news letter

ncbi Nodal Center for Biological Invasions.
Kerala Forest Research Institute

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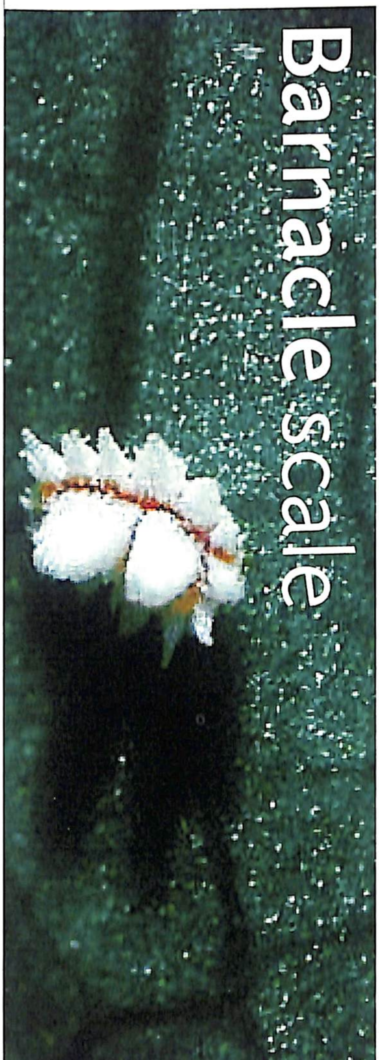
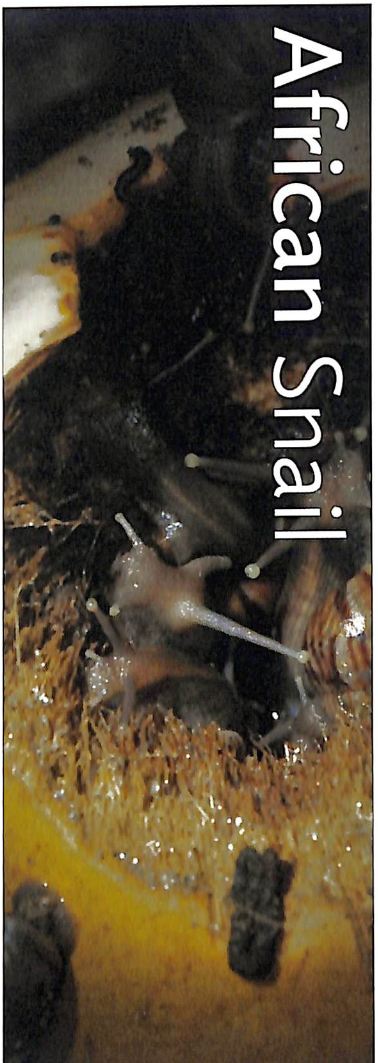
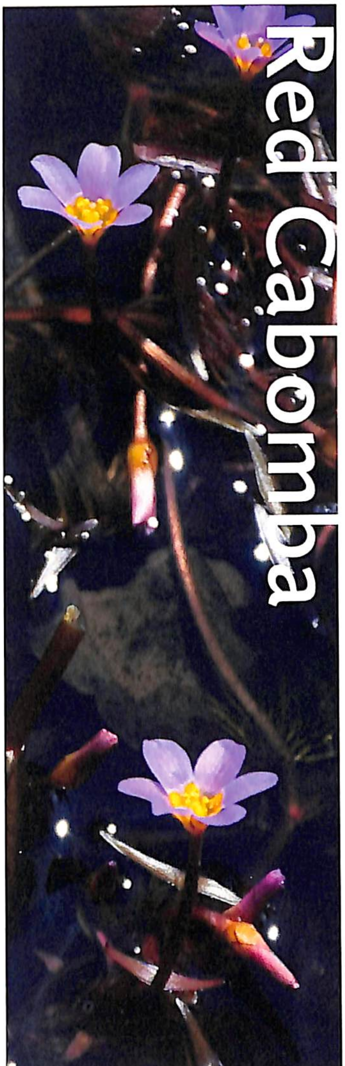






Nodal center for biological invasions was established in February 2018 as a response to increase in the influx of invasive alien species to Kerala and the impact has caused on various habitats and sectors of human activity. There exists a vacuum in governmental agencies addressing the problem of biological invasions which NCBI is filling up. In its brief period of existence, NCBI has attended to plant, insect, snail and turtle invasions in Kerala and has evolved management protocols based on the stage of invasion of each species. NCBI has the following specific objectives : :

- Restoration of alien species invaded landscapes
- Early detection and rapid control of invasions
- Development of policy directives
- Awareness creation among decision makers and general public.

Director's Message

When species move beyond their native boundaries and spread to newer countries, continents and geographic regions, they escape from predator and pathogen pressures and attain a new lease of expansion possibility which threatens the ecology, economy and human health in the sites of arrival. As an institution dedicated to tropical forestry research, the Kerala Forest Research Institute had realized the danger these organisms could pose to the structure and function of forest ecosystems.

Starting from the pioneering work of the former Director of KFRI, Dr KV Sankaran on the spread of the Mile-a-minute weed- *Mikania micrantha*- in Kerala, KFRI has kept biological invasions under close watch. This study was followed up with efforts on its management by adopting classical biological control methods. The first survey of in Kerala recorded 82 invasive alien plants at various stages of spread. Risk assessment of the species using the Nature Serve protocol helped classify these plants for prioritizing management actions.

In February 2018, we launched the Nodal Center for Biological Invasions (NCBI). It was in response to the increasing threat posed by invasive alien species and the situation in which there existed no dedicated agency to address the problems of biological invasions. The launch of NCBI quickly converged the efforts of the critical mass of researchers working on various invading species and brought all their experts together for fast effective management of invasions. It could detect and eradicate the satellite populations of the Wax Scale insect-*Ceroplastes cirripediformis*. This was a perfect demonstration of the Early Detection and Rapid Response (EDRR) procedure in

invasive species management. The standardized management programme for the Giant African Snail *Achatina fulica*- is now being customized for specific local self-governments under NCBI. It could also respond fast to the wild sighting of the Red-eared-slider turtle- a species traded through pet shops. Of particular concerns was the pathogen load of these invasive turtles which could transmit disease to humans. NCBI has responded by collecting turtles from pet owners and maintaining them in rescue centers established at our three field stations of KFRI. We now have more than 150 turtles under study observations and more are on the process of collection. I may now say with certainty that this is a new chapter in invasive species management aided by careful situation analysis, media briefings and judicious pooling in of financial and human resources. The awareness NCBI has created on biological invasions in Kerala and beyond is now being developed into a Citizen Science Program named Invasion watch. This will help people to report invasions, researchers to evolve management methods faster and managers to implement actions before it becomes too late and beyond control.

