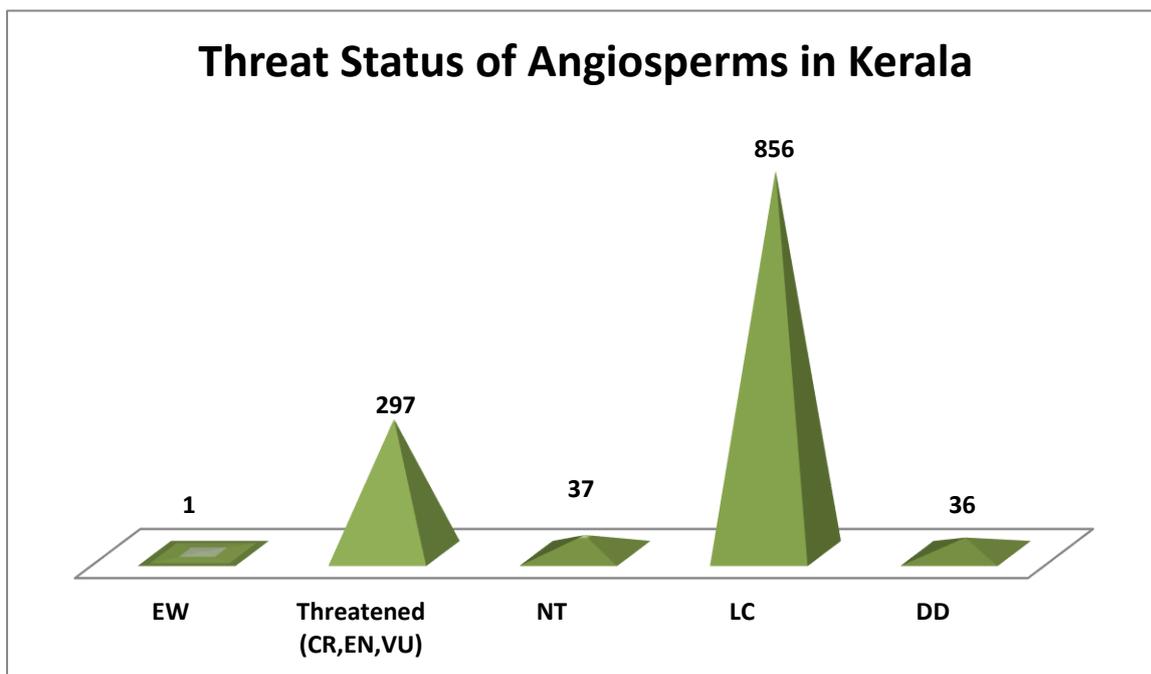


Fig. 28. Angiosperms in Kerala analyzed as per IUCN norms  
 Extinct in the Wild -1; Threatened - 297; Near Threatened - 37; Least Concern - 856;  
 Data Deficient - 36

#### **Conserving RET species/ KSBB funded (Kudumbasree Project)**

The project is an outcome and continuation of the previous project entitled “Preparation of Red Data Book and Assessment of Threatened species of Kerala (flora including Aquatic Species)” undertaken during the year 2021-2022, by JNTBGRI with financial support from The Kerala State Biodiversity Board. A total of 488 Kudumbasree workers belonging to two southern districts namely Thiruvananthapuram and Kollam were given training on the propagation and conservation of the RET species listed in the report. A total of 13 exercises were given for the trainees during the training program. It is a new way of *ex-situ* conservation with people participation which is primarily aimed to make awareness to conserve, protect and propagate the Rare, Endangered and Threatened species. The project has provided a significant boost to the conservation process at the local and regional levels, ensuring availability of these resources in the long run.



Fig. 29. Mr. Shinu Madathara, President, Peringammala Grama Panchayat gives away RET plant seedlings to the Kudumbasree workers during the training programme in JNTBGRI (30 May 2022).



Fig. 30. Smt. G. Komalam, President, Block Panchayat, Vamanapuram felicitates the 10 days training programme on the propagation and cultivation of RET plants. On the dais are Dr. A. V. Santhosh Kumar (KSBB Member Secretary), Dr. C. George Thomas (Chairman, KSBB), Sri. K. V. Govindan (Board Member, KSBB), Dr. R. Prakashkumar (Director, JNTBGRI), Smt. Geetha Priji (Ward Member, Peringammala Grama Panchayat), Dr. K. Satheesh Kumar (Board Member, KSBB).

## **New variety of *Thottea sivarajanii***

The taxonomy team of JNTBGRI has discovered a new taxon, *Thottea sivarajanii* var. *anamalaiana* from the Anamalai hills of Western Ghats. The woody habit, comparatively less pubescent inflorescence and flowers, glabrous stem, petiole and fruits, highly reduced staminodes, prominent bracts and bracteoles etc. are some of the characteristics that delimit this variety from the species proper.



Fig. 31. *Thottea sivarajanii* var. *anamalaiana* Nazarudeen, G. Rajkumar & Alister

## **DIVISION OF ETHNOMEDICINE AND ETHNOPHARMACOLOGY**

The Division of Ethnopharmacology was established in the year 1992, with the mandate for conservation, preservation, sustainable utilization, and bioprospecting of the rich traditional knowledge related to plants used for food and medicine of our country through systematic documentation, pre-clinical studies, molecular ethnopharmacological research to translate/extend the outcome of the research into action for the benefit of the common people.

### **Areas of Research**

Systematic documentation of Traditional Knowledge (TK) and Bio-prospecting through Ethnopharmacological Research, which includes: Ethno-medico-botanical survey and systematic documentation of Traditional Knowledge related to plants used for food and medicine, Preparation of database on Ethnomedicine/Traditional Knowledge associated with plants used for food and medicine, Protection of Traditional Knowledge under Sui generis system, Comparative studies of Ethno-medico-botanical data with Ayurvedic system of medicine for enriching Ayurvedic Pharmacopoeia, Selection of plants for detailed Ethnopharmacological and Phytochemical studies pre-clinical studies based on Molecular-Ethnopharmacological approach through activity guided fractionation and Phytochemical studies, Pharmacognostic studies of selected medicinal plants/ market samples of raw drugs, Integrated drug development programme, technology transfer and commercialization, Implementation of participatory programme on “Conservation and Sustainable utilization of Medicinal and Aromatic plants in tribal/rural areas, “Herbs for All and Health for All” – Sustainable utilization of locally available medicinal and food plants resources for Primary Health Care, Publication of books on various awareness programmes related to biodiversity conservation and sustainable utilization of medicinal/aromatic/wild edible plants, Strengthening research in evaluation of quality, safety and efficacy of Ayurvedic/ herbal medicines/ nutraceuticals and Recognition of IPR through Access and Benefit Sharing

### **Important achievements**

In the In-house project entitled “Systematic documentation and Bio-prospecting of ethnomedically important medicinal plants on tribal/traditional knowledge through molecular pharmacological approach”(P003), the main objective is to undertake a detailed field survey, incentivization and documentation of ethnobotanically important plant species

used by the people inhabiting in the coastal and tribal areas of Kerala is rich in ethnobiology/ethnobotany related knowledge, the reason for taking up such a project, the rich knowledge base (both tribal and coastal) which is undocumented systematically so far. Unfortunately, this priceless Traditional Knowledge transpired over generations is deteriorating rapidly due to various factors including modernization, urbanization, deforestation, changing social and economic standards of the tribal and coastal communities, etc. The Ethnomedicine & Ethnopharmacology Division at JNTBGRI is one of the key research divisions at JNTBGRI which plays a vital role in the conservation, preservation and sustainable utilization of the rich traditional herbal wealth and knowledge system of our country for the benefit of the common people through bioprospecting. The Division's research is vital for identifying plants with potential therapeutic properties and to bridge the gap between traditional knowledge and modern scientific research. The division is engaged in extensive field surveys to systematically document the traditional knowledge and to scientifically validate the potentially useful plant species for different therapeutic claims through ethnopharmacological research. Hence, the prime objective of this project is to immediately document the remaining traditional wisdom of particularly the elderly coastal and tribal communities of Kerala which could provide leads for further research and development.

During the financial year of April 2022 to March 2023, for the establishment of closer ties and interaction with the elected local body members of Gramapanchayats and traditional knowledge holders to establish good rapport for the documentation of traditional knowledge, conducted Gramapanchayat meetings at Elamkunnapuzha, Edavanakkad, Pallipuram and Nayarmabalam Gramapanchayats of Ernakulam district and Pudur Gramapanchayat of Palakkad district. The ethnobiological survey in the coastal areas of Perumbadappu, Pallipuram, Elamkunnapuzha, Nayarambalam and Edavanakkad and the tribal areas Kuttampuzha and Pudur Gramapanchayat of Kerala were completed and documented in total is 857 information were documented which includes 457 drug information, 172 information of food plants/food preparations, 64 information on tools and artefacts and 164 other miscellaneous information from 172 knowledge providers. As part of the one of the deliverables of the project, conducted field trips to the coastal and tribal areas of Ernakulam, Thrissur, Malappuram and Palakkad districts for documentation of traditional practices for the preparation of two video documentary films (Malayalam and English) and video

documented 25 sequences of traditional practices and postproduction and editing is in progress.

As part of the Ethnopharmacological evaluation ,of the plants based on traditional knowledge, the coded plant (RN ) at 800  $\mu\text{g/ml}$  showed the ability to inhibit protein denaturation, at a maximum of 73.49%.It has substantial antiproteinase activity at various concentrations, with the greatest inhibition of 64.64% at 800  $\mu\text{g/ml}$ , and significantly protects against heat-induced protein denaturation at concentrations between 400 and 800  $\mu\text{g/ml}$ . RN at concentration 600, 700 and 800 $\mu\text{g/ml}$  significantly protect the erythrocyte membrane against lysis induced by heat and also in hypotonicity-induced hemolysis and RNHE 800  $\mu\text{g/ml}$  demonstrated the greatest protection (73.84%).

*In vivo* anti-inflammatory study on Carrageenan induced paw edema and formalin induced paw edema with various concentrations of hydroethanolic extract of coded plant on Wistar rats was carried out and it showed significant protection against inflammation.



Fig. 32. Gramapanchayat meeting at Edavanakkad Gramapanchayat, Ernakulam district



Fig. 33. Interaction with knowledge providers at Elamkunnappuzha Gramapanchayat, Ernakulam district



Fig. 34. Interview conducted with tribal knowledge provider at Kuttampuzha Gramapanchayat



Fig. 35. Women of Muthuvan Tribes at Kuttampuzha Gramapanchayat



Fig. 36. Field visit along with traditional vaidya, Shri. Raju Maniyan at Pudur Gramapanchayat, Palakkad district



Fig. 37. Interaction with Kurumba tribal community at Pudur Gramapanchayat, Palakkad district

The DST funded project *Livelihood Enhancement of Tribal of Njaraneely Ward of Peringammala Panchayat, Thiruvananthapuram, Kerala through plant resource enrichment, buy back and Herbal products development* is aimed in the empowerment of unemployed rural women economically by providing them with skills and support for the development of Herbal/ Home care products for livelihood enhancement. As part of the programme, training imparted to unemployed rural women, products developed were displayed in Bio connect Exhibition, at Leela Hotel Kovalam, Kerala.

The studies on the ‘*evaluation of the apoptotic properties of leaf extracts of Simarouba glauca (Simaroubaceae) against human leukemic cancer cells*’ revealed that *Simarouba glauca* leaf extracts inhibited leukemic cells in a time- and dose dependent manner either through mitochondrial or death receptor activation. and found to be nontoxic to lymphocytes which suggests its use for the treatment of leukaemia.

Another study on the ‘*assessment of effect of Morinda umbellata L active fraction (MUAF) on various inflammatory mediators using lipopolysaccharide (LPS) induced in vivo model in Wistar rats*’ revealed that the presence of anti-inflammatory compounds in MUAF can effectively inhibit LPS-induced proinflammatory cytokines TNF- $\alpha$ , IL- $\beta$ , and IL-6 *in vivo*. It also suppressed the over expression of TNF- $\alpha$ , IL-1 $\beta$ , IL-6, iNOS, and COX-2 possibly via downregulating NF- $\kappa$ B activation.

## **DIVISION OF MICROBIOLOGY**

The Microbiology division orchestrates programmes that explore the Microbial Diversity of Kerala state. The scientific programmes are designed to explore the microbial diversity of Kerala and discover the new species of macro, micro fungi, lichens, and microbes. These new and noteworthy species will be screened for various properties of therapeutic importance. Microbial secondary metabolites will be screened for anticancer, antimicrobial and antibiofilm agents. The therapeutically viable metabolites are further explored to elucidate the mechanism of action employed in instrumenting the therapeutic action. The division also maintains a well-established Mushroom herbarium with over 19000 accessions and a microfungus and lichen herbarium.

### **Important achievements**

- a) Various forests of Kerala were surveyed for Mushrooms and 261 samples of Mushrooms were collected and processed. Five new species of mushrooms and eight new Indian records were discovered from Western Ghat Forests. Twenty-six gene sequences were deposited in GenBank. A mushroom Herbarium is maintained with 19022 accessions in the division. Fifty-two samples of foliicolous fungi were collected and added to the existing herbarium. Thirty-seven Lichen samples were collected and added to the existing lichen herbarium.

- b) New species of Mushrooms discovered: During the period of report, altogether five species were described.
- c) During our on-going studies Four new species such as *Agaricus brunneodiscus*, *Agaricus albovariabilis*, *Candolleomyces niveofloccosus* and *C. albosquamosus* were collected on several occasions from JNTBGRI campus and other regions of Kerala. These were described and published in peer reviewed journals.
- d) *Panicum repens* rhizosphere soil samples were collected from different localities of Azhimala beach. 30 actinomycetes isolates were obtained from the rhizosphere samples which were proceeded for fermentation. 19 isolates from 30 selected strains showed antibacterial activity. Two most potential isolates out of the 19 positive actinomycetes were selected for further study and various parameters like Minimum Inhibitory concentration (MIC), Minimum Bactericidal Concentration (MBC) and Minimum Biofilm Inhibitory Concentration (MBIC) were determined.
- e) Described three species and one variety of foliicolous fungi new to science from various forest localities of Kerala part of Western Ghats. Recorded 15 lichens new to India and 11 new to Kerala State from different forest areas. In collaboration with National Botanical Research Institute (CSIR-NBRI), 35 secondary metabolites that are isolated from lichens were tested for biological activities and are listed along with their structure, substance class, and occurrence. Further, bioprospecting studies were also initiated.

### **New mushroom species described from Microbiology Division**



Fig. 38. *Candolleomyces albosquamosus* Nayana & Pradeep

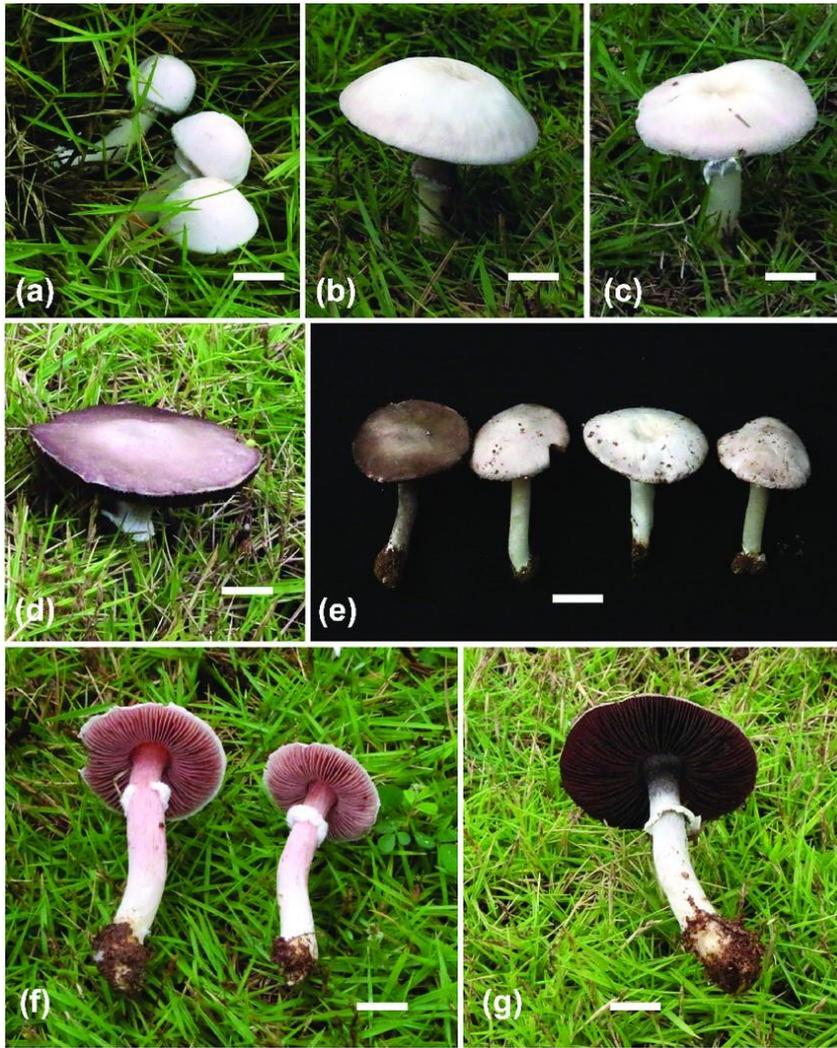


Fig. 39. *Agaricus albovariabilis* C. P. Arya & C. K. Pradeep



Fig. 40. *Agaricus brunneodiscus* C. K. Pradeep & C. P. Arya



Fig. 41. *Candolleomyces niveofloccosus* P. K. Nayana & C. K. Pradeep

## EXTENSION AND TRAINING UNIT

(i) Plant supplied for VIP planting: *Syzygium palodense* saplings were supplied to Kerala Legislative Assembly for planting during the visit of Sri. Ram Nath Kovind, Hon. President of India, on 26.05.2022.

(ii) 3004 numbers of endemic tree saplings were distributed to 10 batches of Kudumbasree peoples trained in the collaborative project of Garden Management and PS & ES divisions funded by KSBB.