While leading the management of invasive species in Kerala, KFRI is of the firm conviction that it is not the species per se that is the root cause of invasion. It is the context we create knowingly or unknowingly that kick starts a biological invasion. It is the mistakes we as human beings commit that creates the problem of invasion. Hence for every invasive species, we need to closely look at its political ecology to decipher the invasion pathways and the socio-political reasons behind them so as to develop policy guidelines to help thwart future invasions.

Globally recognized as the second major reason for biodiversity loss - next only to habitat destruction- Biological invasions necessitate focused research, quick response, active management practices, increased awareness and good legislation. NCBI is attempting this.

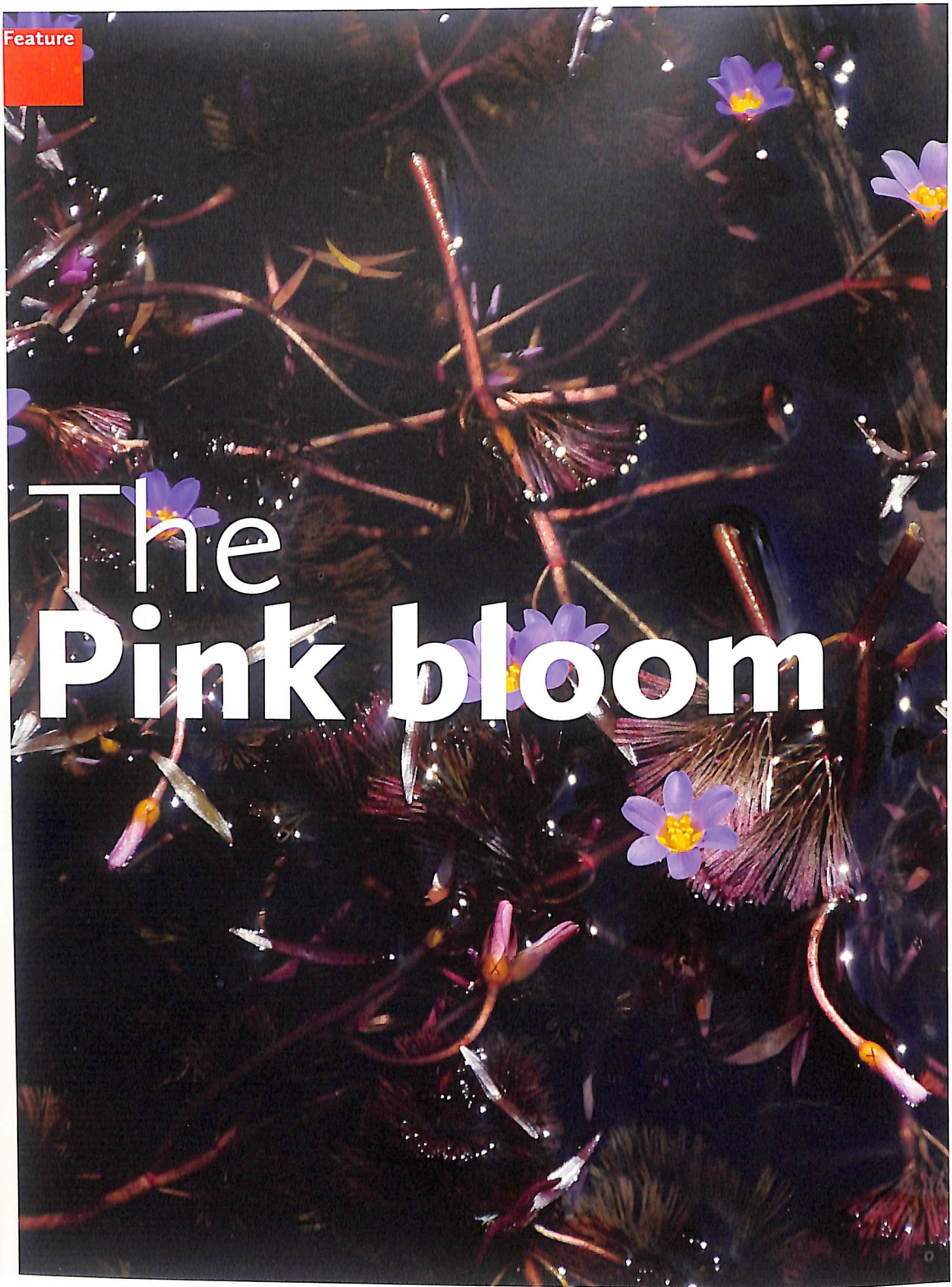
This newsletter will hopefully be the platform where NCBI speaks to the world on its activities. It would also showcase critical research findings from Kerala and elsewhere also and would have stalwarts in the field of Invasion Biology speaking on multifarious aspects of their work. There will be features on specific invasive species in every edition of the newsletter highlighting knowledge gaps and thereby inviting new researchers into the field of biological invasions.

While this newsletter is intended to make the activities of NCBI much more visible we also would like to make it as a platform of interaction and cross fertilization of ideas across researchers, students, landscape managers, policy makers and the general public. We eagerly look forward to your comments and suggestions.

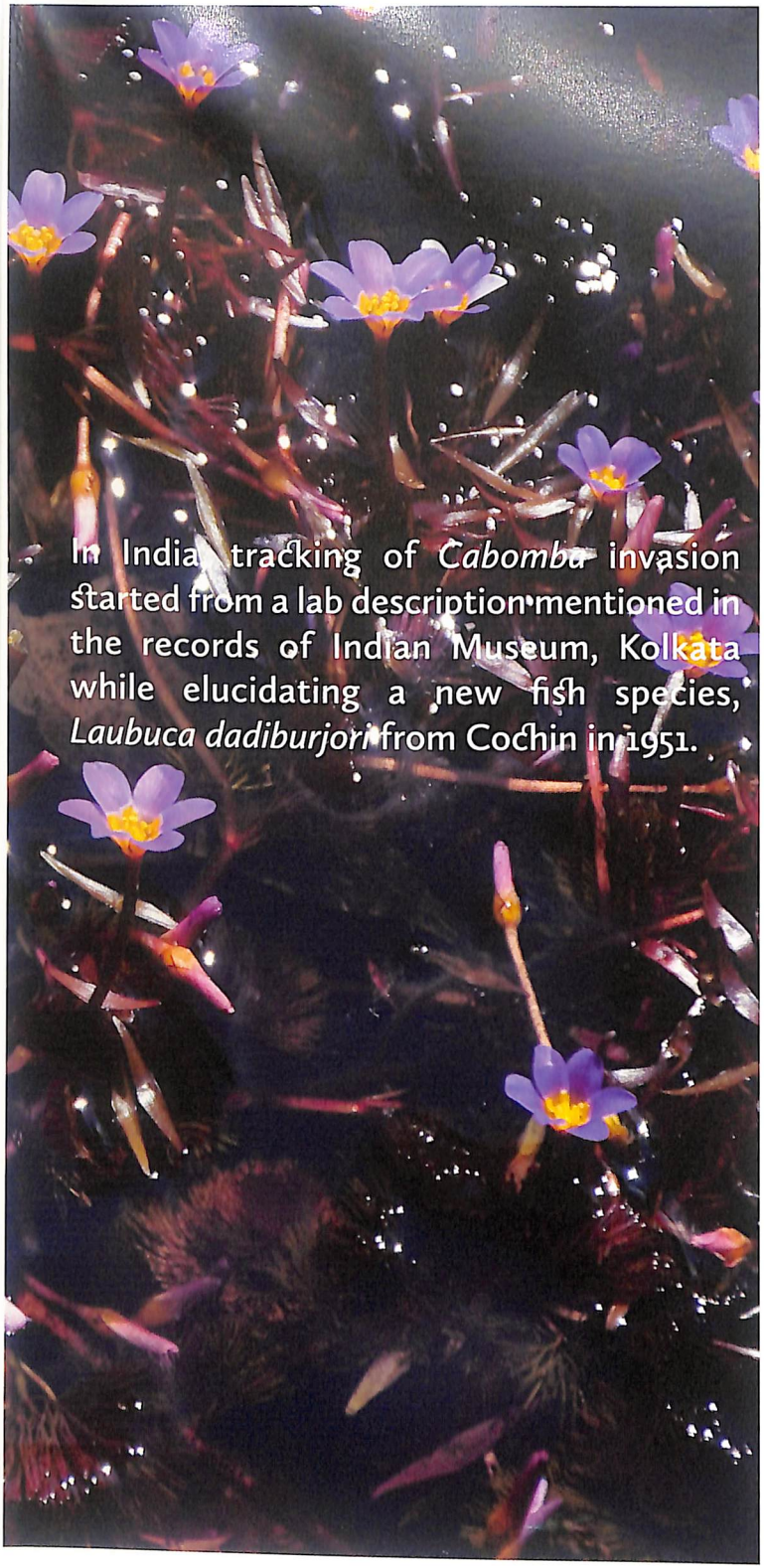
Dr Syam Viswanath
Director
KFRI

KFRI

Feature



The Pink bloom



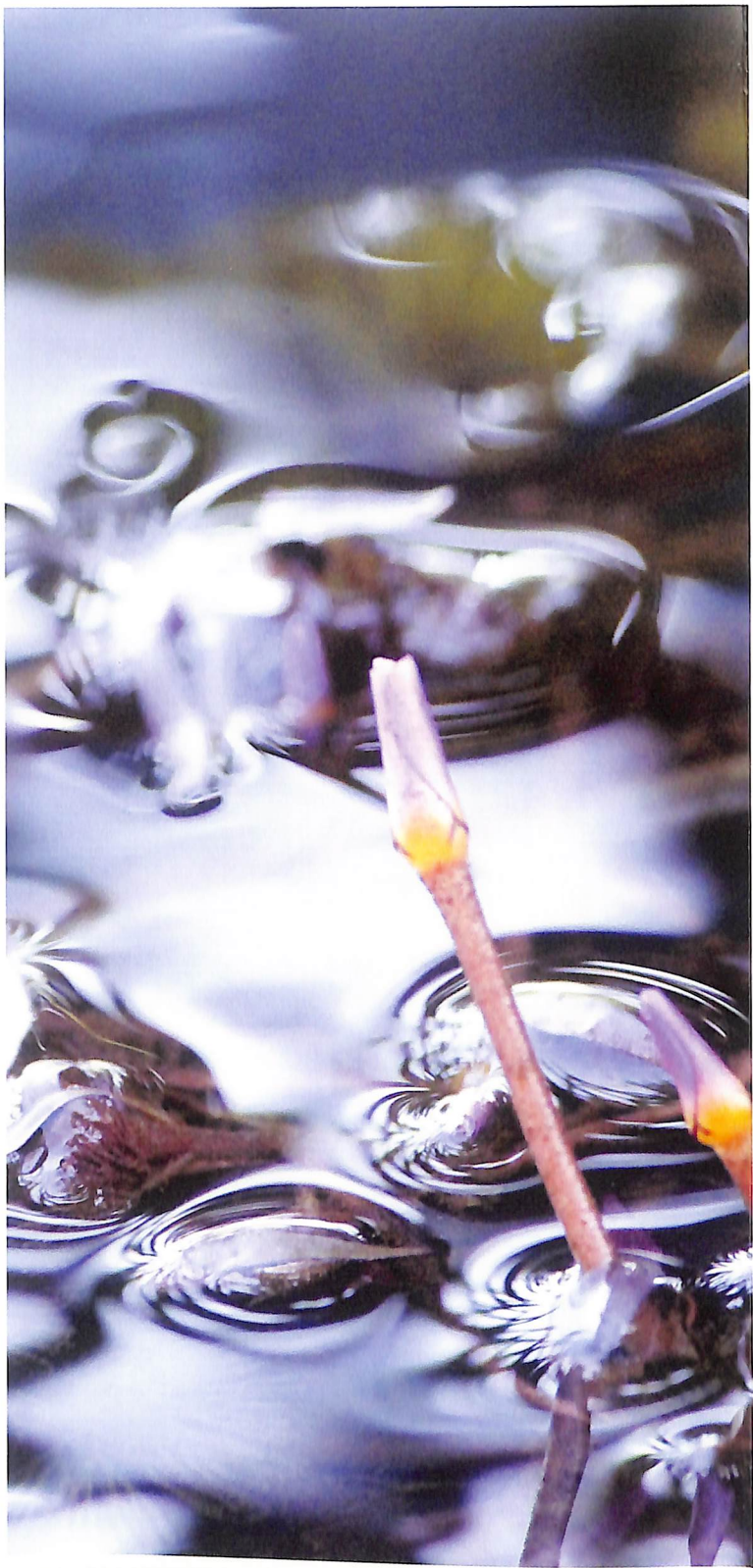
In India tracking of *Cabomba* invasion started from a lab description mentioned in the records of Indian Museum, Kolkata while elucidating a new fish species, *Laubuca dadiburjori* from Cochin in 1951.