## PLANTS FOR SALE

No.	Scientific Name	Common Name/ Local Name	Price
1.	<i>Acalypha fruticosa</i>	ചെറു ചിന്നി	30
2.	<i>Actinodaphne bourdillonii</i>		50
3.	<i>Adenantha pavonina</i>	മഞ്ചാടി	30
4.	<i>Adenium obesum</i>	Desert Rose	50
5.	<i>Aegle marmelos</i>	കുവളം	50
6.	<i>Aeschynanthus radicans</i>	Red lipstick plant	50
7.	<i>Aglaonema costatum</i>	Aglaonema	40
8.	<i>Aglaia</i> sp.	Aglaia	30
9.	<i>Aiphanes horrida</i>	Coyure Palm Tree	50
10.	<i>Allamanda cathartica</i>	മഞ്ഞ കോളാമ്പി	30
11.	<i>Aloevera</i>	കറ്റാർ വാഴ	30
12.	<i>Alpinia calcarata</i>	ചിറ്റുരത്ത	30
13.	<i>Alpinia purpurata</i>	Red Ginger	30
14.	<i>Alternanthera dentata</i>	അലങ്കാര ചുീര	30
15.	<i>Ampelocissus indica</i>	താമേ വള്ളി	30
16.	<i>Annona squamosa</i>	Custard apple, അത്ത	30
17.	<i>Annona muricata</i>	Prickly Custard Apple മുള്ളാത്ത	30 Graft- 100, 150
18.	<i>Anthurium bakeri</i>		50
19.	<i>Anthurium 'miniature red'</i>	Anthurium miniature red	50
20.	<i>Anthurium</i> pot plant	Anthurium Hybrid	150
21.	<i>Anthurium crystallinum</i>		700, 1000
22.	<i>Aphanamixis polystachya</i>	Pithraj Tree	50

23.	<i>Aptenia cordifolia</i>	Baby sun rose	30
24.	<i>Aporosa cardiosperma</i>	പൊൻ വെട്ടി	30
25.	<i>Arachis pintoii</i>	Pinto peanut	30
26.	<i>Arachnothryx leucophylla</i>	Panama Rose	30
27.	<i>Areca catechu</i>	Betel nut palm	50
28.	<i>Areca triandra</i>	ആൻഡമാൻ കമുക്	50
29.	<i>Artemisia parviflora</i>	കർപ്പൂര തുള്ളസി	30
30.	<i>Artocarpus heterophyllus</i>	പ്ലാവ്	30 Graft- 200 to 250 Bud- 150 to 200
31.	<i>Artocarpus hirsutus</i>	ആഞ്ഞലി	30
32.	<i>Artocarpus lacucha</i>	ലക്കൂച്ച	50
33.	<i>Arundina graminifolia</i> (purple)	Purple Bamboo Orchid	100
34.	<i>Arundina graminifolia</i> (white)	White Bamboo Orchid	50
35.	<i>Asparagus racemosus</i>	ശതാവരി	30
36.	<i>Averrhoa bilimbi</i>	ഇലിമ്പിപ്പള്ളി	30
37.	<i>Averrhoa carambola</i>	ആനപ്പുളിഞ്ചി	30 Graft – graft- 75 to 100
38.	<i>Ayapana triplinervis</i>	അയ്യപ്പാന, വിഷപ്പച്ച	30
39.	<i>Azadirachta indica</i>	വേപ്പ്	30
40.	<i>Baccaurea courtallensis</i>	മുട്ടി	50 Graft – 75 to 100
41.	<i>Bacopa monnieri</i>	ബ്രഹ്മി	30
42.	<i>Baliospermum solanifolium</i>	നാഗദന്തി	30
43.	<i>Bambusa bambos</i>	ഏണി മുള	30
44.	<i>Bambusa mizorameana</i>	Mizoram bamboo	30
45.	<i>Bambusa multiplex</i>	Bush bamboo	30
46.	<i>Bambusa multiplex</i> (Yellow)	Yellow bush bamboo	100
47.	<i>Bambusa multiplex</i> (Wamin)	Bellied yellow bush bamboo	100
48.	<i>Bambusa pallida</i>	Bakhal Bamboo	50
49.	<i>Bambusa tulda</i>	Bengal bamboo	50
50.	<i>Bambusa variegata</i>	വേരിഗേറ്റഡ് മുള	30
51.	<i>Bambusa variegata</i>	Variegated Bamboo	30
52.	<i>Bambusa vulgaris</i> ‘vittata’	മഞ്ഞ മുള	50
53.	<i>Barleria cristata</i>	Philippine violet	30
54.	<i>Barringtonia racemosa</i>	സമുദ്ര കായ	50

55.	<i>Barringtonia acutangula</i>	ആറ്റു പേഴ്	50
56.	<i>Bauhinia tomentosa</i>	മഞ്ഞ മന്ദാരം	30
57.	<i>Begonia spp.</i>	Begonia	50
58.	<i>Bentinckia nicobarican</i>	Nicobarian hill Areca palm	50
59.	<i>Biancaea sappan</i> Syn. <i>Caesalpinia sappan</i>	പതിമുഖം/ ചപ്പങ്ങ	50
60.	<i>Bougainvillea spectabilis</i>	കടലാസു ചെടി	30
61.	<i>Buchanania lanceolata</i>	കുളമാവ്	50
62.	<i>Bunchosia glandulifera</i>	Peanut butter fruit	50
63.	<i>Butea monosperma</i>	ചമര	150
64.	<i>Caladium spp.</i>		30
65.	<i>Calliandra haematocephala</i>	Powde rpuff	30
66.	<i>Calophyllum apetalum</i>	ചെറുപുന്ന	50
67.	<i>Calotropis gigantea</i>	എരുക്ക്	30
68.	<i>Canna generalis</i>	canna	30
69.	<i>Capsicum annum</i>	മുളക്	30
70.	<i>Carallia brachiata</i>	വല്ലഭം	30
71.	<i>Carpentaria acuminata</i>	Carpentaria Palm	50
72.	<i>Caryota mitis</i>	Fishtail Palm	500
73.	<i>Cassia fistula</i>	കണിക്കൊന്ന	30
74.	<i>Chamaedorea seifrizii</i>	Bamboo palm	100
75.	<i>Chlorophytum borivilianum</i>	Safed Musli	30
76.	<i>Chlorophytum comosum</i>	Spider plant	30
77.	<i>Chrysophyllum cainito</i>	Star Apple	30 Graft- 75
78.	<i>Chrysopogon zizanioides</i> Syn. <i>Vetiveria zizanioides</i>	രാമച്ചം	30
79.	<i>Cissus quadrangularis</i>	ചങ്ങലം പരണ്ട	30
80.	<i>Citrus maxima</i>	കമ്പിളി നാരകം	30
81.	<i>Citrus medica</i>	ഗണപതി നാരകം	30
82.	<i>Citrus reticulata</i>	Chinese orange	30 Layer-75
83.	<i>Clerodendrum laevifolium</i>	Bridal Veil	30
84.	<i>Clitoria ternatea</i>	ശംഖു പുഷ്പം	30
85.	<i>Cocos nucifera</i> ‘Sunnanki’		200
86.	<i>Codiaeum variegatum</i>	Croton	30
87.	<i>Coleus amboinicus</i>	പനിക്കൂർക്ക / ഞവര	30
88.	<i>Coleus amboinicus</i> ‘variegata’	ഗാർഡൻ ഞവര	50

89.	<i>Coleus scutellarioides</i>	Coleus	30
90.	<i>Coreopsis lanceolata</i>	Lance-leaved coreopsis	30
91.	<i>Coscinium fenestratum</i>	മര മഞ്ഞൾ	50
92.	<i>Couroupita guianensis</i>	നാഗലിംഗ മരം	50
93.	<i>Crataeva magna</i>	നീർമാതളം	100
94.	<i>Cynometra bourdillonii</i>		150
95.	<i>Cyrtostachys renda</i>	Red palm	30
96.	<i>Dalbergia latifolia</i>	Indian rosewood	30
97.	<i>Dendrocalamus brandisii</i>	Furniture bamboo	30
98.	<i>Dendrocalamus calostachys</i>	Arunachal Bamboo	50
99.	<i>Dendrocalamus hamiltonii</i>	Hamilton's bamboo	30
100.	<i>Dendrocalamus longispathus</i>	ഫർണീച്ചർ മുള	50
101.	<i>Dinochloa andamanica</i>	വള്ളി മുള	50
102.	<i>Diospyros bourdillonii</i>	കാക്കകരി മരം	150
103.	<i>Diospyros buxifolia</i>	എലിച്ചുഴി	50
104.	<i>Diospyros ebenum</i>	കരിമരം	50/-
105.	<i>Diospyros malabarica</i>	പനച്ചി	50
106.	<i>Diospyros montana</i>	Bombay ebony	50
107.	<i>Dipterocarpus indicus</i>	കരാഞ്ഞിലി	100
108.	<i>Dipteracanthus elastica</i>	'Bubble Plant'	30
109.	<i>Dracaena sanderiana</i>	'Lucky bamboo Dracaena'	30
110.	<i>Dyopsis lutescens</i>	Yellow palm	50
111.	<i>Dysoxylum malabaricum</i>	അകിൾ	100
112.	<i>Elaeocarpus angustifolius</i> Syn. <i>Elaeocarpus ganitrus</i>	രുദ്രാക്ഷം	100
113.	<i>Elaeocarpus munronii</i>		150
114.	<i>Elaeocarpus serratus</i>	കാർ	30
115.	<i>Epipremnum aureum</i>	Money plant	30
116.	<i>Episcia cupreata</i>	Flame violet	30
117.	<i>Episcia</i> ' Pink Acajou'	Flame violet	30

118.	<i>Eryngium foetidum</i>	ആഫ്രിക്കൻ മല്ലി	30
119.	<i>Eugenia uniflora</i>	സുറിനാം ചെറി	50
120.	<i>Euphorbia tithymaloides</i>	Frilled Jew Bush	30
121.	<i>Equisetum hyemale</i>	Scouring rush	400
122.	<i>Excoecaria cochinchinensis</i>	Chinese croton	30
123.	<i>Excoecaria cochinchinensis</i> 'variegata'	Variegated Chinese croton	30
124.	<i>Ficus benjamina</i>	Weeping fig ശാരദൻ ഫിഗ്	30
125.	<i>Ficus bengalensis</i>	Banyan tree പേരാൽ	30
126.	<i>Ficus krishnae</i>	Krishna's Butter Cup	250
127.	<i>Ficus microcarpa</i>	ഇത്തി	30
128.	<i>Ficus racemosa</i>	അത്തി	30
129.	<i>Ficu sreligiosa</i>	അരയാൽ	30
130.	<i>Fittonia albivenis</i>	Silver Nerve Plant	30
131.	<i>Flacourtia indica</i>	അഘോരി	30
132.	<i>Flacourtia inermis</i>	lovi-lovi	30
133.	<i>Flacourtia montana</i>	കാട്ടുശീമനെല്ലി	30 Graft-100
134.	<i>Garcinia gummi-gutta</i>	കുടംപുളി	30 Graft- 150
135.	<i>Garcinia celebica</i> <i>Syn. Garcinia hombroniana</i>	വൈൽഡ് മാങ്കോസ്റ്റീൻ	30
136.	<i>Garcinia intermedia</i>	Lemon Drop Mangosteen/Baraba	50
137.	<i>Garcinia indica</i>	കൊക്കംപുളി	30
138.	<i>Garcinia kydia</i>		100
139.	<i>Garcinia mangostana</i>	മാങ്കോസ്റ്റീൻ	100 Graft- 400
140.	<i>Garcinia xanthochymus</i>	രാജപുളി	100
141.	<i>Gardenia jasminoides</i>	ഗന്ധരാജൻ	30
142.	<i>Geophila repens</i>	കരികുടങ്ങൽ	30
143.	<i>Gigantochloa albociliata</i>	Clumping bamboo	30
144.	<i>Gigantochloa andamanica</i>	Andaman pole bamboo	30
145.	<i>Gluta travancorica</i>	ചെന്തുരുണി	100

146.	<i>Glycosmis pentaphylla</i>	പാണൽ	50
147.	<i>Gmelina arborea</i>	കുമ്പിൾ	30
148.	<i>Gossypium herbaceum</i>	പരുത്തി	30
149.	<i>Goeppertia rufibarba</i>		30
150.	<i>Goniothalamus rhynchantherus</i>		150
151.	<i>Gymnacranthera canarica</i>	ഉണ്ടപ്പയിൻ	100
152.	<i>Gymnema sylvestre</i>	ചക്കരക്കൊല്ലി	30
153.	<i>Hibiscus heterophyllus</i>	Native rosella	50
154.	<i>Hibiscus rosa-sinensis</i>	ചെമ്പരത്തി	30
155.	<i>Hibiscus tiliaceus</i> 'variegata'	ആറ്റുപരുത്തി	30
156.	<i>Holmskioldia sanguinea</i>	Cup and saucer plant	30
157.	<i>Hopea parviflora</i>	കമ്പകം	50
158.	<i>Hopea racophloea</i>	നാഴ്കമ്പകം	150
159.	<i>Humboldtia decurrens</i>	കാട്ടുശോകം	50
160.	<i>Humboldtia vahliana</i>	ആറ്റുവഞ്ചി	50
161.	<i>Hydnocarpus macrocarpa</i>	ആനമരോട്ടി	50
162.	<i>Hydnocarpus wightianus</i>	മരോട്ടി	50
163.	<i>Hydrangea macrophylla</i>	ഹൈഡ്രാഞ്ചിയ	30
164.	<i>Hydrocleys nymphoides</i>	Water poppy	100
165.	<i>Impatiens balsamina</i>	Balsam	30
166.	<i>Ixora coccinea</i>	തെച്ചി	30
167.	<i>Jasminum grandiflorum</i>	പിച്ചി	30
168.	<i>Jasminum sambac</i>	കുറ്റിമുല്ല	30
169.	<i>Justicia</i> sp. (Pink Flower)	Justicia	30
170.	<i>Justicia adhatoda</i>	ആടലോടകം	30
171.	<i>Adhatoda beddomei</i>	ചിറ്റാടലോടകം	40
172.	<i>Justicia gendarussa</i>	വാതം കൊല്ലി	30
173.	<i>Kaempferia galanga</i>	കച്ചാലം	30
174.	<i>Lantana montevidensis</i>	പൂച്ചെടി	30
175.	<i>Lagerstroemia speciosa</i>	പൂമരൂത്	30
176.	<i>Lawsonia inermis</i>	മൈലാഞ്ചി	30
177.	<i>Licuala grandis</i>	Fan palm	50
178.	<i>Licula peltata</i>	Giant fan palm	50
179.	<i>Licuala peltata</i> var. <i>sumawongii</i>	Swamp Fan Palm	50
180.	<i>Licuala rumphii</i>	Celebes fan palm	50
181.	<i>Litsea cordata</i>		50

182.	<i>Livingstonia rotundifolia</i>	Table Palm	50
183.	<i>Lophopetalum wightianum</i>	വെങ്കോട്ട	30
184.	<i>Ludwigia sedioides</i>	Mosaic flower	100
185.	<i>Machilus glaucescens</i> Syn. <i>Persea macrantha</i>	ഊറാവ്	30
186.	<i>Madhuca longifolia</i>	ഇലിപ്പ	50
187.	<i>Magnolia champaca</i>	ചെമ്പകം	40
188.	<i>Mallotus philippensis</i>		50
189.	<i>Malpighia glabra</i>	വെണ്ണിന്ത്യൻ ചെറി	30
190.	<i>Malvaviscus arboreus</i>	ചെറിയ മുളകു ചെമ്പരത്തി	30
191.	<i>Mangifera indica</i>	മാവ്	30 Graft- 150 to 250
192.	<i>Mansoa alliacea</i>	Garlic vine/ വെളുത്തുള്ളി വള്ളി	30
193.	<i>Maranta leuconeura</i>	Prayer plant	30
194.	<i>Matourea azurea</i> Syn. <i>Otacanthus coeruleus</i>	Amazon Blue	30
195.	<i>Medinilla cumingii</i>	Rose Grapeor Showy Melastoma	50
196.	<i>Melocanna baccifera</i>	Running bamboo/walking bamboo	100
197.	<i>Melia dubia</i>	കാട്ടുവേപ്പ്	30
198.	<i>Memecylonum bellatum</i>	കാശാവ്	30
199.	<i>Mesua ferrea</i>	നാങ്ക്	50
200.	<i>Millingtonia hortensis</i>	Indian cork tree	50
201.	<i>Mimusops elengi</i>	ഇലഞ്ഞി	30
202.	<i>Monstera adansonii</i>	Five Holes Plant	50
203.	<i>Morus alba</i>	മശബറി	30
204.	<i>Murraya koenigii</i>	കറിവേപ്പ്	30
205.	<i>Myristica fragrans</i>	ജാതി/Nutmeg	30
206.	<i>Myristica malabarica</i>	കാട്ടുജാതി	50
207.	<i>Myxopyrum smilacifolium</i>	ചതുരമുല്ല	30
208.	<i>Nelumbo 'Red Philip'</i>	Hybrid Lotus	300
209.	<i>Nelumbo 'Yellow Peony'</i>	Hybrid Lotus	300
210.	<i>Nelumbo 'Ultimate Thousand Petal'</i>	Hybrid Lotus	300 – 500
211.	<i>Neolamarckia cadamba</i>		50

212.	<i>Nepenthes khasiana</i> /Hybrids ( <i>N. mirabilis</i> X <i>N. refflesiana</i> )	Pitcher plant/ സഞ്ചിച്ചെടി	250 – 750
213.	<i>Nephelium lappaceum</i>	റമ്പുട്ടാൻ	30 Graft- 200, 250
214.	<i>Nephelium ramboutan-ake</i> Syn. <i>Nephelium mutabile</i>	Pulasan	30 Graft – 150
215.	<i>Nothopegia aureo-fulva</i>		150
216.	<i>Nyctanthes arbor-tristis</i>	പവിഴ മുല്ല	30
217.	<i>Nuphar lutea</i>	Yellow pond lily	300
218.	<i>Nymphaea</i> ‘Atrans X Gigantea’	Hybrid Waterlily	300
219.	<i>Nymphaea colorata</i>	Blue-Petal Waterlily	300
220.	<i>Nymphaea</i> ‘Jelueangsab’	Hybrid waterlily	300
221.	<i>Nymphaea</i> X <i>marliacea</i>	Marliacea Waterlily	300
222.	<i>Nymphaea micrantha</i>	വയലറ്റ് ആമ്പൽ	200
223.	<i>Nymphaea nouchali</i>	Blue star waterlily	100
224.	<i>Nymphaea omarana</i>	Omarana Waterlily	100
225.	<i>Nymphaea pubescens</i>	Hairy waterlily	100
226.	<i>Nymphoides</i> sp.	നെയാമ്പൽ	50
227.	<i>Ochlandra travancorica</i>	ഇരറ്റ	30
228.	<i>Ocimum basilicum</i>	രാമതുള്ളസി	30
229.	<i>Ocimum gratissimum</i>	കാട്ടുതുള്ളസി	30
230.	<i>Orthosiphon aristatus</i>	പുച്ചമീശ	30
231.	<i>Pandanus amaryllifolius</i>	രംഭ	30
232.	<i>Passiflora edulis</i>	Passion fruit	30
233.	<i>Passiflora trifasciata</i>	Tri-colored Passion Vine	50
234.	<i>Peperomia argyreia.</i>	Watermelon peperomia	30
235.	<i>Peperomia caperata</i>	Emerald ripple peperomia	30
236.	<i>Peperomia obtusifolia</i>	Blunt-leaved peperomia	30
237.	<i>Peperomia scandens Variegata</i>	Cupid Peperomia	30
238.	<i>Pereskia aculeata</i>	Madagascar cherry	30
239.	<i>Persea americana</i>	Avocado, വെണ്ണപ്പഴം	50
240.	<i>Persea macrantha</i>	ഊറാവ്	50
241.	<i>Petrea volubilis</i>	Queen's Wreath	30
242.	<i>Phaius tankervilleae</i>	Common swamp orchid	250
243.	<i>Phyllanthus emblica</i>	നെല്ലി	30 Graft- 100
244.	<i>Pilea depressa</i>	Baby Toes	30