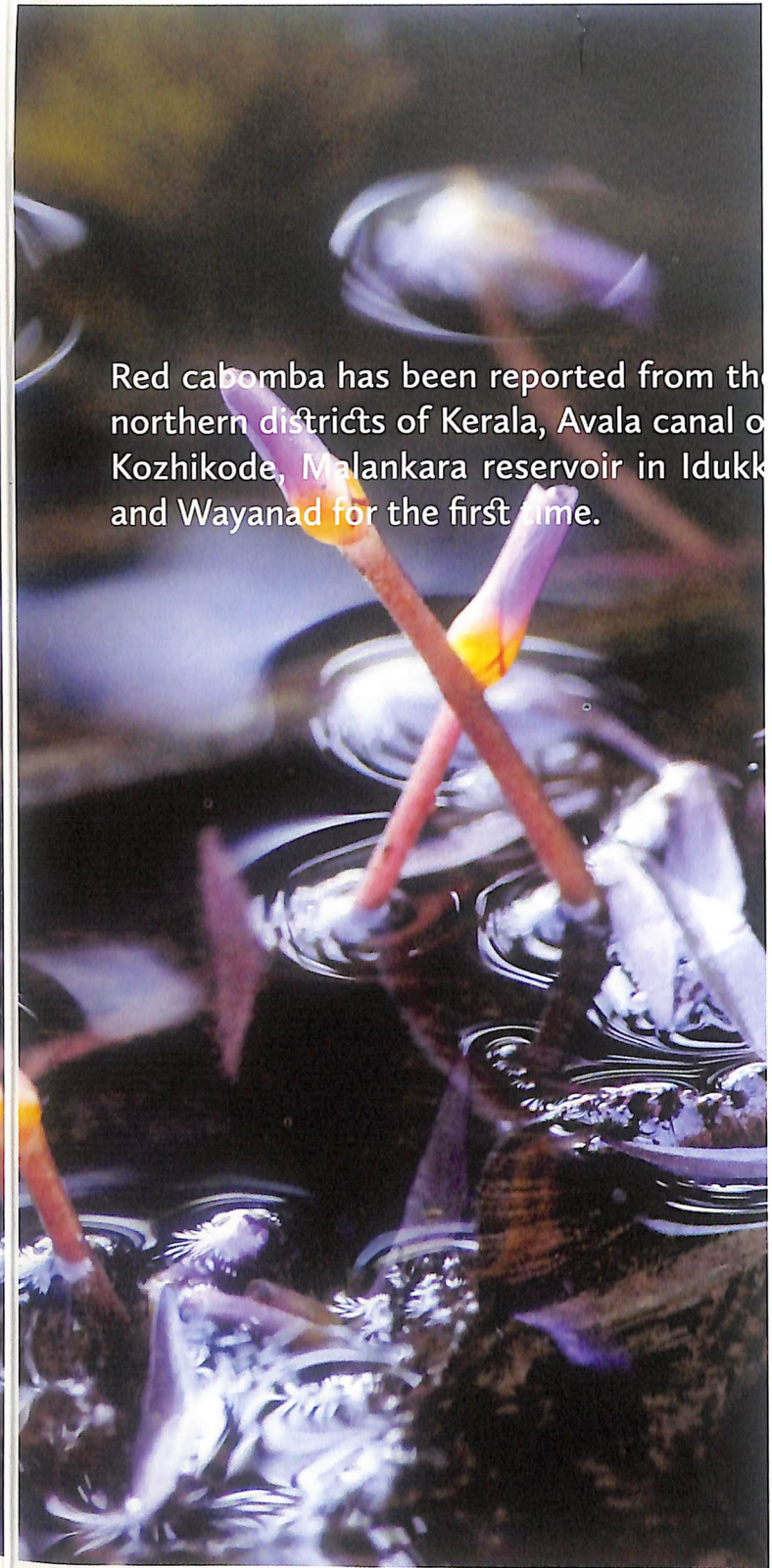
Cabomba furcata from the family of Red Cabomba, the fiercely submerged perennial aquatic invasive plant which is native to Central and South America that turned water bodies into a 'pink mat', became a solemn concern to the environmentalists. This hasty growing species led an aesthetic glimpse but became a potential outspread in the water bodies by active stem propagation which form massive stands of about 12 feet hindering the penetration of light into the water. *Cabomba* was mainly an aquarium plant which caused dispersion and proliferation via global trade outside of its native range prompted inadvertent establishment of *Cabomba* plants stifled economically and ecologically, whereas consumes a huge amount of oxygen and soil nutrients which adversely altered the water quality, indigenous fish varieties and other invertebrates and vertebrates. The species spreads fast by propagating stem fragments and forming dense stands that outnumber native plants in waterbodies and drainage canals.The presence of this species has been recorded from ten out of fourteen districts of Kerala.

The genus *Cabomba* represents

five species; *Cabomba aquatica* *C.caroliniana, C.furcata, C.haynesii* anc *C.palaeformis* in which stems anc nodes are reddish colored ir *C.aquatica, C.furcata* and *C.haynesi* wheres as green in *C.caroliniana* Colour of calyx and corolla are usec to distinguish species morphologically yellow in *C.aquatica*, lilac witl magenta tint in *C.furcata*, White ir *C.caroliniana* and white with ligh lilac shade in *C.haynesii*.

In India, tracking of *Cabomba* invasion started from a lat description mentioned in the records of Indian Museum, Kolkata while elucidating a new fish species *Laubuca dadiburjori* from Cochin ir 1951. Later in 1977 and 1979, the species- *C.caroliniana* found ir Cochin was erroneously identifiec as *C.aquatica*. In 2005 the presence of *Cabomba* was explained in the industrial areas of Cochin including Edayar, Eloor, and Thottumugham In 2010 the spread was well noted ir Kuttanad wetlands of Alleppey district where as the land lies below the sea level and within two years this species invaded River Pamba and Veeyapuram wetlands. A new report of *Cabomba* was outlined ir Aruvikkara Reservoir and the marshy wetlands of Idukki high ranges ir





2015. Suggestions arose with the use of *Cabomba* in transporting the fish species as well as aquarium rearing. Invasion of *Cabomba* in the River Achankovil led to the outbreak in two districts of Kerala. Later the species *C.furcata* has been reported from the northern districts of Kerala, Avala canal of Kozhikode, Malankara reservoir in Idukki and Wayanad for the first time. The Wetland ecosystems encompassing Kole Wetlands of Thrissur which is a famed Ramsar site is more prone to *Cabomba* invasion.

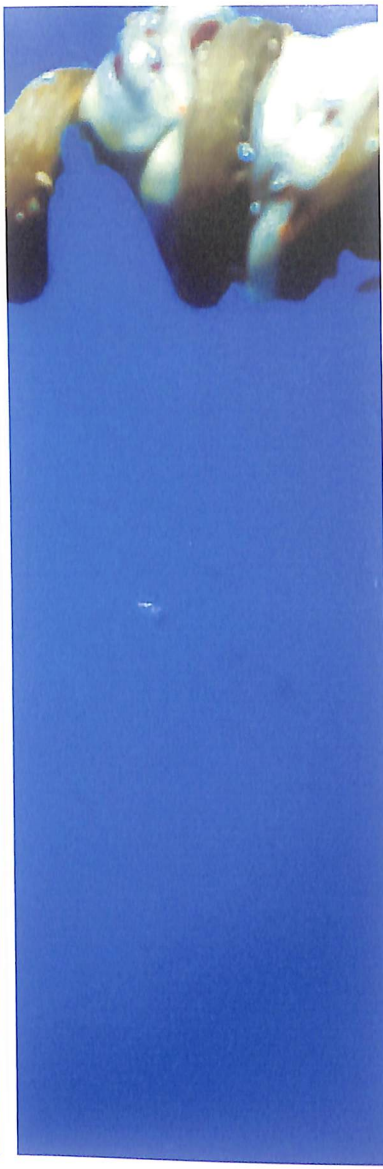
Measures contained for the spread of *Cabomba* include the mechanical removal and drying it on land, increasing shades by planting trees; tarpaulin shade over the infested area especially where it cannot be mechanically removed; regular weeding on both aquatic and terrestrial habitats based on inputs from monitoring. Community awareness and education can also be included with control measures by releasing strict policies or legislation that restricts or bans the trade of such exotic species.

Student project

The management of this insect has become a tedious task because of its cryptic nature and absence of natural enemies in the invaded locations.

EDRR of *Ceroplastes cirripediformis* a success story to contain the invasive alien pest

The study commenced in 2020 with a query of wilting passion fruit which was reported initially by a researcher of Kerala Forest research institute and then the insect was again identified from other locations after a few months. After collecting the specimens from the pest invaded sites it was identified as *Ceroplastes sp.* Being a new incident the problem was followed up by Ms. Swathy N S, postgraduate as her dissertation work was knocked out and identified molecularly as *Ceroplastes cirripediformis.*



Barnacle wax scale insect being native to the Southern United States and the Carribean islands is a consequential invasive pest which causes injuries to fruit bearing host plants and is also spotted in 32 countries mainly in warmer regions and spread was predicted by chinese researchers in areas of india and china became a reality .

The insect is hemispherical in shape of 3-5mm in length with black and brown spots on pearly white waxy coat enclosing their body which varies from reddish brown to brown in color. They destroy the host by sucking its fluid and excreting honeydew to cause coal smudge. Females follow a sedentary life with three larval stages whereas four in males in which they flew off from the host during its third larval period. Infestation patterns are observed with leaf attacks during the period of first and second nymphal stages while they migrate into the woody tissues from the third instar. Being polyphagous, they attack diverse hosts such as Passion fruit, Citrus, Mango, Jackfruit, Ficus and Rambutan including 119 genera in 63 families by drawing plant sap from twigs.

The management of this insect has become a tedious task because of its cryptic nature and absence of natural enemies in the invaded locations. EDRR (Early Detection and Rapid Response) was considered as the best method to manage this invasive alien pest in which their spread hasn't widened to larger areas within Kerala ,moreover steps were taken to detect and track the satellite populations of insects anywhere in the state at the earliest as possible.