245.	<i>Pilea involucrata</i>		30
246.	<i>Pinanga coronata</i>	Ivory Cane Palm	50
247.	<i>Piper retrofractum</i> Syn. <i>Piper chaba</i>	വൻതിപ്പലി	30
248.	<i>Piper betle</i>	വെറ്റില	30
249.	<i>Pleurolobus gangeticus</i> Syn. <i>Desmodium gangeticum</i>	ഓരില	30
250.	<i>Piper longum</i>	തിപ്പലി	30
251.	<i>Plumbago auriculata</i>	നീല കൊടുവേലി	50
252.	<i>Plumbago indica</i>	ചുവന്ന കൊടുവേലി	30
253.	<i>Plumbago zeylanica</i>	വെള്ള കൊടുവേലി	30
254.	<i>Plumeria rubra</i>	ഇഴ ചെമ്പകം	50
255.	<i>Polyscias fruticosa</i>	Ming Arali	30
256.	<i>Pongamia pinnata</i>	ഉങ്ങ/പൊങ്ങ	30
257.	<i>Procris repens</i> Syn. <i>Pellionia repens</i>	Trailing watermelon	30
258.	<i>Pseuderthria viscida</i>	മൂവില	30
259.	<i>Psidium guajava</i>	പേര	30
260.	<i>Pterocarpus marsupium</i>	വേങ്ങ	30
261.	<i>Pterocarpus dalbergioides</i>		50
262.	<i>Pterospermum rubiginosum</i>	എല്ലുറ്റി	50
263.	<i>Ptychosperma macarthurii</i>	Cluster Palm	500
264.	<i>Pterocarpus marsupium</i>	വേങ്ങ	50
265.	<i>Ptychosperma waitianum</i>		50
266.	<i>Ptychosperma sanderianumi</i>		50
267.	<i>Quassia amara</i>	Bitter wood	30
268.	<i>Quassia indica</i>	കരിഞ്ഞൊട്ട	30
269.	<i>Rhapis excelsa</i>	Lady palm	50
270.	<i>Rhododendron simsii</i>	Azalea	50
271.	<i>Rhopaloblaste augusta</i>	Nicobar majestic palm	50
272.	<i>Rondeletia odorata</i>	Red panama rose	30
273.	Rose	Rose	30
274.	Rose in pot	Rose	50
275.	<i>Russelia equisetiformis</i>	Firecracker Plant	30
276.	<i>Sabalm auritiiformis</i>	Bay-leaf palm	250
277.	<i>Sabal minor</i>	Dwarf palmetto	50

278.	<i>Salacia oblonga</i>	കൊരണ്ടി	30
279.	<i>Salacia reticulata</i>	പൊൻ കൊരണ്ടി	50
280.	<i>Sandoricum koetjape</i>	Santol fruit	50
281.	<i>Sapindus trifoliatus</i>	Soap nut/ സോപ്പിൻ കായ മരം	30
282.	<i>Saraca asoca</i>	അശോകം	30
283.	<i>Saraca declinata</i>	Yellow Saraca	100
284.	<i>Selenicereus undatus</i>	Dragon Fruit	100
285.	<i>Semecarpus anacardium</i>	അലക്കു ചേര്/ ചേർക്കുരു	50
286.	<i>Semecarpus auriculata</i>		50
287.	<i>Simarouba glauca</i>	ലക്ഷ്മീതരു	30
288.	<i>Spathiphyllum wallisii</i>	Piece lilly	50
289.	<i>Spathoglottis plicata</i> (Purple)	Philippine Ground Orchid	50
290.	<i>Spathoglottis plicata</i> (Purple cluster flower)		150
291.	<i>Spondias pinnata</i> Syn. <i>Spondias acuminata</i>	അമ്പഴം	50 Veg. sapling- 75
292.	<i>Stevia rebaudiana</i>	Sugar Leaf	30
293.	<i>Streptocarpus ionanthus</i> Syn. <i>Saintpaulia ionantha</i>	African violet	40
294.	<i>Strophanthus gratus</i>	Indian rubber vine	30
295.	<i>Strobilanthes alternata</i>	മുറികൂടി	30
296.	<i>Strobilanthes heyneana</i>	കരികുറുഞ്ഞി	30
297.	<i>Synsepalum dulcificum</i>	Miracle fruit	100
298.	<i>Syzygium caryophyllatum</i>	കരിഞ്ഞാറ	30
299.	<i>Syzygium clavatum</i>		50
300.	<i>Syzygium cumini</i>	ഞാവൽ	30 Graft- 75
301.	<i>Syzygium jambos</i>	Roseapple/ പനിനീർ ചാമ്പ	Layer100
302.	<i>Syzygium mundagam</i>	കാട്ടു ചാമ്പ	50/-
303.	<i>Syzygium samarangense</i>	ചാമ്പ	30

			Layer- 75 Graft- 100
304.	<i>Syzygium zeylanicum</i>	പൂച്ചപ്പഴം	30
305.	<i>Tabernaemontana alternifolia</i> 'Miniature'	നന്യാർവട്ടം	30
306.	<i>Tabebuia heterophylla</i>	തബുബിയ	50
307.	<i>Talinum portulacifolium</i>	സാമ്പാർചീര	30
308.	<i>Tamarindus indica</i>	വാളൻപുള്ളി	30
309.	<i>Tecomaria capensis</i>	Capehoney suckle	30
310.	<i>Tectona grandis</i>	തേക്ക്	30
311.	<i>Terminalia arjuna</i>	നീർമരൂത്	50
312.	<i>Terminalia bellirica</i>	താനി	50
313.	<i>Thunbergia grandiflora</i>	Blue Trumpet Vine	30
314.	<i>Thyrsostachys siamensis</i>	ലാത്തിമുള്ള	30
315.	<i>Trapa natans</i>	Water chestnut	100
316.	<i>Trichopus zeylanicus</i> ssp. <i>travancoricus</i>	ആരോഗ്യപ്പച്ച	100
317.	<i>Vateria indica</i>	വെള്ളകുന്തിരിക്കം	100
318.	<i>Vincetoxicum indicum</i> Syn. <i>Tylophora indica</i>	വള്ളിപ്പാല	30
319.	<i>Vriesea splendens</i>	Flaming sword	100
320.	<i>Whitfieldia elongata</i>	White Candles	30
321.	<i>Wodyetia bifurcata</i>	Foxtail Palm	400
322.	<i>Wrightia tinctoria</i>	കോപ്പാല	30
323.	<i>Xylia xylocarpa</i>	Burma Ironwood	50
324.	Rare Cycads <i>Cycas, Dioon, Encephalartos, Zamia</i>	Cycas, Dioon, Encephalartos, Zamia	200
325.	Rare/IUCN threatened species		100

## TISSUE CULTURE PLANTS FOR SALE

Item	Variety	Price
Anthurium	Hawaii Orange	50
Anthurium	Caesar violet	30
Anthurium	Dora	50
Orchid	<i>Dendrobium</i> pink DP, AJ18	35
Orchid	<i>Dendrobium</i> SONIA	35
Orchid	<i>Dendrobium</i> white	35
Orchid	<i>Dendrobium</i> venus	35
Orchid	<i>Dendrobium</i> triple fantasy	35
Orchid	<i>Dendrobium</i> indigo blue	35
Orchid	<i>Phalaeopsis</i> White/Medium	50
Orchid	<i>Phalaeopsis</i> Pink Small/ Medium	50
Banana	'Poovan'	15
Banana	'Robusta'	15
Banana	'Palayankodan'	15
Banana	'Nendran'	15
Pepper cutting	Pepper cuttings	20

## LIBRARY AND INFORMATION CENTRE (LIC)

The Institute Library plays a vital role in facilitating research by providing timely and relevant information to the researchers and scientists. It is one of the best specialized libraries in the field of Botany and allied sciences. Its mission is to build up a relevant collection of information materials and timely dissemination of information. Collecting scientific materials is one of the important functions of the library. The library caters to the needs of Scientists/researchers from other national and international Institutions as well as students from different Universities. The resources consist of Books, Floras, Journals, Back volumes of Periodicals, CDs, Reports, Reprints, Theses, Maps and Atlases.

## JNTBGRI library – Reference wallet

Books	6596
Theses	191
Technical Report	165
Reprints	1641
Journals	Indian 18; Foreign 11
Back Volumes	3654
Reports	978

Library operations and services are automated. Its services are accessible through campus LAN to enable member's access from their desktops. Digital collection includes Scientific Papers, Classic Books in Botany (in CDs), Annual Reports, and Index to journal articles database. During the year under report, 35 books were added to the Collection. The database of books and journals is being updated on day-to-day basis with details of recently acquired materials. Facilities are provided for scientists/researchers/students for Internet browsing. To cater to the information needs of the scientists/researchers/students the following services are provided.

- Selective dissemination of Information
- Current awareness service
- Indexing service
- Bibliographic service
- Conference alert service
- Press clippings service
- Reprographic service
- Internet browsing service
- Reference service
- Document Delivery service
- Literature Search Service

Library subscribes to JSTOR Biological Sciences Collection including Global Plants Initiative. JNTBGRI Library has membership in International Association of Plant Taxonomy and Botanical Gardens Conservation International.

The following lists are compiled and updated regularly:

1. List of latest additions
2. List of Current Journals

3. List of Holding
4. List of CDs
5. List of Publications
6. List of Patents
7. List of Ph. D. Theses

The library is using the software LIBSOFT which is an integrated multi-user Library Management System that supports all in house operations of the library. It has different modules like Acquisition, Catalogue, Circulation, Serial Control. Circulation control is bar code enabled.

Sale of JNTBGRI Publications is through the library and currently the following books are available for sale.

Sl. No.	Author	Title	Year of publication
1.	Abraham & Vatsala	Introduction to orchids	1981
2.	Pushpangadan, P., Ulf Nyman & V. George	Glimpses of Indian Ethnopharmacology	1995
3.	Hosagoudar, V. B., Abraham, T. K. & P. Pushpangadan	Fungi of Kerala	1996
4.	Pushpangadan, P., Rajasekharan, S. & S. D. Biju	Muringa (Malayalam)	1996
5.	Hosagoudar, V. B., Abraham, T. K. & P. Pushpangadan	Meliolales of India – A supplement	1997
6.	Nayar, T. S., Rasiyabeegam, A., Mohanan, N. & G. Rajkumar	Flowering plants of Kerala	2006
7.	Koshy, K. C.	Bamboos at TBGRI	2010
8.	Sathish Kumar, C. & B. Sabulal	Plant wonders of evolution and genetics	2012
9.	Rajasekharan, S., Latha, P. G., Mohanan, N., Mathew Dan; Vinodkumar T. G. Nair, Navas, M. & C. S. Vimalkumar	Students Handbook on Medicinal and Food Plants	2013
10.	Nayar, T. S., Rasiyabeegam, A. & M. Sibi	Flowering plants of the Western Ghats India (volume 1 & 2)	2014
11.	Mathew, P. J., Mathew Dan, Muraleedharan Unnithan, C., Premkumar, V., Jose, P. A. & Thomas Davis	Bees Herbal Garden: a garden in the forest @ JNTBGRI	2015
12.	Pradeep, N. S., Shiburaj, S., Binu, S. & P. G. Latha	വാഴവിഭവങ്ങൾ	2015
13.	Mathew Dan, Rasiyabeegam, A., Biju, H. & V. Sujatha	Scientific Contributions of JNTBGRI (A Bibliography)	2016
14.	Mohanan, N. & P. J. Mathew	Live Plants of JNTBGRI	2016

15.	Ninan, C. A. & P. M. Mathew	Ferns and lycophytes of Kerala. Taxonomy, Cytology and Evolution	2016
16.	Saleem, M., Balaji, V. K., Mathew Dan, Lekshmi, R., Job J. Neriamparambil & Salish J. Menachery	Orchids of Eravikulam National Park, Munnar	2022
17.	Bijeesh, C., Pradeep, C. K. & K. B. Vrinda	Poisonous Mushrooms of Kerala, India: An illustrated Handbook	2022
18.	Anilkumar, S. & Mathew Dan	Faunal Denizens@JNTBGRI Butterflies, Birds & Mammals	2023
19.	Saleem, M., Radhika, B. J., Jis Sebastian; Hasaeen, R. William Decruse, S. & Mathew Dan	ഓർക്കിഡ്സൂക്ഷ്മകൃഷി: ഒരുമാർഗ്ഗരേഖ	2023

## EXHIBITIONS

- Staff members at Puthenthope Centre participated in the creation of a pageantry exhibited in connection with Onam Week Celebrations 2022, organized by Tourism Department, Govt. of Kerala.
- The public relations unit of the division has coordinated arranging stalls highlighting ex-situ conservations and sustainable utilization research activities of JNTBGRI on exhibitions arranged by Government or quasi-Government institutions. The important ones are CUSAT exhibition from 25th Oct to 28th Oct. 2022, 35th Kerala Science Congress organized by KSCSTE, The Palode Agri/ Cattle Fare, 2nd Kerala Biodiversity Congress, Kozhikode, Vaiga Agro Expo 2023, Putharikandam, Trivandrum and Flower show organized by Pinarayi Peruma Cultural Society started on 30/03/2023 at Pinarayi, Kannur.

## MAJOR INFRASTRUCTURE FACILITIES CREATED

- Bamboo Craft Centre for training and preparation of Bamboo Products and Crafts.
- Shallow Earthen Check-Dam across stream in the Bambusetum.
- Mist house with multilayered UV sheets & manual gravitational misting aid and metal benches for hardening of bamboo saplings.
- Pergola was constructed at the entrance of open orchidarium, and a new trail developed with rows of *Grammatophyllum speciosum* plants.
- Poly house near DBT Building with the financial support of MoEF&CC project.

- Biorepository has been developed under BGCI Global Genome Biodiversity Network (GGBN) project comprised of 57 plant species which are endemic to the Western Ghats region of Kerala.
  - UV-VIS Spectrophotometer.
  - Centre of Excellence in Phytochemical-Nanotechnology (CEP) at KSCSTE-JNTBGRI under the scheme State Higher Research centres of Excellence in Science & Technology Applications (SHRESTA)-KSCSTE.
  - LC-MS (CIF).
  - Upgradation of HPTLC.
  - HPLC
  - Aquatic conservatory display gallery: Gallery style display frame for the educational demonstration of Aquatic plants, especially special adaptations, is constructed near the reservoir dam. The structure comprises of five numbers of two feet broad stepping terraces outward and three numbers inward.
- (ii) Chain link wild animal protection boundary constructed in about 200m perimeter of the Arboretum nursery.
- (iii) A seedling hardening shed 10 x 4 m<sup>2</sup> plinth area with 70% shade net was constructed in the fruit garden.
- (iv) 10x4 m<sup>2</sup> area shade house with wooden pillars was renovated and restructured with roof alteration
- v) Roof sheet of the 5 x 10 m<sup>2</sup> of the hardening house in the Central Nursery changed with 70% transparent sheets.

#### **HONOURS/ AWARDS/ RECOGNITIONS**

1. Achuthan, S., best paper award, National Seminar on Fundamental and Applied Dimensions in Plant Sciences, KSCSTE-JNTBGRI, Thiruvananthapuram, March 24 – 25, 2022.
2. Akhilesh S. V. Nair, best oral presentation award, International Conference on Sustainable Utilization of Bioresources. Dept. of Botany, University of Kerala (2022).
3. Akhilesh S. V. Nair, best paper award, National Seminar on Fundamental and Applied Dimensions in Plant Sciences, KSCSTE-JNTBGRI, Thiruvananthapuram, March 24– 25. 2022.

4. Anooj, S. L. and G. Rajkumar, 2023. Received best oral presentation Award: Ethno Botanical Study of Kani Tribes in Oruparakarkkalam Settlement in Peringammala Gramapanchayat, Thiruvananthapuram Dist., Kerala, in National seminar on Biodiversity challenges and Threats; Current Scenario. PG and RD of Botany Sree Narayana College Kollam, 21-22 December 2022.
5. Anurag Dhyani becomes the Associate Editor, Conservation Science & Practice, USA.
6. Anurag Dhyani becomes the Associate Editor, Frontiers in Conservation Science, Switzerland.
7. Anurag Dhyani becomes the Editor, Plants, People, Planet, UK.
8. Anurag Dhyani becomes Member, British Ecological Society Review College, UK.
9. Anurag Dhyani becomes Member, Global Tree Specialist Group, IUCN.
10. Anurag Dhyani becomes the Section Editor, Journal of Seed Science, Brazil.
11. Anurag Dhyani becomes the Subject Editor, Neotropical Biology and Conservation, Brazil.
12. Anurag Dhyani has attended Plants People Planet Editorial Board meeting organized by New Phytologist Foundation at Edinburgh, Scotland, United Kingdom, 8 December (2022).
13. Aparna G. S., best paper award, International Seminar on 'Plant Chemistry, Gene Prospecting and Clinical Biology- 2022', Kerala Academy of Sciences, Thiruvananthapuram & Department of Chemistry, Mar Ivanios College, Thiruvananthapuram, November 10 -11, 2022.
14. Arya, M. R. has secured the best paper award. Morpho-molecular characterisation and intraspecific diversity assessment in *Clitoria ternatea* L. In: International Seminar on New Horizons in Plant Sciences. Dept. of Botany, University of Kerala, Kariavattom, Kerala. 21 -23 March 2023.
15. Ashi Anu Mathew, Shaju, T., and M. Rajendraprasad, 2022. Best Paper Award: Riparian vegetation in Kerala's River basins: Diversity, Ecological Functions and Conservation Prospects. National Seminar 'Fundamental and Applied Dimensions in Plant Sciences'. KSCSTE-Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, 24 - 25 March 2022.
16. Jinu Mathew, best paper award, International Seminar on 'Plant Chemistry, Gene Prospecting and Clinical Biology- 2022', Kerala Academy of Sciences, Thiruvananthapuram & Department of Chemistry, Mar Ivanios College, Thiruvananthapuram, November 10 - 11, 2022.

17. Joemon Jacob has received the special jury award in the Prof. A. Abraham memorial award, 2022. JNTBGRI, 28 June 2022.
18. Keerthi Sugathan, J. has bagged the best poster presentation award. *In silico* identification of multi-target inhibitors against SARS-CoV-2 from *Tamarindus indica* L. International Conference on Recent Advances in Biological Sciences ICRB-2023. ICEIB - University of Kerala, 17-19 January 2023.
19. Lekshmi, R. K. has bagged the third prize in the Prof. A. Abraham Memorial Award Contest presentation. JNTBGRI, 28 June 2022.
20. Priya Rani, M., best poster award, Scientific Social Responsibility, Scientist category. 34<sup>th</sup> Kerala Science Congress, KSCSTE. January 27-29, 2022
21. Radha, R. K. has won the Serb Power Grant 2023, SERB, DST, Govt. of India.
22. Rijuraj, M. P., Shaju, T. and A. G. Pandurangan, 2022. Best Oral Presentation Award: Socio-Economic significance of low land Grasslands in Lateritic zones of Northern Kerala, India”. National Seminar on ‘Sustainable Management of Agrobiodiversity’ at Biodiversity Club, St Thomas College, Kozhencherry, December 2, 2022.
23. Sabulal, B., best scientist award, KSCSTE, 2022.
24. Suja, S. R. has chaired a session on RBAT INDO-US seminar on “Recent Biochemical Approaches in Therapeutics (RBAT-IX)” from February 1-3, 2023, at the Department of Biochemistry, University of Kerala, Kariavattom.
25. Vinodkumar T. G. Nair attended as Expert in the National Commission for Indian Systems of Medicine, Ministry of AYUSH, Government of India organized workshop for ‘Development of Syllabus for Second Professional BAMS subjects from 1<sup>st</sup> to 3<sup>rd</sup> February 2023 at IIIT-Delhi Sonipat Campus, Khewra, Haryana.
26. Vipin Mohan Dan has received Alumni Achiever Award for contribution in Research & Publication awarded by Amity University, Noida, Uttar Pradesh, 25th June 2022; with award citation.

## **MoU AND RESEARCH COLLABORATIONS**

JNTBGRI has made collaborated with the following institutions:

1. Chhattisgarh State Medicinal Plant Board, Chhattisgarh to produce planting materials.
2. Industry centre-CARe KERALAM Ltd., Thrissur.

3. VSSC, ISRO, Govt. of India, Thiruvananthapuram (EEC Member).
4. ICAR – Indian Institute of Horticultural Research, Govt. of India, Bangalore.
5. Germplasm Collections/ Plant Exploration – Kerala, Tamil Nadu, and Karnataka Forests.
6. ICAR-NBPGR, Regional Station, Thrissur as per the request from the Athiyannor Block Panchayat President visited Nellimoodu area for developing river tourism – Necessary guidelines for establishing greenery on both sides of the river, islands and establishing mangrove forest patches aesthetic landscaping and restoration of natural ecosystem, etc have been given. The DPR of the project is under processing.
7. University of Kerala, Thiruvananthapuram
8. Cochin University of Science and Technology, Kerala
9. Indian Institute of Technology, Guwahati
10. Indian Institute of Technology, Bombay
11. Kerala Agricultural University, Vellayani
12. Sree Chitra Tirunal Institute of Medical Sciences and Technology, Trivandrum.
13. CEP-SHRESTA-KSCSTE collaboration with University of Oklahoma Health Sciences Centre, Oklahoma City, USA.
14. Collaborated with KFRI and KFD in RET species conservation.
15. MoU signed with National Botanical Research Institute (NBRI), Lucknow to utilize the facilities and plant resources.
16. Collaboration with Department of Computational Biology, University of Kerala, and College of Agriculture, Vellayani for carrying out transcriptome analysis of tomato upon on challenging the tomato plants with *Ralstonia solanacearum*, causative agent of Bacterial wilt of tomato.
17. As per the MoU (15-02-2019) between the University of Kerala and JNTBGRI, the herbarium digitization of the University of Kerala has been undertaken by JNTBGRI and jointly developed a digital botanic herbarium of the University of Kerala on payment basis and made available on the URL [www.stecjntbgri.in/kuherbarium](http://www.stecjntbgri.in/kuherbarium).
18. In view of compatibility study among wild orchids and its genetic improvement, germplasm evaluation of vegetable crops and analysis of seed quality as part of plan project collaboration has been maintained with Department of Plant Breeding and Genetics, Kerala Agricultural University (17-10-2012).
19. For in vitro anti-tuberculosis activity screening of plant extracts and phytochemicals collaborating with ICMR-NIRT, Chennai.

20. MoU with Dr. Udaya Kiran Murelli National Chemical Laboratory, Pune, on Natural product discovery from microbes.
21. MoU with Dr. Chepuri V. Ramanaa, National Chemical Laboratory, Pune on Natural product based synthetic anticancer drugs.
22. MoU with Dr. S. Asha Nair and Dr. T. R. Santhosh Kumar, Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram on Anticancer microbial metabolite study.

### **HYBRID REGISTERED**

Developed two orchid hybrid *Phalaenopsis* Tiger Stripes (*Phalaenopsis manni* X *Phalaenopsis fascinata*) and *Phaiocalanthe* Pink Splash (*Phaius tankervilleae* X *Calanthe rubens*) and registered with the Royal Horticultural Society (International Registration authority for orchid hybrids) dated 17<sup>th</sup> November 2022.

### **Ph.D. AWARDED**

1. Geetha, R. Nair, 2023. Antihepatotoxic, Antioxidant and Pharmacognostic studies of *Asystasiachelonoides* Nees var. *chelonoides* (Acanthaceae), University of Kerala.
2. Jisha Daniel, 2023. Systematic Studies and Phytogeographical Affinities of Family Oxalidaceae - Southern Western Ghats, India. University of Kerala.
3. Renju, K., 2022. Identification of the elite lines of *Centella asiatica* and *Bacopa monnieri* and their biological activity studies. University of Kerala.
4. Reshma, V. R. Nair, 2021. Phytochemical investigation and biological activity studies of *Humboldtia unijuga* var. *unijuga*. University of Kerala.
5. Stephan, J., 2023. 'Taxonomic Revision of the Family Symplocaceae Desf. of India'. University of Kerala.

## Ph.D. PROGRAMMES ONGOING

1. Ajinsha, J. S. Ethnobotanical Study of Muthuvan Tribes of Idukki District of Kerala. University of Kerala.
2. Akhilesh, S. V. Nair. Biosystematics and molecular phylogenetic investigation of the genus *Ophiorrhiza* L. in Western Ghats of India. University of Kerala.
3. Aleena Joseph. Assessment of Anti-inflammatory, Anti-arthritic, and Wound healing potential of *Malaxis versicolor* (Lindl.) Abeyw. through molecular pharmacological and green synthetic approach. University of Kerala.
4. Aneeth Sneha Saj; Evaluation of anti-obesity and anti-diabetic potential of *Biophytum veldkampii* A.E.S. Khan, E.S.S.Kumar, and Pushp. through molecular pharmacological approach. University of Kerala.
5. Anooj, S. L. Ethnobotanical Study of Kani Tribes in Western Ghats of Kerala University of Kerala.
6. Arunkumar, N. S. Phylogenetic relationships among species of *Strobilanthes* in Kerala by combining evidence from morphology and chemotaxonomy. University of Kerala.
7. Arya, C. P. Taxonomic and Phylogenetic Studies on the Genus *Agaricus* (Basidiomycota) of Kerala. University of Kerala.
8. Arya, S. 'Studies on Floral Variations in *Clitoria ternatea* L. and its inheritance pattern'. University of Kerala.
9. Aswathi, S. V. Molecular docking, spectroscopic investigation and DFT studies of selected bioactive phytochemicals from *Garcinia* species. University of Kerala.
10. Aswathy Chandran. Screening phytochemicals and optimization of lead molecules with inhibitory activity on multiple cobra venom protein. University of Kerala.
11. Aswathy V. Nair. Insights into the Anti-Inflammatory, Wound healing and Gastroprotective potential of *Phyllocephalum rangacharii* (Gamble) Narayana, an ethnomedicinal plant used by Cholanaikkan tribe of Kerala. University of Kerala.
12. Aswathy, J. Phytochemical incorporated scaffolds for regeneration in osteoarthritis - An experimental approach. University of Kerala.

13. Aswathy Anand. Utility of Semiochemicals and exploitation through *in vitro* technology of *Etilingera fenzlii*, an ethnobotanical insect repellent plant species of the Andaman Nicobar Islands in pest/insect management and its popularization as an eco-friendly mosquito repellent Products. University of Kerala.
14. Athira, M. Systematic documentation, phytochemical analysis and comparative toxicological evaluation of *Thottea siliquosa* (Lam.) Ding Hou with tribal herbal preparations of Kerala. University of Kerala.
15. Athul Hari, S. Antidiabetic activity of selected *Ficus* species in the Kerala region of Western Ghats. University of Kerala
16. Chandni, C. L. Prey capture and pollination in *Nepenthes*: morphology, anatomy, and phytochemical studies of *Nepenthes khasiana* Hook. f. flower and pitcher. University of Kerala.
17. Devika S. Kumar. The Invasion of Non-Native Plant Species in Ecology and Biodiversity of Different Ecosystems of Thiruvananthapuram District: A Quantitative Approach. University of Kerala.
18. Devipriya, S. Search for bioactive principles from the water lily, *Victoria amazonica* against inflammation associated with neurological disorders. University of Kerala.
19. Divya, N. Murali. 'Documentation of wild Relatives of Edible Cultivated Crops of Agasthyamala Biosphere Reserve in Kerala Region and Conservation strategies of Selected Taxa'. University of Kerala.
20. Gayathri, R. S. Assessment of chemical/bioprospecting studies on the endemic species of Western Ghats and Activity guided isolation of bioactive principles from one promising endemic species. University of Kerala.
21. Gokul, B. S. Phytochemical and Biological Activity Studies of Indian Pitcher Plant, *Nepenthes khasiana*. University of Kerala.
22. Greeshma Nair, B. Pharmacological properties of Essential oils and essential oils encapsulated nanoparticles of promising *Thottea* and *Clausena* species. University of Kerala.
23. Jisha Daniel. Systematic Studies and Phytogeographical Affinities of Family Oxalidaceae - Southern Western Ghats, India. University of Kerala.
24. Karthika, T. S. Morpho taxonomy and Chemotaxonomy of the Genus *Goniothalamus* Hook. f. & Thoms. (Annonaceae) in The Western Ghats.

University of Kerala.

25. Keerthi Sugathan. *In silico* and *in vitro* evaluation of anti-Covid-19 activity in selected plant-derived nutraceuticals. University of Kerala.
26. Keerthi. V. Systematic Studies on the Genus *Pluteus* (Basidiomycota, Fungi) of Kerala State. University of Kerala.
27. Lekshmi S. Nath. A Molecular Pharmacological approach on the assessment of Hepatoprotective and Anti-inflammatory potential of *Lagenandra ovata* (L.) Thwaites an ethnomedicinal plant. University of Kerala.
28. Lekshmi, K. Phytochemical profiling and pharmacological investigation in *Plectranthus vettiveroides* (Jacob) N. P. Singh & B. D. Sharma. University of Kerala.
29. Lekshmi, R. K. Evaluation of Phytochemicals from selected medicinal plants for anti-dengue leads. University of Kerala.
30. Mohammed Ali Noushad. Analysis of changes in gene expression and identification of differentially expressed miRNAs in cardamom cultivated in high and low altitude areas. University of Kerala.
31. Nayana, P. K. Morpho-and molecular taxonomic studies on the genus *Candolleomyces* (Psathyrellaceae, Basidiomycota) of Kerala State. University of Kerala.
32. Neethu, T. Bioprospecting of wild germplasm of *Salacia* species (high-value antidiabetic plants) across the Western Ghats concerning its antidiabetic constituents. University of Kerala.
33. Princy Raju. Regeneration protocol for the conservation of *Madhuca neriifolia* (Moon) H. J. Lam., An endangered species in southern Western Ghats. University of Kerala.
34. Remya, R. Phytochemical profiling and pharmacological investigation in *Plectranthu svettiveroides* (K. C Jacob) N. D. Singh & B. D. Sharma. University of Kerala.
35. Reshma Elizabeth Alex. Reproductive Biology and Conservation of *Goniothalamus keralansis*. University of Kerala.
36. Revathy, S. Development of Molecular Markers and Population Genetic Structure Analysis of *Cullenia exarillata* A. Robyns (Bombacaceae), an Endemic Species from Western Ghats. University of Kerala.

37. Rijuraj, M. P., 2023. Studies on the Lateritic flora and their Ecological adaptive Significance in Northern Kerala, India. University of Kerala.
38. Shaina Jerald. *Ex-situ* conservation of Selected Economically Important Lesser-Known Species of the Andaman & Nicobar Islands. University of Kerala.
39. Shefin, B. Validation of the efficacy of anti-tuberculosis activity in selected nutraceutical plants through *in silico* and *in vitro* screening methods. University of Kerala.
40. Shibin Felix. *Ex situ* conservation, molecular and chemical profiling of 'sweet flag' (*Acorus calamus* L.) from the Western Ghats. University of Kerala.
41. Smridina Ramesh, M. V. Systematic Studies on the flowering Plants of Palode Forest Range, Kerala. University of Kerala.
42. Soorya, S. Development of molecular markers for sex determination in Palmyra palm. University of Kerala.
43. Sreedevi S. Kumar. Scientific validation of comparative antidiabetic effect of root extract and pod extract of *Cyamopsis tetragonoloba* (L.) Taub. with special emphasis on diabetic complications. University of Kerala.
44. Sreeja Devi, P. S. Phytochemical profiling and biological activities of different jack fruit (*Artocarpus heterophyllus* Lam.) genotypes of Kerala. University of Kerala.
45. Sreejesh, K. H. Morphological and Molecular Taxonomy of the Genus *Milium* Lesch. ex A. DC. (Annonaceae) in India. University of Kerala.
46. Subin Mathew. *In silico* and *in vitro* screening and identification of lead compounds against hepatitis B in selected plants. University of Kerala.
47. Suchitra G. Krishnan. Systematic Studies of Family Aristolochiaceae from the Western Ghats. University of Kerala.
48. Suresh Kumar, P. Collection, Documentation and Conservation Strategies of Selected Promising Wild Ornamental Plants of Kerala. University of Kerala.
49. Vini C. Sekhar. Neuropharmacological and molecular effects of polymer encapsulated *Bacopa monnieri* secondary metabolite nanoparticles in kainic acid induced seizures. University of Kerala.

## STUDENTS INTERNSHIP PROGRAMME

1. Anjana, K. A. Systematic Enumeration and Herbarium Documentation of Medicinal Trees in JNTBGRI Medicinal Plants Grden, Palode. St. Berchmans College, Changanassery, Mahatma Gandhi University. B. Sc. Dissertation, under Dr. G. Rajkumar, submitted on 14 March 2023.
2. Anjana, V. A. Systematic Enumeration and Herbarium Documentation of Medicinal Shrubs in JNTBGRI Medicinal Plants Grden, Palode. St. Berchmans College, Changanassery, Mahatma Gandhi University. B. Sc. Dissertation, under Dr. G. Rajkumar, submitted on 14 March 2023.
3. Anupama, S. Economic and taxonomic evaluation of the tree species in the Palode Forest Range, Thiruvananthapuram District, Kerala. Iqbal College, Peringammala, University of Kerala. Submitted on 7 September 2023 (M. Sc. Dissertation; Guide Dr. A. Nazarudeen).
4. Arya Krishna, M. R. Survey, documentation, and taxonomic evaluation of the aquatic and marshy macrophytes in the Palode Forest Range, Thiruvananthapuram, Kerala. Christian College, Kattakada, University of Kerala. Submitted on 5 September 2023 (M. Sc. Dissertation; Guide Dr. A. Nazarudeen).
5. Balasanker, P. Field and herbarium-based studies on the taxonomic and economic characters of the family Araceae in the Palode Forest Range, Thiruvananthapuram District, Kerala. Central University of Tamil Nadu, Thiruvavur, Tamil Nadu. Submitted on 12 September 2023 (Internship Training; Guide Dr. A. Nazarudeen).
6. Fathima Harish. Studies on the obnoxious invader weeds disturbing natural vegetation in the Palode Forest Range, Thiruvananthapuram District, Kerala. St Berchmans College, Changanassery, Mahatma Gandhi University, Kottayam. Submitted on 14 March 2023 (B.Sc. Dissertation; Guide Dr. A. Nazarudeen).
7. Rosmy Varghese. Reviews on the edible plants in the Palode Forest Range and adjoining areas in Thiruvananthapuram District, Kerala. St Berchmans College, Changanassery, Mahatma Gandhi University, Kottayam. Submitted on 14 March 2023 (B.Sc. Dissertation; Guide Dr. A. Nazarudeen).
8. Shyam, V. Studies on seed storage, germination, and viability physiognomies of five rare and endemic angiosperms in Kerala. One month course work, completed on 5 September 2022 (Guide Dr A. Nazarudeen).

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## **FINAL TECHNICAL REPORTS**

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2. Eco-tourism Initiative at JNTBGRI. Status Report and Statement of Expenditure submitted to the Directorate of Tourism, Govt. of Kerala, Thiruvananthapuram on 18 May 2022.
3. Heritage and aesthetic garden at Thiruvananthapuram. The FTR has been submitted to the Hon'ble Chief Minister of Kerala on 24 August 2022. Regular maintenances are carried out during the period.
4. Submitted Quarterly Report (F.No.Z.18017/187/CSS/R&D/KE-04/2020-21-NMPB-IV A) -(Project Number -R&D/KE-04/2020-21)-National Medicinal Plants Board (NMPB), Ministry of Ayush, Govt. of India-) – PI, Dr Radha RK
5. Submitted first Year report (Project Number -NO:19-47/2020/RE) - The Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India – PI. Dr. Radha, R. K.
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**jntbgri**

FINAL TECHNICAL REPORT  
Submitted to  
**THE KERALA STATE BIODIVERSITY BOARD**  
GOVERNMENT OF KERALA

OCTOBER 2022

**RED DATA BOOK**  
AND ASSESSMENT OF THREATENED SPECIES  
OF KERALA - FLORA  
INCLUDING AQUATIC SPECIES

Fig. 42. Red Data Book of Kerala, FTR

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## **BOOK PUBLISHED**

1. Saleem, M., Balaji, V. K., Mathew Dan, Lekshmi, R., Job, J. Neriamparambil and Salish J. Menachery, 2022. Orchids of Eravikulam National Park, Munnar. Jointly published by JNTBGRI, Kerala Forest Department and UNDP.
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Fig. 43. Dr. T. N. Seema releases '*Orchids of Eravikulam National Park, Munnar*', a book authored by M. Saleem et al. (2022) at Kerala Arts and Craft Village, Vellar, Kovalam on 29 Jun 2022

## SEMINAR/SYMPOSIA PAPERS

1. Nazarudeen, A. Chedikalile Vamshanasham: Karanangalum Pariharavum. Training Programme: Development of Propagation Techniques and Establishment of Nurseries for Indigenous RET Plants and Species Notifies under Biological Diversity Act and Promoting Cultivation with the Support of Research organizations, Kudumbasree and MNREGS. JNTBGRI, 30 May to 29 July 2022.
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  68. Raju Antony, 2022. Diversity of Ferns in the Western Ghats. National Seminar on Biodiversity Challenges and Threats: Current Scenario. Postgraduate and Research Department of Botany, S. N. College, Kollam, 21 December 2022.
  69. Raju Antony, 2022. Ferns and climate change. International Seminar on Plant Response to Climate Change. Scott Christian College, Nagercoil, Tamil Nadu, 11 December 2022.
  70. Rashmi, K. A., Nithyamol, K. M., Abdul Jabbar, Joemon Jacob, 2023. *Ex situ* conservation of Palms from the Andaman –Nicobar Islands, a success story by JNTBGRI. Mar Baselios Christian College of Engineering and Technology, Kuttikkanam, Idukki., 12-14 February 2023.
  71. Raveendran, M. Sarppakavukalum Apoorvva Sasyangalum. Training Programme: Development of Propagation Techniques and Establishment of Nurseries for Indigenous RET Plants and Species Notifies under Biological Diversity Act and Promoting Cultivation with the Support of Research organizations, Kudumbasree and MNREGS. JNTBGRI, 30 May to 29 July 2022.
  72. Remya, R. P., Sreekumar, S. and C. K. Biju, 2022. Validation of anti-diabetic activity in *Plectranthus vettiveroides* and identification of lead molecules through *in silico* method. In the International Conference on Advanced Biology 2022. Inter University Centre for Evolutionary and Integrative Biology, University of Kerala, 23-25 February 2022.
  73. Renju Kunjumon, Anil John Johnson, Sabulal Baby, 2022. Search for elite lines of *Centella asiatica* based on their bioactive constituents. International Conference on Sustainable Utilization of Bioresources (ICSUB 2022), Department of Botany, Kerala University, January 10-15, 2022.
  74. Reshma, E. A., Jothish, P. S. and G. Rajkumar, 2023. Floral Morphology and pollinator trapping mechanism of *Goniothalamus keralensis*, an endemic Annonaceae of Kerala, India. International Conference on Emerging Trends in Plant Science