Ms. Swathy N S, Post graduate student, Sree Kerala Varma College, Thrissur

Major news on invasion threat

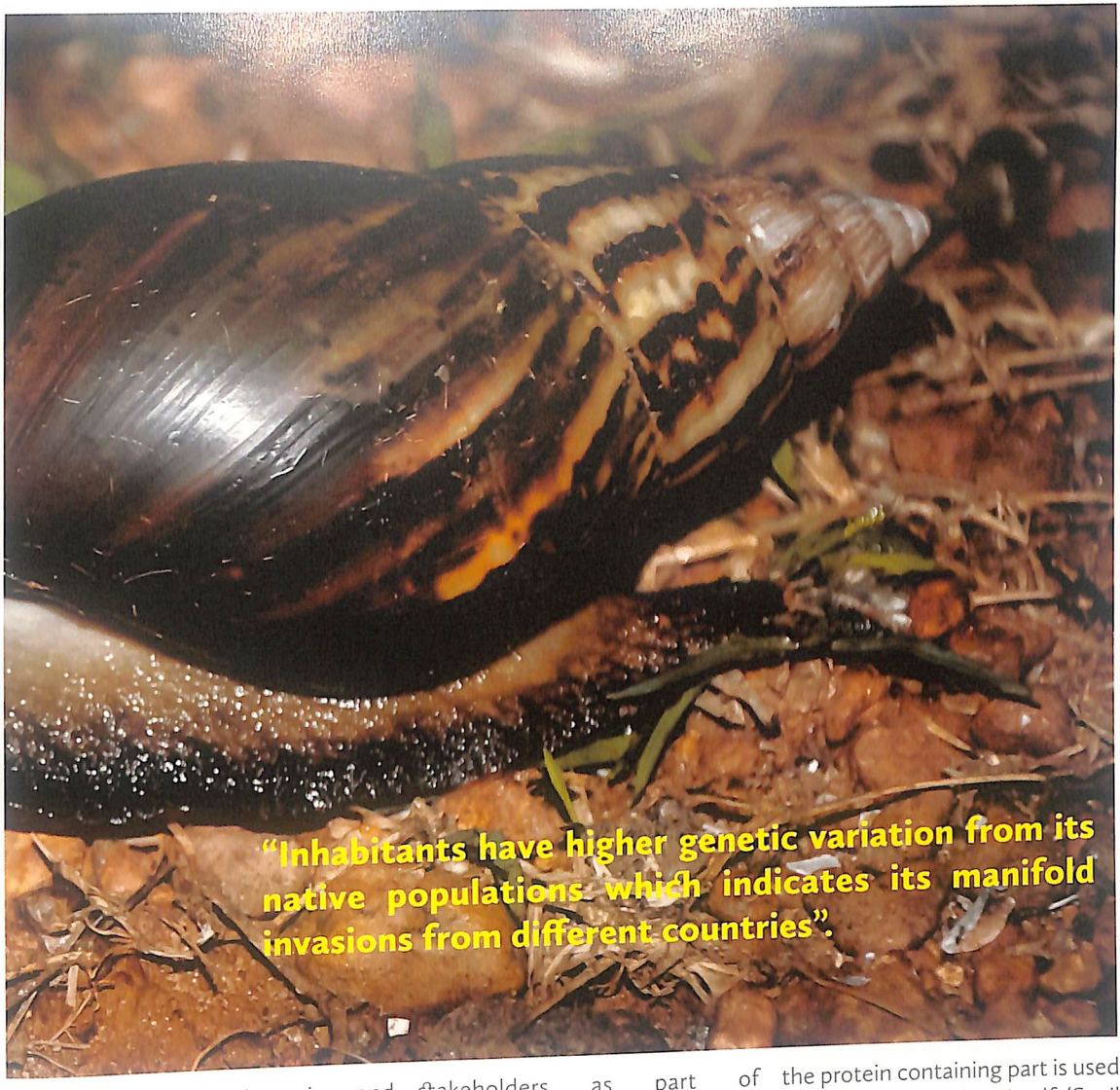
"This species is suspected to cause health troubles viz Eosinophilic Meningitis, Septicaemia and Peritonitis".

The Giant African Snail in Kerala, India

Recent waves on Giant African snail found to be dangerous pest species in India especially in Kerala, through multiple episodes of invasions and the continuous arrival of new populations from countries across the world. The study was reported by Keerthy Vijayan, a research scholar KFRI, during her work in the year of 2006-2020, observed that inhabitants have higher genetic variation from its native populations which indicates its manifold invasions from different countries.

Achatina fulica - Giant African Snail, became the most vicious global invasive species which is native to the African subcontinent was first reported in India in 1847 and in 1955 reported in Kerala which became a serious threat to the locals in the period of 1965- 1970 and 2005 . The Giant African snails got their new home due to timber importation which boomed their vast proliferation and in 2005 the spread was reported in three districts in Kerala, farther after 15 years in 2020 the surge spread aggressively to all districts except one.

This species is suspected to cause health troubles viz Eosinophilic



Meningitis, Septicaemia and Peritonitis and it was reported among children in two districts of Kerala. Total control and eradication of these species became a tedious and challenging quest due to its long term hibernation periods and multiple invasions .Soon enough, a mixture of Tobacco Decoction – Copper Sulphate (TDCS) is prepared and sprayed by the farmers and other stakeholders as part of extermination, but a long term method should come across to eradicate them.

In the recent news, Dr Abdul Kalam Farmer producer's society initiated a program in Ezhukone in Kerala to pay an amount of Rs.3 per snail and it will be turned into fertilizer in which its calcium containing shell is removed and the protein containing part is used as feed by the society itself. 'Snail kill' pellets made from the mixture of snow peas and metaldehyde were distributed among the farmers of a municipality in Kochi to kill the snails while they feed on them was a further recent breakthrough.

PhD Theses

1

Tracking the invasion: molecular phylogeography and phyloclimatic modelling of the Giant African Snail *Achatina fulica* (Bowdich, 1822) in South India.

The Giant African Snail *Achatina fulica* (Bowdich, 1822), a native to East Africa is one of the rapid spreading invasive alien species in India. The current study attempted to track the invasion of the Giant African Snail to understand whether the invasion was a single event or whether multiple introductions have happened. The study also tried to predict the future pattern of infestations based on phyloclimatic modelling. The snail infested localities were surveyed and samples were collected for molecular analyses. Two mitochondrial markers 16s rRNA gene and cytochrome oxidase subunit I (COI) gene were selected to trace the invasion events and their origin in south India. A total of 268 snail infested localities were surveyed in South India, out of which 208 samples were subjected to 16s rRNA gene amplification and 47 samples to cytochrome oxidase subunit I (COI) gene amplification. From this study, a total of 17 16s rRNA haplotypes from India and 12 COI haplotypes from the world were identified. Out of the 17 16s rRNA haplotypes, 14 are new and unique haplotypes in India identified by this study. Out of the 12 COI haplotypes, 8 are from India. The most common 16s rRNA haplotype is C whereas the most common COI haplotype is E in India. The study has also recorded haplotype H of the 16s rRNA gene from Kerala, which was previously known from Mayotte and Mauritius in the Indian Ocean Islands. The wood import data of the Cochin Port during the year 2016-2017 was corroborated with the molecular data. The data showed that many different wood items were being imported from the snail infested countries which includes Tanzania, a native range of the snail. The first known introduction to India was through snails brought to Calcutta from Mauritius. From Calcutta, the snails have spread into many parts of South East Asia. Even though haplotype C and H are present in Mauritius, haplotype H is not present in any of the South-East Asian countries. With the evidence of the 16s rRNA and COI gene sequences, which was supported by the heavy traffic of shipping between snail infested countries and Kerala, the likelihood of the multiple invasion events to India is proved. The global bioclimatic models proved that there is an increasing trend in the potential distribution of the snail from the past to present to future. The variable contribution analyses imply an increase in the spread of Giant African Snail in response to predicted global warming and climate change.