- Research on 6 - 7 March 2023. Catholicate College, Pathanathitta, pp. 19-20. ISBN 978-93-5812-966-3.
75. Reshma, M. D., Anilkumar, C. and P. M. Radhamany, 2022. Metabolomic profile of *Bentinckia condapanna* Berry ex. Roxb. seeds developed in diurnal temperature stress. Strength of Redox systems. Book of abstracts, international conference on physiological and molecular mechanisms for abiotic stress tolerance in plants. Department of Botany, University of Calicut (October 26-27, 2022), jointly organized by the Indian Society for Plant Physiology. OPSR-13. pp. 119.
  76. Rijuraj, M. P., Shaju, T. and A. G. Pandurangan, 2022. Socio-Economic significance of low land Grasslands in Lateritic zones of Northern Kerala, India. Biodiversity Club, St. Thomas College, Kozhencherry.
  77. Sabu, T. *Marangalile Apoorva Inangal*. Training Programme: Development of Propagation Techniques and Establishment of Nurseries for Indigenous RET Plants and Species Notifies under Biological Diversity Act and Promoting Cultivation with the Support of Research organizations, Kudumbasree and MNREGS. JNTBGRI, 30 May to 29 July 2022.
  78. Sabu, T., 2022. *Ex-situ* conservation of seven endangered tree species at S.N College Kollam dist., Biodiversity challenge and threats, a case study. S N College Kollam, 20 December 2022.
  79. Sabu, T., 2022. Invasive alien flowering plants of selected sacred groves vegetation in Kattakkada Assembly Constituency, Thiruvananthapuram district, Kerala, South India. National Conference on 'Bioinvasions: Trends, Threats, and Management. Craft village, Vellar, organized by Kerala State Biodiversity Board, 3 December 2022.
  80. Saleem, M., Balaji, V. K. and M. Dan, 2023. Orchids of Eravikulam National Park, Kerala. National Seminar on 'Multidisciplinary Approaches in Studies, Conservation and Resource Development of Medicinal and Ornamental Orchids. Dept. of Botany, Punjab University, Chandigarh. 3-5 March 2023.
  81. Sathyakrishna, P. K., Suja, S. R., Stephan, J. and Mathew Dan 2022. Morphological and Anatomical investigation on *Piper betle* L. from Andaman Islands in comparison with the popular Cultivar from the Southern western Ghats aiming bioprospecting. National symposium and the 32<sup>nd</sup> Annual Conference of the IAAT.
  82. Sekhar, V. C., Gulia, K. K., Deepti, A., Baby Chakrapani, P. S., B. Sabulal and G. Vishwanathan, 2023. Nanoencapsulated Bacoside A and Bacopside I: Overcoming

- blood-brain barrier to treat seizures. 35<sup>th</sup>Kerala Science Congress, Mar Baselios Christian College of Engineering and Technology, Kuttikanam, Idukki, 10-14 February 2023.
83. Shintu Scaria, Jothish, P. S. and C. Anilkumar, 2022. Phytosociology of *Humboldtia unijuga* Bedd. var. *trijuga* J. Joseph & V. Chandras., critically endangered tree species in the Western Ghats. Abstract Book of International Conference on Sustainable Utilization of Bioresources. Department of Botany, University of Kerala, Karyavattom Campus, Thiruvananthapuram, pp.73.
  84. Shintu Scaria, Jothish, P. S. and C. Anilkumar, 2022. Population status and conservation of a critically endangered tree species *Humboldtia unijuga* Bedd. var. *trijuga* J. Joseph & V. Chandras., in the Western Ghats. Abstract Proceedings of the National Seminar on Fundamental and Applied Dimensions in Plant Sciences. Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, pp.20.
  85. Shintu Scaria, Jothish, P. S. and C. Anilkumar, 2022. Vegetative propagation and conservation of a critically endangered tree species *Humboldtia unijuga* Bedd. var. *trijuga* J. Joseph & V. Chandras. Book of Abstracts, National Seminar on Biotechnology, Environment and Conservation. Post Graduate Department of Botany. St. Dominic's Collage, Kanjirapally, pp.88.
  86. Shintu Scaria, Jothish, P. S. and C. Anilkumar, 2023. *Ex-situ* conservation through vegetative propagation of *Humboldtia unijuga* Bedd. var. *trijuga* J. Joseph & V. Chandras., a critically endangered tree of southern Western Ghats. Proceedings of the International conference on emerging trends in plant science research. Catholicate College, Pathanamthitta. ISBN 978-93-5812-966-3, pp.17-18.
  87. Soorya, S., Swapna T. S. and K. K. Sabu, 2023. Selection of Dominant Reference Gene and Expression of Agamous Gene via QRT-PCR in *Borassus flabellifer* L. Proceedings of the 35th Kerala Science Congress, 10-14 February 2023 at Mar Baselios Christian College of Engineering and Technology, Kuttikkanam, Idukki. Kerala State Council for Science, Technology & Environment, Thiruvananthapuram.
  88. Vinayak, V., Thania Sara Varghese, Rajani Kurup S. R., Sabulal, B. and V. Gayathri, 2022. Insecticidal and biological activities of four different essential oils against stored grain pests. 34th Kerala Science Congress. Mar Ivanios College, Thiruvananthapuram, 27-29 January 2022.

## INVITED TALKS

1. Biju, H. Digest of Lichens. KSCSTE - Malabar Botanical Garden and Institute of Plant Sciences (MBGIPS) in connection with green skill Development Programme of the Ministry of Environment, Forest and Climate change, Government of India, 4 May 2022.
2. Joemon Jacob. Plant Wonders and Curious Plants. N. S. S. College, Pandalam, 23 February 2023.
3. Rajendraprasad, M. has made an invited before selected School Children on the topic, basic elements of life. The talk was organized by the Darshanam Samskarika Vedi, Kozhikkode on 25 July 2022.
4. Rajkumar, G. has participated in the 32<sup>nd</sup> Annual Conference of Indian Association for Angiosperm Taxonomy and National Symposium on The Contribution of Angiosperm Taxonomy to Human Wellbeing and the Risks Associated with its Decline organized by the Department of Botany, Karnatak University, Karnatak Science College, Dharwad, Karnataka from 11-13 November 2022.
5. Rajkumar, G. has presented a lecture in the seminar 'Floristic Diversity of Western Ghats' organized by the Department of Botany, St. Thomas College, Ranni on 21. October 2022.
6. Rajkumar, G. has presented a paper Relevance of Herbarium in Medicinal Plants Research in the Workshop on Conservation, Cultivation and Sustainable Utilization of Medicinal Plants organized by Centre for Biodiversity Conservation, Department of Botany, University of Kerala on 11. October .2022.
7. Rajkumar, G., has presented a paper on Floristic Diversity of Southern Western Ghats- Phytochemical Perspectives organized by the Department of Botany, Women's Christian College and Research Centre, Nagercovil on 11 March 23.
8. Raju Antony. Morphology of Ferns. Department of Botany, Mar Ivanios College, Thiruvananthapuram, 20 February 2023.
9. Rijuraj, M. P. Socio-Economic significance of low land Grasslands in Lateritic zones of Northern Kerala, India (Presentation). Biodiversity Club, St. Thomas College, Kozhencherry.
10. Sabu, K. K. DNA barcoding of plants. International Training Workshop on DNA Barcoding and Molecular Taxonomy – ITW'04. Dept of Marine Biology, Microbiology and Biochemistry, School of Marine Sciences, Cochin University of Science and Technology (CUSAT), 11 - 16 July 2022.

11. Sabu, K. K. Keynote address: Functional genomics for understanding stress responses in plants. International Virtual Conference on Evolving Paradigms in Biotechnology: Combating Contemporary Challenges. Department of Life Sciences, Kristu Jayanti College, Autonomous in collaboration with Jawaharlal Nehru Tropical Botanic Garden and Research Institute, 2 April 2022.
12. Saleem, M. Orchid Biology. Green Care Kerala Annual Meet, Thiruvananthapuram, 12 October 2022.
13. Santhosh Kumar, E. S. Identification of Medicinal Plants. Workshop on “Conservation, cultivation and sustainable utilization of medicinal plants”. Dept of Botany, University of Kerala, 11 October 2022.
14. Sreekumar, S. Digital Technology in Taxonomy with emphasis on Herbarium Digitization. Add on course “Herbarium Technique and Management”, Department of Botany, University of Kerala, Kariavattom, Thiruvananthapuram, 3 October 2022.
15. Suja, S. R. Traditional knowledge- Valuable lead for Biodiversity prospecting and drug development. Plenary lecture, technical session, International Conference on Environment, Forestry and Sustainable Agriculture, GKVK campus, University of Agriculture, Bangalore 23 - 25 November 2023.
16. Vipin Mohan Dan. Pathogen biology. KSCSTE - Malabar Botanical Garden and Institute of Plant Sciences (MBGIPS) in connection with green skill Development Programme of the Ministry of Environment, Forest and Climate change, Government of India, 4 May 2022.

## **OUTREACH PROGRAMMES**

1. Dr. M. Rajendraprasad has attended 2 meetings at Collectorate in connection with 1<sup>st</sup> anniversary of Govt of Kerala, 4 April 2022.
2. Dr. M. Rajendraprasad has attended consultative meetings of Govt. programme Freedom Fest 2023 on 30-12-23 at the office of the State Lottery, Gorkhi Bhavan, Thiruvananthapuram.
3. Dr. M. Rajendraprasad has attended State Level Expert Committee meeting on Conservation of Sacred groves & Vanamithra at Forest Head Quarters on 16-12-22.
4. Dr. M. Rajendraprasad has become the co-convener of the Publication Committee. 35<sup>th</sup> Kerala Science Congress, Kuttikkanam, Idukki.

5. Dr. M. Rajendraprasad has corrected the script of the TV documentary -Jalanilangal- News 18 Keralam, broadcasted on 5 June 2022.
6. Dr. M. Rajendraprasad has extended service as examiner and external expert during 7-10 October 2022, for the dissertation and *viva-voce* of M.Sc. Biodiversity exam III semester in the University of Kerala.
7. Dr. M. Rajendraprasad has extended service as examiner and external expert during 26-27 July 2022, for the dissertation and *viva-voce* of M.Sc. Biodiversity exam IV semester in the University of Kerala.
8. Dr. M. Rajendraprasad has extended service as the Chairman of the open defence of Ph.D. thesis of Gokul G. Nair on the topic entitled Black Mildew Fungi in Konni Forest Division. Mahatma Gandhi University, Kottayam.
9. Dr. M. Rajendraprasad has participated in a workshop on conservation of ponds in Kannur and presented a proposal for conservation of ponds at the Pinaray convention centre, Pinaray on 13 November 2022.
10. Dr. M. Rajendraprasad has participated in the district wise monitoring of National Green Corps at KSCSTE, Sastra Bhavan on 19 October 2022.
11. Dr. M. Rajendraprasad has participated in the Ente Keralam programme, Annual Celebration for Showcasing the Achievements of the Government of Kerala (27 May – 2 June 2022).
12. Dr. M. Rajendraprasad has participated in the First Kerala State Climate Change Stakeholders Consultation Workshop, IRIS, Hotel Apollo Dimora, Thiruvananthapuram on 1 August 2022.
13. Dr. M. Rajendraprasad has participated in the Neerdhara Padhathi, a watershed management programme, Govt. of Kerala 21 April 2022.
14. Dr. M. Rajendraprasad has participated in the preparation of a Float in the theme ‘Biodiversity conservation to restrict pandemics’ in the Onam celebrations, 2022, organized by the Department of Tourism, Govt. of Kerala.
15. Dr. M. Rajendraprasad has participated in the workshop on Vamanapuram River Rejuvenation Programme held at the District Collectorate, Thiruvananthapuram on 2 April 2022.
16. Dr. M. Rajendraprasad has supervised the Green Mission activities of Mar Thoma College, Thiruvalla and certified the Green Audit Report for the period 2022-2023 academic year.

17. Dr. M. Rajendraprasad has supervised the Green Mission Initiatives of Iqbal College, Peringammala and certified Green Audit Report for the period 2022-2023 academic year.
18. Dr. Vinodkumar T G Nair has attended as expert in the Workshop for ‘Development of Syllabus for Second Professional BAMS Subjects’ at IIIT-Delhi Sonipat Campus, Khewra, Haryana, organized by National Commission for Indian Systems of Medicine, Ministry of AYUSH, Government of India, 1 - 3 February 2023.

### **WORKSHOP/TRAINING / WEBINARS ORGANISED OR ATTENDED**

1. Abdul Jabbar, M. has directed in the garden 34 BAMS students from Govt. Ayurvedic College and Hospital, Balangir, Odisha at Medicinal Garden on 17-01-2023.
2. Abdul Jabbar, M. has extended scholarly guidance to the Senior Beat Forest officers from the Arippa Forest Training Institute on 23-08-2022.
3. Abdul Jabbar, M. has served as the resource person for the Senior Beat Forest Officers from the Arippa Forest Training Institute who had visited the PGR Division on 23-08-2022.
4. Ajinsha, J. S. has attended the 35<sup>th</sup> Kerala Science Congress organised by Department of Botany, Mar Baselios Christian College of Engineering and Technology, Kuttikkanam, Idukki from 12-14 February 2023.
5. Ajmi Shahul has attended the two-day workshop in phytochemical techniques in aromatic plant research at JNTBGRI on August 10 & 11 2023.
6. Ajmi Shahul has attended training in Molecular biology techniques training Programme at Unibiosys Biotech Research Labs Kalamassery, Kochi from July 05 to 28, 2023.
7. Ajmi Shahul, Aswathy V. Nair, Lekshmi S. Nath and Aleena Joseph has attended the 5 days training programme on ‘Animal handling’ at Sree Chitra Tirunal Institute for Medical Sciences and Technology, Poojapura, Trivandrum during 08.05.2023 to 12.05.2023.
8. Aneeth Sneha Saj has attended the 5 days National workshop on Animal Cell Culture and Molecular Biology Techniques at PG & Research Department of Zoology, Mar Ivanios College, Thiruvananthapuram, 4 -8 December 2023.

9. Aneeth Sneha Saj has attended the two-day workshop in phytochemical techniques in aromatic plant research at JNTBGRI on August 10 & 11 2023.
10. Anilkumar, C. has participated in the International Conference on Physiological and Molecular Mechanisms for Abiotic stress Tolerance in Plants. Department of Botany, Calicut University, 25 - 29 October 2022; presented a paper and chaired a technical session.
11. Anilkumar, S., Saleem, M., Gopakumar, B., Mathew Dan, Abdul Jabbar and B. J. Radhika were involved as resource persons in the Open House and Science Orientation Programme for school students during 23-05-2022 to 27-05-2022.
12. Anooj, S. L. has attended the 35<sup>th</sup> Kerala Science Congress organised by Department of Botany, Mar Baselios Christian College of Engineering and Technology, Kuttikkanam, Idukki from 12-14 February 2023.
13. Anooj, S. L., Ajisha, J. S., Bibin V. Arkathu, Ashi Anu Mathew and Devika S. Kumar has undergone three days skill training programme on Ecological and Biodiversity Status for EIA Projects' Organized by CSIR-NEERI, Nagpur from 7- 9 on 2022 December 2022.
14. Biju H. and A. Sabeena have attended a National Webinar organised by Association of Fungal Biologists, on "Fungal Metabolites in Drug Development" and "Future of Fungal Systematics", held on 18th February 2023.
15. Biju H. and A. Sabeena have attended one day 'National Webinar on Nanotechnology', organized by Kerala Academy of Sciences, along with the Central University of Kerala, Kasaragod and the Dale View College of Pharmacy and Research Centre, Thiruvananthapuram on May 11th, 2022.
16. Biju, H. and A. Sabeena have attended a Talk on the topic 'Floristic diversity of Indonesia-Phytochemical perspective' by Dr. Kholis Abdurachim Audah from Swiss German University, Indonesia, held at JNTBGRI on 9th November 2022.
17. Biju, H. and A. Sabeena have attended a Talk on the topic 'Orchid Conservation and Use of Orchids to Connect People with Nature' by Dr. Viswambharan Sarasan from Royal Botanic Gardens, Kew, held at JNTBGRI on 2 November 2022.
18. Biju, H. and A. Sabeena have participated in the World Fungus Day Lectures on October 2, 2022, organized by Myco Asia Journal, in collaboration with Sri Venkateswara University, Tirupati, India.

19. Gopakumar, B. has conducted a class on “Prakrithi Samrakshanathil Mulayude Pradhanyam” for the volunteers of National Service Scheme at Govt. Higher Secondary School, Parassala on 16-08-2022.
20. Gopakumar, B. has participated in the 19<sup>th</sup> edition of Kerala Bamboo Fest from 27 November to 4 December 2022 at Kaloor Jawaharlal Nehru International Stadium, Ernakulam.
21. JNTBGRI exhibition team has participated in 35<sup>th</sup> KSC Expo at MBC College of Engineering, Kuttikkanam, Idukki on 10-02-2023 to 14-02-2023.
22. JNTBGRI exhibition team has participated in the Orchid show at Punjab University, Chandigarh in connection with the Orchid Society of India Conference (Bagged First place in Flower arrangement competition).
23. JNTBGRI exhibition team has participated in the Palode Mela held during 07-02-2023 to 16-02-2023.
24. JNTBGRI has exhibited Bamboo Hybrid Culms in the 2<sup>nd</sup> Kerala Biodiversity Congress at Govt. Arts and Science College, Meenchantha, Kozhikode from 18-02-2023 to 23-02-2023.
25. Mathew Dan and Abdul Jabbar have conducted demonstration classes on the ‘Relevance of Plant Genetic Resources and its conservation’ to BFO Trainees from Forest School, Arippa on 11-05-2022.
26. Mathew Dan and M. Abdul Jabbar have served as resource persons for the training –programme for the D. Pharm students on 17-08-2022.
27. Mathew Dan and M. Abdul Jabbar have served as resource persons to teach the 15-member team of PG students of Environmental Studies from Norwegia who had visited the garden as part of their training at Centre for Development Studies on 31-08-2022.
28. Mathew Dan has attended the Board of Studies meeting of Department of Botany, Sacred Heart College, Kochi on 11-07-2022.
29. Mathew Dan has attended the meeting of the expert group under the programme "Assistance to Botanic Gardens” scheme of MoEF&CC, held under the Chairmanship of Dr. Sujit Kumar Bajpayee, Joint Secretary, on 07-10-2022 in Indus Conference Hall, Indira Paryavaran Bhawan, Jor Bag, New Delhi.
30. Mathew Dan has participated in the National symposium and the 32<sup>nd</sup> Annual Conference of the IAAT and served as a member of the judging panel for the best

paper award on ‘Modern Techniques in Plant Taxonomy’ and attended different sessions and deliberations.

31. Mathew Dan has served as Resource Person for field visit of PG Ayurvedic students from KMCT Ayurvedic college Kozhikode and KTGANC Ayurvedic college Karnataka at JNTBGRI on 25-11-2022 and delivered a lecture on the ‘Importance of Conservation and Utilization of Medicinal plants’.
32. Mathew Dan has served as resource person in Regional Children’s Science Congress of Jawahar Navodaya Schools held at NIIST, Pappanamcode and delivered a talk on ‘Biodiversity and its Conservation’ on 01-12-2022.
33. Mathew Dan has served as Resource Person in the seminar on ‘Conservation and Sustainable utilization of Local Bio-resources’ at Govt. Higher Secondary School, Cithara on 2<sup>nd</sup> November 2022 and delivered a talk on ‘Relevance of Biodiversity Conservation’.
34. Mathew Dan has served as resource person in the Ten-day Training programme on Threatened Plants Propagation and Nursery Practices of Kerala State Biodiversity Board in JNTBGRI during 30-May to 29 July 2022. Gopakumar, B. has handled classes on ‘Propagation and Conservation of Bamboos at JNTBGRI to the trainees.
35. Mathew Dan has served as resource person to students and faculty of IIST outreach programme at JNTBGRI on 17-06-2022. M. Abdul Jabbar has conducted an awareness class to the students on ‘Field Gene Bank and field conservatory of Andaman plants and B. J. Radhika has given demonstration classes on Tissue Culture to the students.
36. Mathew Dan has served as the Research Advisory Committee member, in the 11<sup>th</sup> RAMC of BSI held during 20-21 October 2022 at the BSI-Central National Herbarium, Howrah, Calcutta.
37. Mathew Dan has visited the INFOSYS campus on request, to identify the trees/medicinal plants in the site on 11-04-22.
38. Mathew Dan served as a resource person during the visit of Student Police Cadets from Govt. Vocational Higher Secondary School, Vithura at JNTBGRI on 24-05-2022 and delivered a class on ‘Plant Genetic Resources and its Conservation’. Abdul Jabbar and B. J. Radhika were also involved in the awareness programme.

39. Dr. S. Sreekumar, S. has organised one week training to the UG students of NISH on the topic “Cultivation& multiplication practices on ornamentals, vegetables and medicinal plants” from 1-7 June 2022 at STEC-JNTBGRI, Puthenthope.
40. Organized successfully the 2-day Biodiversity awareness programme for school children during 27-05-2022 & 28-05-2022 in which 25 High School children from 15 different schools participated.
41. Dr. S. Sreekumar and Biju, C. K. has provided two weeks internship training to six B.Sc. Botany students from AJ College, Thonnakkal, Thiruvananthapuram.
42. Radha, R. K. has attended the Technical Committee Meeting (Scrutiny of Research Projects) of Chhattisgarh State Medicinal Plant Board at SMPB, Chhattisgarh on 26<sup>th</sup> September 2023.
43. Rajendraprasad, M has participated as co-convener in the National Seminar on Fundamental and Applied Dimensions in Plant Sciences, Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, Kerala (2022).
44. Rajendraprasad, M. has participated in The International Conference on Sustainable Utilisation of Bioresources 2022. University of Kerala, Karyavattom.
45. Rajendraprasad, M. has participated in the online seminar on “Science and Society”, Vigyan Utsav as part of Azadi Ka Amrit Mahotsav programme. Kerala State Council for Science, Technology & Environment.
46. Rajkumar, G. has participated in the 32<sup>nd</sup> Annual Conference of Indian Association for Angiosperm Taxonomy and National Symposium on The Contribution of Angiosperm Taxonomy to Human Wellbeing and the Risks Associated with its Decline organized by the Department of Botany, Karnataka University, Karnataka Science College, Dharwad, Karnataka, 11-13 November 2022.
47. Rajkumar, G. has participated in the 35<sup>th</sup> Kerala Science Congress organised by Department of Botany, Mar Baselios Christian College of Engineering and Technology, Kuttikkanam, Idukki, 12-14 February 2023.
48. Sabu, K. K. has provided hands-on training on Basic Molecular Biology Techniques, 15 to 18 March 2023.

49. Sabu, T. has visited the project site dealing with the ecological studies of Sacred groves of Kottamugal, Maranalloor along with other team members from KSBB in connection with the Carbon Neutral Kattakkada Project on 7.10.22.
50. Saleem, M has given a training class on ‘Orchid breeding’ to the B.Ed. students from Iqbal Training College, Peringammala on 30-09-2022.
51. Saleem, M. has conducted a training program on Orchid conservation on 30-08-22 at Eravikulam National Park, Idukki.
52. Saleem, M. has evaluated one project entitled “Development of Novel Hybrids orchids” submitted by Dr. Resmi Paul, Kerala Agriculture University, as part of Science Research Scheme of KSCSTE.
53. Saleem, M. has participated in the planting of Orchids at Kanakakunnu campus on 01-11-2022, as part of Kew initiative programme.
54. Santhosh Kumar, E. S. and T. Sabu have attended a one-day workshop organized by Kerala State Biodiversity Board on Access and Benefit Sharing at IMG Campus Trivandrum on 27.02.2023.
55. Sreekumar S has provided one month internship training to 4 B. Tech and 3 M.Sc. students.
56. Dr. S. Sreekumar has provided one week training to Reshmi R.P., Ph.D. Scholar, Malankara Catholic college, Mariagiri, Tamil Nadu, on the topic “*In silico* drug discovery” from 1-9 November 2022.
57. Sreekumar, S. has attended the brainstorming session on Science Technology and Environment Vision 2050 and the inaugural session of the Golden Jubilee celebrations of Science Technology in Kerala held at Kerala Arts & Craft Village, Vellar, Thiruvananthapuram on 29<sup>th</sup>May 2022.
58. Sreekumar, S. has participated in the training programme on GCP and NDCT rules, issues in research with traditional system of medicine, ICMR National Ethics Guidelines and Role & Responsibilities of Ethics Committee organized by the Department of Homoeopathy, Govt. of Kerala, in collaboration with the Forum of ethics review committee in India (FERCI) on 6<sup>th</sup> August 2022.
59. Sreekumar, S. has participated in the webinar “An introduction to rational structure-based design methods using Flare, organized by Cresser London on 28-07-2022.

60. Suja, S. R. has attended the 5 days National workshop on Animal Cell Culture and Molecular Biology Techniques at PG & Research Department of Zoology, Mar Ivanios College, Thiruvananthapuram, 4 - 8 December 2023.
61. Suja, S. R. has attended the 5 days National workshop on Animal Cell Culture and Molecular Biology Techniques. PG & Research Department of Zoology, Mar Ivanios College, Thiruvananthapuram, 4 -8 December 2023.
62. Suja, S. R. has attended the Hands-On-Workshop on Advanced Imaging Applications in Biology at RGCB BIC campus, Aakulam, Trivandrum, 5 -9 June 2023.

### POPULAR ARTICLES

1. Abinlal, K. C. and A. Dhyani, 2022. Collecting seeds in the Southern Western Ghats from a rare and endemic tree, *Garcinia gamblei*. Samara- The International Newsletter of the Millennium Seed Bank Partnership, Royal Botanic Gardens Kew 38. 13.
2. Bindu, S. and C. Anilkumar, 2023. Sarpagandhi. *Aaranyam* Forestry Information Bureau Publication, Forest Department of Kerala 44 (2): 17-18.
3. Deepu, S. and A. Dhyani, 2022. Dipterocarpaceae in India. Red List of Dipterocarpaceae. Botanic Gardens Conservation International, Richmond, UK.
4. Dhyani, A. and T. Abeli, 2022. Plant translocation for threatened species conservation. *Proceedings* 80 (1):1 <https://doi.org/10.3390/proceedings2022080001>.
5. Dhyani, A., 2022. My second trip to the Western Ghats. *The North American Lily Society Quarterly Bulletin*. 76 (1): 39-44.
6. Govind, M.G., Mathew Dan and K.B. Ramesh Kumar, 2023. *Paschimaghata vanangalile jathi vrikshangal* (Myristica Trees in the forests of Western Ghats), *Aaranyam*, Forestry Information Bureau Publication, Forest Department of Kerala 43(5): 20-23.
7. Jothish, P. S. and C. Anilkumar, 2023 *Silent valleyude swandam neeral*. *Aaranyam* Forestry Information Bureau Publication, Forest Department of Kerala 44(4) 36 -38.

8. Khoo, E., Barstow, M., Maycock, I. C., Anurag Dhyani et al. (2022). Red List of Dipterocarpaceae. Botanic Gardens Conservation International. Richmond, UK.
9. Nazarudeen Ahammed, 2023. Choodamaram: Kuttalam Kunnile Pythrika Maram. *Aranyam* 43 (11): 38-39.
10. Nazarudeen Ahammed, 2023. Kanyavanagalile Kattupazhangal. *Aranyam* 43 (5): 11-15.
11. Sabu, T., 2023. Fibre yielding trees in Kerala. *Aranyam*, Forestry Information Bureau Publication, Forest Department of Kerala.43 (5):41-43.

### **SIGNIFICANT ASSIGNMENTS AND CONSULTATIONS**

- Anilkumar, C. has addressed on “Seeds sprouting for a species” for Highschool students on 25.5.22 and awareness classes on seed banking activities were taken in association with the ‘Open House and Science Orientation Programme – 2022’ sponsored by KSCSTE. Anilkumar, C. has prepared Question Paper set on paper II Plant physiology and Biochemistry of Ph.D. Preliminary Qualifying Examination, University of Calicut (DO. No. 150593/EX-II-Asst-2/2021/PB dated 5-7-22.
- Anilkumar, C. has evaluated a session “Biodiversity and Conservation” in the International Seminar, New Horizons in Plant Sciences, Department of Botany, University of Kerala, Kariavattom, 21 March 2023.
- Anilkumar, C. has evaluated oral presentations for sessions in connection with an International Sminar NHPS 2023 conducted at the Department of Botany, Kariavattom campus, University of Kerala on 21-3- 2023.
- Anilkumar, C. has participated in the panel discussion on the role of Millets with the Wayanad Seed Festival Community Agrobiodiversity Centre MSSRF, Wayanad, 10 - 11 March 2023.
- Anilkumar, C. has participated with the panel discussion on role of Millets with the Wayanad Seed Festival from 10th to 11th March 2023 organized by the Community Agrobiodiversity Centre MSSRF, Wayanad.
- Anilkumar, C. has supervised dissertation work by five students of BSc. Botany from National College, Manacaud, Thiruvananthapuram on ‘Relevance of seed banking in the conservation of Plant Families’.
- Anilkumar, C. was the external examiner to Ph.D preliminary qualifying

examination at Research Department of MES Asmabi Collage, Kodungallur (Calicut University Order No. 82065/Research –Asst-1/2014/ Admn dated 12-06-2022.).

- Anurag Dhyani, Anuradha Agrawal, Kanchit Thammasiri (Special Issue). Plant Cryopreservation. *Frontiers in Conservation Science*.
- Chuck Cannon, Anurag Dhyani, Chen Jin, Malin Rivers (Special Issue). Global Tree Assessment. *Plants, People, Planet*.
- John Stephen, S. has completed one month dissertation work from Presidency College, Chennai on ‘Systematic validation of *Meiogyne* species through fruit and seed studies.
- Radha, R. K. has presented the First Year Report before 1<sup>st</sup> Technical and Financial Committee on Environmental Research and Developmental Program meeting for Research and Development, held on the 12th of October 2023 under the Chairmanship of Dr. Ruplal (Dept. of Zoology, University of Delhi) at MOEFCC office, New Delhi.
- Radha, R. K. has presented through video conferencing, the 2<sup>nd</sup> Year Progress Report of NMPB Project before the 79<sup>th</sup> meeting of the Project Screening Committee for Research and Development, held on the 18<sup>th</sup> of May 2023 under the Chairmanship of Dr. Suresh Kumar Malhotra, Director, Directorate of Knowledge Management in Agriculture (ICAR), Minister of Agriculture & Farmers Welfare, New Delhi.
- Sreekala, A. K. has delivered a lecture on “How biodiversity can be conserved by understanding Reproductive Biology”. Malabar Botanic Garden, 13 May 2022.
- Different units of Garden Management Division have supplied 82nos. of 41 indigenous species to Acharya Jagadish Chandra Bose Indian Botanic Garden, Kolkata (on exchange basis).

### **TRAININGS CONDUCTED**

1. A Bamboo Product Exhibition and Sale was organized at Darsana Higher Secondary School, Nedumangad, on 01-11-2022 as part of “Keralappiravi” celebrations, 2022.
2. A four-day national Workshop on Taxonomy, Identification and Conservation of Mushrooms was organized at KSCSTE-Jawaharlal Nehru Tropical Botanic Garden & Research Institute from 18-21 October 2022 in association with Kerala State

Biodiversity Board. A total of 15 participants were selected from different states. The participants included were faculties, research students and M.Sc. students. They were given field and lab-oriented hands-on training was given on fungal systematics.

3. A Three-days training programme on 'Medicinal Plants Cultivation and Management' was organized for fifty trainees during 25<sup>th</sup> to 27<sup>th</sup> July 2022 at JNTBGRI. The programme was funded by Kerala State Medicinal Plant Board. Dr. Mathew Dan and Dr. M. Abdul Jabbar were the resource persons for the programme.
4. A training programme has been carried out on the plant propagation techniques to a group of farmers from ATMA of Dep. of Agriculture under Govt. of Kerala on 31.05.2022.
5. Puja, A., a landscape architect student from Chennai has been given 30 days training (November-December 2022) by Dr. Raj Vikraman, R., particularly on the 'Landscape Designing and Ornamental Plant Taxonomy'.
6. The Bamboo unit (PGR Division) of JNTBGRI has given awareness classes (25 - 27 May 2022) on the topic 'Bamboo Resource for Sustainable Living', for the student trainees and co-ordinated a 'hands own training on bamboo handicrafts' with the help of Mr. N. Santhoshkumar, Master craftsperson, Kerala State Bamboo Mission, on 25-05-2022.
7. The Garden Management Division has given one week training on the vegetative propagation and nursery management to the B.Ed. students of Iqbal College, Peringammala from 26-09-2022 to 30-09-2022.
8. The Garden Management Division has given training on special techniques of fruit plant propagation for a 30 number team of farmers brought by farmers training centres Pandalam (Department of agriculture development and farmers welfare), on 06/03/2023.
9. The Plant Systematics and Evolutionary Division, , has conducted a 10 days training programme ( 30 May 2022 to 29 July 2022) was conducted with the aim of developing propagation techniques and establishment of nurseries for indigenous RET species notified under Biological Diversity Act and promoting cultivation with the support of Research Organizations, Kudumbasree and MNREGS. A total of 488people belonging to the Kudumbasree units of Thiruvananthapuram and Kollam Districts were given training. The programme has been financed by the Kerala State

Biodiversity Board. Apart from the experts from the Plant Systematics and Evolutionary Division, resource persons were also hired from the Garden Management Division, Plant Genetic Resources Division, Conservation Biology Division and Biotechnology and Bioinformatics Division of JNTBGRI.



Fig. 44. First Batch of the Trainees with the Resource Persons at JNTBGRI (30-05-2022)



Fig. 45. Dr. Mathew Dan speaks as Resource Person in the training programme on the propagation techniques of Medicinal Plants to a group of farmers from ATMA of Dep. of Agriculture under Govt. of Kerala

## PATENTS GRANTED

1. Rajasekharan, S., Latha, P. G., Suja S. R. and Ragesh R. Nair. Herbal drug composition possessing multiple therapeutic effects. Application No. 201641010849 Application No. 201641010849. Indian patent granted April 27<sup>th</sup>2023.
2. Rajasekharan, S., Latha, P. G., Suja, S. R., Siril, E. A., Aneesh Kumar, A. L., and R. Prakashkumar. Novel single herbal drug formulation possessing multiple therapeutic effects as wound healing, burn healing, anti-cancer, analgesic, anti-inflammatory, immuno enhancing, platelet augmentation and antioxidant. Appl No. 5667/CHE/2014. Indian patent granted, Feb 22<sup>nd</sup>, 2023.

## VIP VISITS

1. Prof. Carl-Henrik Heldin, Chairman of the Board of the Nobel Foundation and the Renowned Swedish Molecular Scientist and Director of the Ludwig Cancer Research, Uppsala has visited JNTBGRI on 16 February 2023.
2. Dr. E. Sreekumar, the Director, Institute of Advanced Virology (IAV) has visited JNTBGRI on 10 January 2023.



Fig. 46. Prof. Carl-Henrik Heldin, Chairman, Nobel Foundation in the mini amphitheatre, Palmetum, 16.02.2023



Fig. 47. Prof. Carl-Henrik Heldin chairman, Nobel Foundation, walks through the reflexology pathway, Palmetum. 16.02.2023.

#### **SPECIAL TALKS ORGANIZED**

1. Dr. Viswambharan Sarasan, Research Leader, Conservation Genetics and Molecular Ecology, Royal Botanic Garden, Kew. Topic: Orchid Conservation and use of orchids to connect people with nature. JNTBGRI Seminar Hall, 2 November 2022.
2. Dr. Kholis Abdurachim Audhah, Director of Research and Community Services, Swiss German University, Indonesia. Floristic Diversity of Indonesia: Phytochemical Perspective., JNTBGRI Seminar Hall, 9 November 2022.

3. Prof. Vibin Ramakrishnan, Department of Bioscience and Bioengineering, IIT, Guwahati. Mapping Drug-target Interactions and Synergy in Multi-molecular Therapeutics. JNTBGRI Seminar Hall, 16 December 2022.
4. Dr. Prathapan, K. D., Associate professor, Kerala Agriculture University. Taxonomy of leaf beetles. JNTBGRI, 5 June 2023.
5. Prof. S. D. Biju, Delhi University. Biodiversity in Crisis: Understanding life through the study of frogs. JNTBGRI Seminar Hall, 13 June 2023.
6. Padmasree M. C. Dathan. Prof. A. Abraham Memorial Talk. JNTBGRI Seminar Hall, 16 June 2023.
7. Dr. C. Sathish Kumar. Prof A. Abraham Memorial Talk. JNTBGRI Seminar Hall, 16 June 2023.
8. Dr. Ethan Freid, Botanist, Bahamas National Trust and Leon Levy Native Plant Preserve, Eleuthera. Plant Biodiversity and Conservation in the Bahamas. JNTBGRI Seminar Hall, 2 August 2023.
9. Mr. Aby Joseph, Assistant professor and Forensic DNA Consultant, Amity University, Dubai. Planting Justice: Role of Botany in Criminal Investigation. JNTBGRI Seminar Hall, 3 August 2023.



Fig. 48. Prof. S.D. Biju, Delhi University speaks on 'Biodiversity in Crisis: Understanding life through the study of frogs', JNTBGRI Seminar Hall, 13 June 2023.