Dr Keerthy Vijayan former research scholar of KFRI, focused on using DNA and protein sequences to build molecular phylogenies & molecular phylogeography in order to investigate evolutionary relationships to control and manage the invasive alien crop pests. Currently she is Assistant Professor of Kalasalingam School of Agriculture and Horticulture, Kalasalingam Academy of Research and Education, Tamil Nadu.

2

Faunal responses to biological invasions: A case study of the giant African snail *Achatina fulica* Bowdich infestations in Kerala.

Achatina fulica (Bowdich) commonly known as the giant African snail is an invasive species which has spread to many countries outside its native range. Being native to East Africa (Kenya and Tanzania), it has spread to Pacific regions, South Asia and Southeast Asia. *A. fulica* is listed as one of the world's 100 worst invasive species due to the impact caused by it. Introduced to Kerala in around 1955, it had and continues to have a major impact on agriculture and human habitations. The snail has only recently been noticed to have invaded most districts in the state of Kerala.

Unlike the case of resident agricultural pests, fast invading alien invasive pests require a faster response, the involvement of various agencies and the general public and state-of-the-art scientific support. In the event of an increasing number of local populations of the Giant African Snail, an attempt was made to conduct action research aimed at containing the current populations in Kerala. Since the snail always occupies human habitat, and since the pest never escapes human attention, both print and visual media were used to create awareness of the species and to help report the areas of occurrence. A total of 217 snail infested sites were recorded from thirteen districts of Kerala. All reported sites were physically verified and mapped. Once the spatial information was collected, it was transferred to GIS platform and Maxent modelling was done for predicting the possible infestation areas. Ernakulam district was predicted with the high risk of infestation and Idukki district, the least. The model results predicted entirely new areas of potential infestation which largely corroborated with the findings of the later field surveys. The history of the introduction of *A. fulica* and the pathways of spread in Kerala were traced during the study. Timber depot, sewage farm and hitchhiking were found to be the major pathways for the spread. This snail is also spread to new places as pets.

A. fulica is interacting with the native species of Kerala. We studied the response of indigenous species to this invasion by way of direct observationof associations and signs thereof, experiment trialsand information collected from peopleresiding in snail infested areas. Of direct engagement were 5 species of mammals, 5 birds, 4 species of millipedes, 11 molluscs, 5 species of insects and one crustacean. Many of these were niche sharing species which engage in the competitive relationship while

Dr. Maneetha T K, Former research scholar at KFRI in which her research focused to the issue of Malacology, Entomology and Invasive species. Pest management is a significant field of science which found more applications and possibilities in the aspects of biological control. Currently she works as a lecturer in the Department of Zoology of Mahatma Gandhi Memorial College, Udupi.

others were predators. The predators of the snail were mammals like *Sus scrofa*, *Rattus rattus*, *Bandicota indica*, *Herpestes edwardsii*, *Suncus murinus*, birds like *Centropes sinensis*, *Pavo cristatus*, *Anas sp.*, *Gallus gallus*, *Egretta sp.*, and insects like *Lamprigera sp.*and *Nyctophila sp.*. Molluscs like *Mariaella dussumieri*, *Laevicaulis alte*, *Rhachistia pulcher*, *Rhachistia trutta*, *Euplecta sp.*, *Cryptozona bistrialis*, *Macrochlamys sp.*1, *Macrochlamys sp.*2, *Opeas gracile*, *Glessula sp.*, *Ariophanta sp. Eurochlamys sp.*, and millipedes like *Orthomorpha coarctata*, *Phyllogonostreptus sp.*, *Trigoniulus sp.*, and ants like *Camponotus sp.*, *Monomorium sp.* and *Anoplolepis gracilipes* were found to be niche sharing species. *S. scrofa* and *C. sinensis* were the only predators which could suppress the population of the invasive species. Owing to their small size, Lampyrid predators had only very little impact on the population size of the snails. The study shows that there are a variety of responses of native species to an invading species, ranging from peaceful co-existence to complete destruction of the population of the invading species. Spatial separation of the snails from the major predator helps them to continue their spread in the state of Kerala. At these sites, human intervention is the key factor regulating population size.