Fig. 49. Dr. Prathapan, K. D., Associate Professor, Kerala Agriculture University talks on the ‘Taxonomy of leaf beetles’, 5 June 2023, JNTBGR



Fig. 50. Prof. A. Abraham Memorial Programme, 16 June 2023. Dr. M.C. Dathan, Dr. C. Satheesh Kumar and Dr. B. Sabulal on the dais



Fig. 51. Dr. M. Saleem receiving the Prof. A. Abraham Memorial Best Annual Achievement Award 2022 from Padmasree M.C. Dathan, 16 June 2023



Fig. 52. Aswathy, J. receives the best paper presentation award during Prof. A. Abraham Memorial Award Contest 2023, JNTBGRI, 16 June 2023

**PLAN FUNDED RESEARCH AND INFRASTRUCTURE PROGRAMMES**

SN	CODE	PROJECT NAME	DIVISION
1	P-001	1) <i>Ex situ</i> Conservation and Sustainable Utilization of Selected Plant Genetic Resources in the Southern Western Ghats through the invention of Biotechnology and Bioinformatics. 2) Analysis of species distribution and reinforcement of two threatened trees in the Kerala region of the Western Ghats for the improvement of their conservation status, Co-Investigator, Plan Program.	Biotechnology & Bioinformatics
2	P-002	Studies on conservation biological aspects of selected Flowering Plants of Kerala.	Conservation Biology
3	P-003	Systematic documentation and Bioprospecting of ethnomedically important medicinal plants on tribal/traditional knowledge through molecular pharmacological approach	Ethnopharmacology & Ethnomedicine
4	P-004	Development and Upkeep of Germplasm Conservatories and Landscapes & Dissemination of Botanical knowledge	Garden Management, Education, Information and Training.
5	P-005	Survey, Inventory, Bioprospecting and Sustainable Utilization of Microbial & Lichen Diversity of Western Ghats.	Microbiology
6	P-006	Community Agro Biotech Resource Centre (CARC)	Microbiology
7	P-007	Sustainable utilization of medicinal, aromatic and other potential economic plants of the Kerala region of Western Ghats through phytochemical and pharmacological means	Phytochemistry & Phytopharmacology
8	P-008	Germplasm Conservation, Conventional & Non-Conventional Multiplication, Maintenance and Sustainable Utilization of Medicinal, Aromatic, Orchid, Anthurium,	Plant Genetic Resource

		Bamboo and Crop Related plants from Western Ghats and Andaman /Nicobar Islands.	
9	P-009	Survey, Exploration and Documentation of Floristic wealth of Kerala & Assessment of Ecosystem Services	Plant Systematics & Evolutionary Science
10	P-10	Inventory, documentation and phylogenetic studies of mushrooms of Western Ghats & Establishment of a regional reference centre for mushrooms	Plant Systematics & Evolutionary Science
11	P-11	Establishment of STEC-JNTBGRI as a nodal Centre for multidisciplinary research, production, and supply of quality seeds, large scale cultivation of high value ornamental plants and human resource development	Biotechnology & Bioinformatics
12	P-12	Integrated R&D Centre of JNTBGRI – An extension of the Screw pine Tissue culture project at Kuzhur, Kodungalloor	Biotechnology & Bioinformatics
13	P-13	Improvement of Existing Landscape and Field Gene Bank	JNTBGRI
14	P-14	Central Instrumentation Facility	JNTBGRI
15	P-15	JNTBGRI Infrastructure Programmes	JNTBGRI
16	P-16	Development of a comprehensive database on achievements of JNTBGRI Bioinformatics	Biotechnology & Bioinformatics

## EXTERNALLY FUNDED PROGRAMMES

No.	Project Code	Title of the project	Principal Investigator
1	A-19	Establishment of Sub-Distributed Information centre at TBGRI under Bioinformatics Programme	Dr. S. Sreekumar
2	A-113	Development of Tissue Culture Protocol for mass propagation of selected Screw pine ( <i>Pandanus</i> spp.) plants leading to technology transfer and establishment of tissue culture facility at KIDS	Dr. K. Satheeshkumar
3	A-114	Systematic documentation of Traditional Knowledge Related to plants used for Food and Medicine from the Oral Tradition	Dr. Vinodkumar T.G. Nair
4	A-168	Production and Supply of Quality Seedlings of selected 10 Medicinal Plants	Dr. Mathew Dan
5	A-176	Identification of Potential Chemical Marker Compounds and Biological Studies of <i>Gloriosasuperba</i> and their Geographical Variations	Dr. S.R. Suja
6	A-193A2	Ecology and Conservation of Fresh water Swamp Ecosystems of the Western Ghats-Kerala Region	Dr. M. Rajendra Prasad
7	A-193A3	Comparative Biogeography of Plants of the Western Ghats	Dr. N. Mohanan
8	A-193B1	Identification of the elite lines of <i>Centella asiatica</i> and <i>Bacopa monnieri</i> for commercially significant constituents for standardization of their extracts.	Dr. B. Sabulal
9	A-193B2	Bioprospecting of two coded anti-diabetic medicinal plants based on ethnomedical leads with special reference to diabetic complications. A molecular Pharmacological Approach	Dr. S.R. Suja
10	A-193B4	Antiviral from medicinal plants of Western Ghats selected based on Traditional Knowledge/Ethnomedical information	Dr. S.R. Suja
11	A-193B5	Characterization, recombinant expression process scale up and validation of selected hydrolases from native action-bacteria for commercial exploitation	Dr. S. Shiburaj
12	A-203	Genetic Diversity Conservation and	Dr. S. William

		Population Study of Selected Notified Endangered Plant Species of Western Ghats Region of Kerala	Decruse
13	A-219	Establishment of a Herbal Garden at Raj Bhavan	Dr. Mathew Dan
14	A-222	Development of Lakeshore Leisure Trail Landscape, JNTBGRI, to enhance the aesthetics of the Garden	Dr. R. Raj Vikraman
15	A-225	Cultivation, Conservation and Sustainable Utilization of Medicinal Plants Through the Participation of Unemployment Women Folks	Dr. S. Binu
16	A-229	Biotransformation of saponins to diosgenin for enhanced yield from <i>Dioscorea</i> sp. using indigenous fungal strains	Dr. S.R. Reji
17	A-231	Training on Familiarization and Propagation of Medicinal Plants	Dr. Mathew Dan
18	A-233	Effect of selected nanoparticles synthesized from plant secondary metabolite on seizures induced by kainic acid in mice	Dr. V. Gayathri
19	A-241	DBT Fellowship	Ms. Soumya S. Dharan
20	A-242	CSIR Fellowship	Ms. S. Nusrin
21	A-248	CSIR studentship programme	Ms. Divya S. Pillai
22	A-249	Solvent tolerant protease from <i>Exiguobacterium</i> sp. TBG-PICH01: Cost effective Bioprocess Development and Functional Characterization for Industrial Applications	Dr. S. Shiburaj
23	A-250	Exploration of Banana Biodiversity and its Biotechnological Research in Nagaland	Dr. K.K. Sabu
24	A-254	Process Optimization and Scale up of Tannase from Marina Fungi and Evaluation of its Application in the Production of Value-Added Products from Cashew Apple	Dr. S. Shiburaj
25	A-255	Green Skill Development Programme (GSDP) – Entrusting the Certificate Course on Plant Tissue Culture Techniques and its Applications	Dr. K.K. Sabu
26	A-257	Phytochemical profiling of the aromatic Cyperaceae members of South India	Dr. K.B. Rameshkumar
27	A-258	Population Structure and Genetic Variability Analysis of <i>Cullenia exarillata</i> populations	Dr. K.K. Sabu

		in Western Ghats	
28	A-259	Analysis of genetic diversity, development of sex-linked SCAR markers and marker assisted selection of Aisan Palmyra palm ( <i>Borassus flabellifer</i> L., Arecaceae)	Dr. K.K. Sabu
29	A-260	Sustainable utilization of the seeds of <i>Garcinia</i> species from the Western Ghats	Dr. M. Priya Rani
30	A-261	Biological Diversity awareness through setting up a butterfly garden in JNTBGRI (KSCSTE)	Dr. S. Anilkumar
31	A-266	ICMR Studentship programme of Reshmi Nair R.J.	Mrs. R.J. Reshmi Nair
32	A-268	ICMR Studentship programme of Vini C. Sekhar	Mrs. Vini C. Sekhar
33	A-269	Taxonomic Revision and phylogeny of the genus <i>Piper</i> L. (Piperaceae) in India with its Biogeography	Dr. Mathew Dan
34	A-271	Conservation of Endemic and critically endangered <i>Buchanania barberi</i> in India	Dr. Anurag Dhyani
35	A-272	KSCSTE Studentship programme of Mrs. Aswathy Anand	Mrs. Aswathy Anand
36	A-274	Back to Lab Programme: Molecular phylogeny of Meliolaceous fungi of Kerala	Mrs. S.S. Dhanusha
37	A-275	Development of Database Application Tool and Digitization of botanical herbarium specimens (University of Kerala)	Dr. S. Sreekumar
38	A-276	M.Sc. Integrated Biotechnology students	Director, JNTBGRI
39	A-278	Population Biology of <i>Humboldtia unijuga</i> var. <i>trijuga</i> , an endemic and endangered tree species of the southern Western Ghats and its conservation	Dr. P.S. Jothish
40	A-279	Travel grant to Mr. Nandu T.G., SRF for the tour conducted to Sri Lanka	Mr. T.G. Nandu
41	A-280	Population Dynamics and agroecology of <i>Trichopus zeylanicus</i> Gaertn. subsp. <i>travancoricus</i> (Bedd.) Burkill ex Narayanan 'Árogyappacha'	Dr. C. Anilkumar
42	A-281	DST INSPIRE Fellowship of Mrs. Aswathy, J.	Mrs. J. Aswathy
43	A-282	The production of 50000 seedlings of <i>Tinospora cordifolia</i> as a part of Nation-wide campaign on 'Amrita for Life'	Dr. Mathew Dan
44	A-283	Conservation vulnerable sandalwood	Dr. Anurag Dhayni

		( <i>Santalum album</i> L.) through propagation and reintroduction.	
45	A-284	Landscaping and gardening in the G.V. Raja Sports School, Mylom (Directorate of Sports & Youth Affairs, Govt. of Kerala).	Dr. S. Sreekumar
46	A-285	Certificate Course on Quality Planting Material Producer to KSCSTE-JNTBGRI, Palode	Dr. Mathew Dan
47	A-286	Certificate Course on Plant Tissue Culture Techniques and its Applications to KSCSTE-JNTBGRI, Palode	Dr. K. K. Sabu
48	A-287	Central Instrumentation Facility, Internship, training, workshop etc.	Dr. K. K. Sabu & Dr. K. B. Rameshkumar
49	A-288	Development of Controlled Release Formulation of Eco-friendly Pesticides in Stored Pest Management	Dr. V. Gayathri
50	A-290	Establishment of Biodiversity Park at Block Panchayat Premises, Chirayinkeezhu, Thiruvananthapuram (Chirayinkeezhu Block Panchayat)	Dr. R. Raj Vikraman
51	A-292	Conservation of Orchids – Setting up of Orchidarium and Orchid Interpretation Centre at Eravikulam National Park (UNDP)	Dr. Mathew Dan
52	A-293	Search for Potential Biologically Active Constituents from the Indian Pitcher Plant, <i>Nepenthes khasiana</i> .	Dr. B. Sabulal
53	A-294	Three days training for selected unemployed women on familiarization and methods of cultivation of selected economically important medicinal plants.	Dr. S. William Decruse
54	A-295	One year student project programme	Dr. S.R. Suja
55	A-296	Eco-restoration and sustainable development of Poredam, Mahadevar Temple's sacred grove at Chadayamangalam, Kollam (KSBB).	Director, JNTBGRI
56	A-297	Best paper award project	Dr. A.L. Aneesh Kumar
57	A-298	Establishment of Bamboo Craft Centre at JNTBGRI (Kerala State Bamboo Mission)	Dr. Mathew Dan
58	A-299	Establishment of Bamboo Tissue Culture Unit and expansion of Bamboo Conservatory at JNTBGRI campus (Kerala State Bamboo Mission).	Dr. Mathew Dan

59	A-300	Establishment of Bio-park in Kukkirippara (Maranalloor Panchayat), Thiruvananthapuram District (KSBB).	Dr. R. Raj Vikraman
60	A-301	Preparation of Red Data Book and Assessment of Threatened Species of Kerala	Dr.Nazarudeen Ahammed
61	A-302	Chemical Profiling of cardamom essential oils	Dr. B. Sabulal
62	A-303	Eco Tourism at Jawaharlal Nehru Tropical Botanical Garden and research Institute, Palode, Thiruvananthapuram	Director, JNTBGRI
63	A-304	Beautification of Virology campus	Dr. R. Raj Vikraman
64	A-305	Pumba river biodiversity conservation	Dr. E.S. Santhosh Kumar
65	A-306	The livelihood enhancement of the tribal of Njaraneely ward for Peringammala Panchayat, Thiruvananthapuram district, Kerala through plant enrichment buy back and herbal products development (DST, Govt of India).	Dr. S. Binu
66	A-307	Ex-situ conservation of five critically endangered plants of the Western Ghats, India.	Dr. Anurag Dhani
67	A-308	Species distribution modelling and bioprospecting of wild germplasm of Salacia species (high-value antidiabetic plants) across the Western Ghats (National Medicinal Plant Board (NMPB), Ministry of Ayush, Govt. of India).	Dr. R.K. Radha
68	A-309	Micropropagation and cultivation of native orchids and hybrids for on-farm conservation and income generation in Kerala through cluster formation.	Dr. Prakash Kumar
69	A-310	Establishment of a biorepository of the plants in the Southern Western Ghats of India with particular emphasis on endemics (BGCI GGI Gardens Award Programme)	Dr. R. Prakash Kumar
70	A-311	Erudite public lecture	Dr. R. Prakash Kumar
71	A-312	CSIR Fellowship – Ms. Arya	Ms. C.P. Arya
72	A-313	Establishing a Butterfly Garden at Aashramam Biodiversity Centre, Kollam	Dr. S. Anilkumar
73	A-314	CSIR, Fellowship Mr. Muhammed Ali	Mr. Muhammed Ali
74	A-315	Reverse the Red: Assessing the population	Dr. Deepu Sivadas

		trends and developing recovery programme for two <i>Cinnamomum</i> species endemic to the Western Ghats.	
75	A-316	Nutritional analysis and development of nutraceuticals/ food supplements based on Arogyapacha: an ethnomedically important plant	Mrs. Angala Mathew
76	A-317	GSDP	Dr. R. Raj Vikraman
77	A-318	Development of propagation techniques and establishment of nurseries for indigenous RET plants and species notified under Biological Diversity Act and promoting cultivation with the support of research organizations, Kudumbasree and MNREGS.	Dr. A. Nazarudeen
78	A-319	National seminar	Dr. K. B. Rameshkumar
79	A-320	INSA Fellowship	Dr. Anurag Dhyani
80	A- 321	Habitat distribution modelling and reinforcement of two threatened trees in Kerala region of the Western Ghats for the improvement of their conservation status (MoEFCC), Govt. of India)	Dr. R.K. Radha
81	A-322	Inventory Systematics and conservation of <i>Ixora</i> L. (Rubiacea) of Kerala (Kerala Forest Department).	Dr. G. Rajkumar & Dr. A. Nazarudeen
82	A-323	Tri party action plan for the reintroduction of Red Plants of Kerala	Dr. C. Anilkumar
83	A-324	Open house	Dr. K. B. Rameshkumar
84	A-325	SHRESTA	Director, JNTBGRI
85	A-326	National workshop	Dr. C.K. Pradeep
86	A-327	Green Kerala Initiative (KSCSTE)	Director, JNTBGRI
87	A-328	Course fee for M.Sc. Biotechnology students	Dr. K. K. Sabu
88	A-329	Course fee for M.Sc. Biotechnology students	Dr. K. K. Sabu
89	A-330	Establishment of a green ambience at the Institute of Advanced Virology IAV campus, Thonnakkal (IAV, Govt. of Kerala).	Dr. S. Sreekumar
90	A-331	Evaluation and Characterization of Antimicrobial Potential of Wild Edible Mushrooms of Kerala (KSCSTE)	Dr. C. K. Pradeep
91	A-332	New Phytologist Foundation to Support the Research and teaching	Dr. Anuraj Dhyani
92	A-333	Cardamom for rainforest conservation	Dr. K. K. Sabu

		(Kerala Forest Development Fund (KFDF), Forest Department, Govt of Kerala)	
93	A-334	Identification, creation of database, propagation, conservation and value addition of wild and underutilized edible varieties of leafy vegetables, tubers, fruits, pulses, edible mushrooms etc	Dr. A. Nazarudeen
94	A-335	Documentation, Database and Conservation of Edible Mushroom Resource of Kerala (KSBB)	Dr. C. K. Pradeep
95	A-336	Database on anti-viral plants with emphasize on nutraceuticals <i>in silico</i> validation of photochemicals and formulation of a herbal product	Dr. S. Sreekumar
96	A-337	Conservation, eco restoration and popularization of three endemic and threatened tree species of Kerala (Kerala Forest Department).	Dr. A. K. Sreekala
97	A-338	Survey and documentation of Folk use of plants used by the Kani tribes of Kerala part of Agasthyamala Bioserve with emphasis on NWFPA based livelihood aspects (Kerala Forest Department).	Dr. G. Rajkumar & Dr. A. Nazarudeen
98	A-339	Building a Biorepository of Western Ghats Medicinal and Aromatic Plants (GGI-BGCI, UK).	Dr. Mathew Dan
99	A-344	Preparation of a monograph on selected medicinal plants used as Substitutes / Adulterants in Ayurveda with special reference to <i>Mesua ferrea</i> L: An Integrated Pharmacognostic, Phytochemical and Pharmacological Approach (NMPB, Ministry of AYUSH, Govt. of India).	Dr. Suja S R
100	A-351	Biotechnological interventions for defensible conservation and restoration of <i>Dialium travancoricum</i> Bourd., a Critically Endangered Endemic Tree of the Southern Western Ghats (SERB, DST, Govt. of India).	Dr. Radha, R. K.
101	A....	Implementation of Special Purpose Planting	Dr Radha RK

		in the selected natural habitats of the VSSC Campus as part of the Environmental Conservation & Clearance Committee (VSSC, ISRO, Govt. of India).	
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## RESEARCH COUNCIL

SN	NAME & DESIGNATION	POSITION
1	Dr. Balakrishnan Pisupathy Former Chairman, NBA Vice Chancellor, Trans Disciplinary University, Bangalore	Chairman
2	Prof. Aravind M Lali Professor & Head Centre of Energy Bioscience Institute of Chemical Technology Nathalal Parekh Marg, Matunga, Mumbai-400019	Member
3	Dr. Mohammed Aslam Senior Advisor Department of Biotechnology Ministry of Science & Technology 6-8 <sup>th</sup> Floor, Block 2, CGO Complex, Lodhi Road New Delhi - 110003	Member
4	Dr. Madhmitha Biswas Director Ministry of Environment, Forest & Climate Change Indira Paryavaran Bhavan, Jorbagh Road, New Delhi - 110003	Member
5	Prof. M. Sabu Department o Botany University of Calicut Malappuram District Calicut University P.O. Pin. 673635, Kerala	Member
6	Dr. N. Anil Kumar Director M. S. Swaminathan Research Foundation Community Agro Biodiversity Centre Puthoorvayal P.O. Meppadi, Wayanad Pin- 673577, Kerala	Member
7	Dr. S. Pradeep Kumar Member Secretary Kerala Sate Council for Science Technology and Environment, Government of Kerala Sasthra Bhavan, Pattom P.O., Thiruvananthapuram-695004	Permanent Invitee

6	Dr. R. Prakashkumar, Director Jawaharlal Nehru Tropical Botanic Garden & Research Institute, Palode, Thiruvananthapuram - 695562	Member Convener
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### MANAGEMENT COMMITTEE

SN	NAME & DESIGNATION	POSITION
1	Dr. R. Prakashkumar, Director, JNTBGRI	Chairman
2	Dr. S. Pradeep Kumar, Member Secretary, KSCSTE	Member
3	Dr. Syam Viswanath, Director, KFRI	Member
4	Dr. B. Sabulal, Senior Principal Scientist, JNTBGRI	Member
5	Mr. Madhu, Additional Secretary, Science & Technology Department	Member
6	Mr. P. Ashok Kumar, Registrar, JNTBGRI	Member Convener

### STAFF LIST

SN	NAME	DESIGNATION
1	Dr. R. Prakash Kumar	Director (Rtd. On 31-07-2022)
	Dr. B. Sabulal (HoD, Phytochemistry)	Director (i/c after 31-07-2022)
<b>Garden Management, Education, Information &amp; training Division</b>		
2	Dr. R. Raj Vikraman	Principal Scientist & Head
3	Dr. A. A. Prasannakumari	Scientist
4	Mr. V. Premkumar	Public Relations Officer
5	Dr. Raju Antony	Technical Officer Gr. III
6	Dr. Joemon Jacob	Technical Officer Gr. IV
7	Mr. S. Muhammed Shareef	Technical Officer Gr. IV
8	Dr. E. S. Santhosh Kumar	Technical Officer Gr. III

9	Dr. T. Sabu	Technical Officer Gr. III
10	Dr. K. J. Lathan Kumar	Technical Officer Gr. III
11	Dr. A. Hussain	Technical Officer Gr. III
12	Mr. K. S. Kalesh	Technical Officer Gr. II
13	Mr. B. Harilalkumar	Gardener Gr. IV
14	Mr. K. Vijayakumar	Gardener Gr. IV
15	Mr. K. Anilkumar	Gardener Gr. IV
16	Mr. J. Rajan	Gardener Gr. IV
17	Mr. V. Satheesan	Gardener Gr. III
18	Mr. M. Shajahan	Gardener Gr. IV
19	Mr. R. Lalan	Gardener Gr. I
20	Mr. R. Suresh Kumar	Gardener Gr. III
21	Mr. P. Babu	Gardener Gr. III
22	Mr. D. Udaya Kumar	Gardener Gr. III
23	Mr. N. Pradeep	Gardener Gr. III
24	Mr. P. S. Hanikumar	Label Writer
25	Mr. A. Ullas	Gardener Gr. I
26	Mr. S. Shafeerkhan	Photocopy Operator Gr. I
<b>Plant Genetic Resources Division</b>		
27	Dr. Mathew Dan	Principal Scientist & Head
28	Dr. Sam P. Mathew	Senior Scientist (Rtd.on 30-06-2022)
29	Dr. M. Abdul Jabbar	Technical Officer Gr. III
30	Dr. M. Saleem	Technical Officer Gr. III
31	Dr. B. Gopakumar	Technical Officer Gr. IV
32	Dr. B. J. Radhika	Technical Officer Gr. IV
33	Mr. M. K. Sreekumaran	Technical Officer Gr. II
34	Mr. B. Jayakumar	Garden Maestri Gr. II
35	Mr. G. Manoharan	Gardener Gr. IV
36	Mr. S. Ajayakumar	Gardener Gr. IV
37	Mr. K. Ashok Kumar	Gardener Gr. IV
38	Mr. B. Jayalalkumar	Gardener Gr. IV
39	Mr. S. Thulaseedharan	Gardener Gr. IV

40	Mr. K. Asokachandran Nair	Gardener Gr. IV
41	Mr. G. Sudarsana Kurup	Gardener Gr. III
42	Mr. A. K. Azeem	Gardener Gr. III
43	Mrs. T. Mini Thomas	Gardener Gr. I
<b>Biotechnology and Bioinformatics Division</b>		
44	Dr. S. William Decruse	Principal Scientist & Head
45	Dr. S. Sreekumar	Principal Scientist
46	Dr. K. K. Sabu	Principal Scientist
47	Dr. C. K. Biju	Principal Scientist
48	Dr. R. K. Radha	Senior Scientist
49	Dr. M. Raveendran	Scientist
50	Dr. S. Shailaja Kumary	Technical Officer Gr. II
51	Mrs. V. S. Sindhu	Lab Attendant Gr. IV
52	Mrs. S. Syamala Kumary	Lab Attendant Gr. IV
53	Mrs. S. Kanakasundaram	Lab Attendant Gr. IV
54	Mr. B. Chandran	Gardener Gr. III
55	Mr. M. Vijayan	Gardener Gr. III
56	Mr. R. Anil Kumar	Gardener Gr. III
57	Mr. M. Shajahan	Gardener Gr. III
58	Mr. G. S. Madhusoodhanan Asary	Office Attendant Gr. III
59	Mrs. R. Sreekumari	Gardener Gr. I
<b>Conservation Biology Division</b>		
60	Dr. C. Anilkumar	Principal Scientist & Head
61	Dr. A. K. Sreekala	Principal Scientist
62	Mrs. A. Rasiyabeegam	Senior Scientist
63	Dr. Anurag Dhyani	Scientist
64	Mrs. C. R. Chitra	Technical Officer Gr. IV
65	Mr. M. Sibi	Technical Officer Gr. IV
66	Mr. S. Suresh	Technical Officer Gr. III
67	Mrs. S. Bindu	Technical Officer Gr. III
68	Mr. G. Madhu	Gardener Gr. III
<b>Ethnomedicine &amp; Ethnopharmacology Division</b>		

69	Dr. S. R. Suja	Principal Scientist & Head
70	Dr. K. Radhakrishnan	Senior Scientist (Rtd on 31-07-2021)
71	Dr. Vinod Kumar T. G. Nair	Senior Scientist
72	Dr. M. Navas	Technical Officer Gr. IV
73	Mr. S. Radhakrishna Pillai	Technical Assistant
74	Mr. G. Anilkumar	Lab Attendant Gr. IV
<b>Phytochemistry &amp; Pharmacology Division</b>		
75	Dr. B. Sabulal	Senior Principal Scientist & Head
76	Dr. K. B. Rameshkumar	Principal Scientist
77	Dr. V. Gayathri	Senior Scientist
78	Dr. Anil John	Technical Officer Gr. III
79	Dr. S. Ajikumaran Nair	Technical Officer Gr. III
80	Dr. S. R. Rajani Kurup	Technical Officer Gr. III
81	Mr. G. Santhoshkumar	Technical Assistant
82	Mrs. P. Sasikala	Lab Attendant Gr. IV
83	Mrs. A. Leela	Office Attendant Gr. III
<b>Plant Systematics &amp; Evolutionary Science Division</b>		
84	Dr. G. Rajkumar	Principal Scientist & Head
85	Dr. M. Rajendraprasad	Principal Scientist
86	Dr. A. Nazarudeen	Senior Scientist
87	Dr. T. Shaju	Senior Scientist
88	Dr. Dhruvan Thandyekkal	Scientist (Rtd. On 31-07-2022)
89	Dr. V. S. Usha	Herbarium Asst. Gr. III
90	Dr. M. P. Geethakumary	Technical Officer Gr. IV
91	Dr. K. P. Deepthi Kumary	Technical Officer Gr. III
92	Dr. G. Thulasidas	Technical Officer Gr. III
93	Mr. R. Thulaseedharan Nair	Gardener Gr. III
<b>Microbiology Division</b>		
94	Dr. N. S. Pradeep	Principal Scientist & Head (Trnsf. on 28-02-2022)
95	Dr. C. K. Pradeep	Principal Scientist
96	Dr. Vipin Mohan Dan	Scientist

97	Dr. H. Biju	Technical Officer Gr. III
98	Dr. A. Sabeena	Technical Officer Gr. III
99	Mrs. S. Sheeja	Office Attendant Gr. I
<b>CARC Programme</b>		
100	Dr. S. Binu	Principal Scientist
<b>Library and Information Centre</b>		
101	Mrs. V. Leena Kumary	Office Attendant Gr. II
102	Mr. C. R. Vinu Krishnan	Office Attendant Gr. II
<b>Administrative Staff</b>		
103	Mr. M. Anilkumar	Sect. Officer Gr. I
104	Mrs. R. Subha Sankar	Computer Operator Grade III
105	Mrs. R. Sofia	Assistant Grade II
106	Mrs. S. Sudha	Assistant Grade I
107	Mr. Vishnu P.S.	Assistant Grade I
108	Mr. K. P. Eliyas	Store Assistant Gr. II
109	Mr. K. Mohammed Habeebulla	Typist/ Data Entry Operator Gr. III
110	Mr. B. R. Dinesh	Record Keeper Gr. II
111	Mr. G. Murukesan Nair	Driver Gr. I
112	Mr. S. Sanalkumar	Driver Gr. I
113	Mr. N. Hariprasad	Driver Gr. I
114	Mr. Balachandran	Driver Gr. I
115	Mrs. K. S. Bindu	Office Attendant Gr. II
116	Mrs. J. Anithakumari	Office Attendant Gr. I
<b>Engineering Section</b>		
117	Mr. S. Ajith	Assistant Work Supervisor Gr. IV
118	Mr. V. S. Sureshkumar	Technical Assistant Gr. IV
119	Mr. P. Ajithkumar	Technical Assi. (Electrical) Gr. IV
120	Mrs. M. R. Geetha	Technical Assistant
121	Mr. G. Ajayakumar	PABX Operator Gr. II
122	Mrs. K. Lalikutty	Sweeper Gr. III
<b>Security Section</b>		
123	Mr. S. Vikraman Nair	Security Guard Gr. I

124	Mr. C. Sureshkumaran Asari	Security Guard Gr. I
125	Mr. R. Prasannakumar	Security Guard Gr. I
126	Mr. R. Nagappan	Security Guard Gr. I
127	Mr. G. Anilkumar	Security Guard Gr. I

**List of staff retired/ departed/ left by VRS in the report period (2022-2023)**

1	Sri. K. Vijayan	Section Officer Gr. I	Departed 30-06-2022
2	Sri. Jayakumar C.	Security Guard Gr. I	30-04-2022
3	Sri. L. Thulaseedharan	Gardener Gr. III	30-04-2022
4	Sri. Devaraj P.	Security Guard Gr. I	31-05-2022
5	Dr. Sam P. Mathew	Senior Scientist	30-06-2022
6	Sri. Ashokkumar G.	Security Guard Gr. I	30-06-2022
7	Smt. Shyladevi P.S.	Typist Gr. III	30-06-2022
8	Dr. R. Prakashkumar	Director	31.07.2022
9	Dr. Dhruvan Thandyekkal	Scientist	31-07-2022
10	Sri. V. Sudheeshkumar	Driver Gr. IV	31-07-2022
11	Smt. B. S. Ajanthakumary	Assistant Gr. III	VRS
12	Smt. R. Prasannakumary	Stenographer Gr. IV	31-01-2023

# EXPENDITURE STATEMENT

Palode, Thiruvananthapuram  
 (A Unit of Kerala Council For Science, Technology and Environment of Govt of Kerala)  
**Income and Expenditure Account for the year ended 31st March, 2023**

Expenditure	Sch no.	Year Ended		Income	Sch no.	Year Ended	
		31 March 2023	31 March 2022			31 March 2023	31 March 2022
To Research & Development Expenses(Plan)	9	4,50,17,668	4,54,39,966	By Grant From Govt of Kerala Reckoned	13	19,85,95,210	25,61,91,461
To Salaries and Allowances (Non Plan)	10	16,48,47,966	21,75,93,846	By Other Receipts	14	1,20,91,483	70,84,301
To Administrative Expenses (Non Plan)	11	8,21,070	7,60,423	By Interest from Banks		-	5,18,451
To Expenditure to External Projects	12	1,72,53,127	1,25,03,082	By External Projects			
To Depreciation				Grant for External Projects Reckoned	15	1,63,19,907	1,12,32,531
Institute	5A	89,34,249	89,34,249	Other Receipts-External Projects	16	9,33,220	1,78,881
External Projects	5B	86,13,050	86,13,050	Interest from Banks-External Projects			
<b>TOTAL</b>		<b>24,54,87,130</b>	<b>29,38,44,596</b>	By Depreciation written back		1,75,47,299	10,91,641
				<b>TOTAL</b>		<b>24,54,87,130</b>	<b>29,38,44,596</b>

The accompanying notes form an integral part of the financial statements  
**For Jawaharlal Nehru Tropical Botanic Garden & Research Institute**

In terms of our report attached  
 For Mohan & Mohan Associates  
 Chartered Accountant  
 FRN:002092

*[Signature]*  
 Director

*[Signature]*  
 Finance officer

*[Signature]*  
 Registrar

R Suresh Moha  
 Partner  
 M.No.01339

Place : Thiruvananthapuram  
 Date :

UDIN: 23010398 B4XXJ 7077



# BALANCE SHEET

(A Unit of Kerala State Council for Science, Technology and Environment of Govt. of Kerala)  
 Balance sheet as at 31st March 2023

Liabilities		As at 31 March 2023	As at 31 March 2022	Assets	
Sch No.				Sch No.	
1A	Capital Reserve Institute	6,99,13,635	6,61,31,472	5A	Property, Plant & Equipment Institute
		5,98,05,081	6,51,21,353		
2A	Unspent Balance Institute	(5,73,30,637)	(4,77,08,766)	6A	Current Assets Institute
		2,01,04,814	4,48,45,054		
2C	General Fund	2,40,93,729	2,40,93,729	7A	Loans & Advances Institute
		4,79,03,075	4,79,03,075		
3	Loan Funds	2,09,904	2,09,904	8	Suspense Accounts
		3,00,000	3,00,000		
4A	Current Liabilities Institute	4,23,291	4,23,291		
		3,38,99,229	2,00,17,369		
4B	External Projects	10,81,027	10,01,251		
		25,73,594	25,73,594		
5A	Control Accounts	23,63,850	23,63,850		
		4,36,237	4,36,237		
<b>Total</b>		<b>20,57,76,830</b>	<b>22,77,11,414</b>	<b>Total</b>	

The accompanying notes form an integral part of the financial statements  
 For Jawaharlal Nehru Tropical Botanic Garden & Research Institute

In terms of our report attached.  
 For Mohan & Mohan Associates  
 Chartered Accountants  
 FRN:002092S

*[Signature]*  
 Registrar

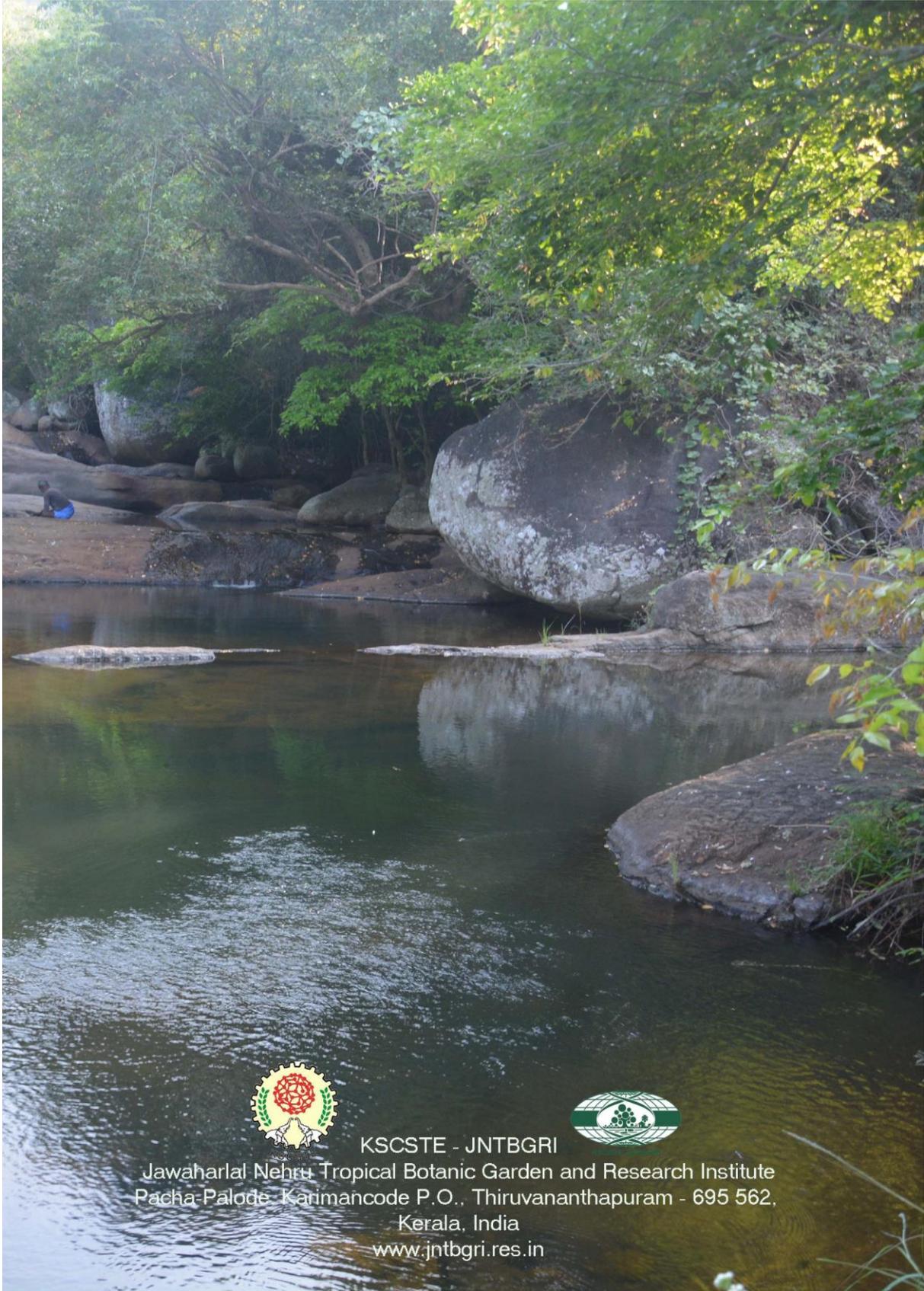
*[Signature]*  
 Finance officer

*[Signature]*  
 Director



UDIN: 2301334866XXXXJ7059

Place : Thiruvananthapuram  
 Dated :



KSCSTE - JNTBGRI

Jawaharlal Nehru Tropical Botanic Garden and Research Institute  
Pacha-Palode, Karimancode P.O., Thiruvananthapuram - 695 562,  
Kerala, India  
[www.jntbgri.res.in](http://www.jntbgri.res.in)