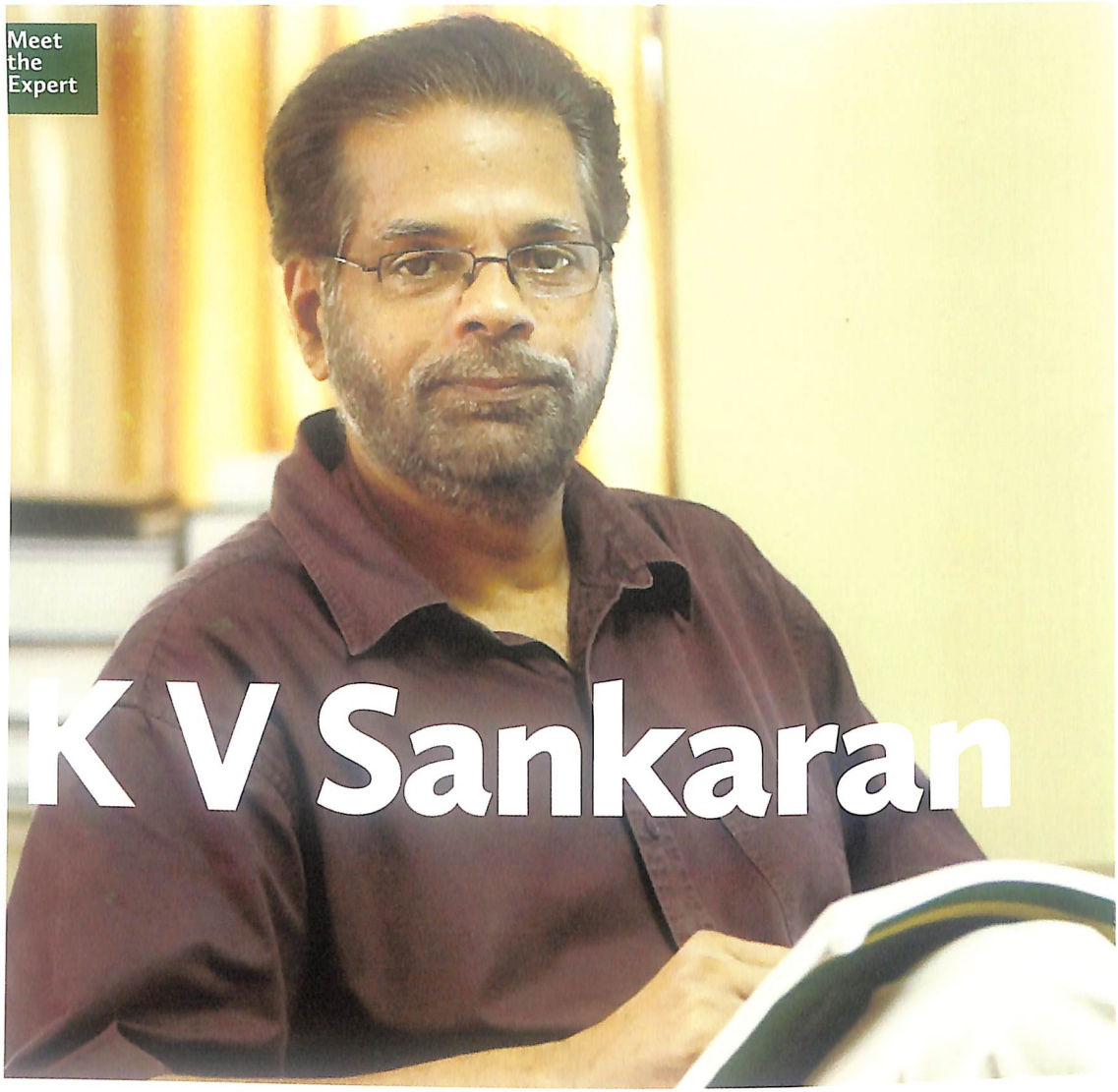
For the management of a species, it is necessary to have good estimates of population size and distribution of the targeted species. The population of *A. fulica* is not uniform in its density in the infested places. As it is normally impossible to count all the snails in a habitat, it is necessary to estimate the population by sampling. In a low infested area enumeration is the best method for this. Using bait traps we can directly collect the snails present in the area. Enumeration will be a difficult task in case of high infested regions and mark-recapture method can be adopted. In such cases recapture should be done after 15 days giving enough time for mixing of the marked and unmarked individuals. Based on the data derived on the snail population density, the classification scheme arrived at: low (< 100 snails/acre), medium (101-2500 snails/acre) and high (>2500 snails/acre).

Economic impacts of invasive species are not much reported due to the lack of study on the impact caused by the invasive species to the environment. Timely management of invasive species will be possible by

studying the impact caused by the organisms. In our study, the impact of *A. fulica* infestation was examined mainly in the aspect of crop damage and the cost of control. The ecological impacts caused by the invasive snail *A. fulica* were studied by checking the abundance of the native species in both *A. fulica* infested sites and uninfested sites in Kerala. Reproductive rate, tolerance in summer, and feeding rate were also checked to compare both native and invasive species. In Kerala, the economic impact is high in house holdings of 1 h to 2 h followed by marginal holders (<1h) and small homesteads. Ecological impact is by way of the use of molluscicides. Various control options for managing *A. fulica* were compared for effectiveness and impact on non-target organisms and the best method was field tested. Tobacco Decoction-Copper Sulphate mixture was found to be the most efficient method for eradicating snails. This mixture has been recommended all over Kerala and is now being practiced in many places. Plant extracts tested even though showed irritated response by the discharge of more mucus and retraction of snail body into the shell had no lethal properties in this mollusc. Experiments on baits tested found cabbage mixed with beer to be the most effective. All local self-governments highly predicted by the Maxent models were alerted on the issue and posters and brochures were provided regarding the problems caused by the snail, and also the do's and don'ts and the control method. The entire effort was used as a case study to evaluate capability in addressing alien pests in a holistic manner with the current institutions, governance structures, and public attitude. The study revealed critical gaps in addressing alien invasions in Kerala due to primarily inadequate institutional mechanisms.

A questionnaire survey was done in all snail infested regions of Kerala to study the human response towards the management of the African snail. Local people of the snail infested sites were contacted and data collected by telephonic conversation and direct interviews. Assessment was done on the basis of interaction with the people of snail infested regions. From the study, it was found that organized and efficient human response was better in rural areas as compared to urban settings. Public participation is a crucial factor in management of invasive species. Public education helped to contain the invasive species by preventing the deliberate spread of the species. In the case of giant African snails, women were more concerned and the places where women were involved in the decision-making process found success in controlling the invasive species in their area. The failure in the management of *A. fulica* was mainly due to unawareness, insufficient funds and lack of cooperation among people and local self-governing bodies. Media helped in increasing awareness among people and it is a fundamental tool in mediating information and structuring public opinions in front of the authorities and research communities. Invasive outbreaks need a quick response for which no institutional mechanism exist in Kerala. The study brings out the components of a comprehensive institutional mechanism to address the problems caused by alien invasive species in Kerala.

Meet the Expert



K V Sankaran

■ When we trace the history of invasive species research in India, you are one among the pioneers. What prompted you to take up research on invasive alien species at a time when the topic was in its infancy?

I had the opportunity to assess the impact of different invasive alien plants on natural and planted forests during my field trips to forest areas in the late 1980's. But a requirement to manage these species became mandatory when one of my research plots at Vazhachal in Kerala was heavily infested by *Mikania* and *Lantana*. This was also the time when the Kerala Forest Research Institute (KFRI) was approached by the Kerala Forest Department seeking advice on managing *Mikania*

Dr KV Sankaran is the founder Coordinator of the FAO'S Asia-Pacific Forest Invasive Species Network (APFISN) and former Director, Kerala Forest Research Institute. He is currently Invasive Specialist of the FAO and the coordinating lead author of IPBES which has roped in experts from 130 countries to draft the document on Risk assessment and control of invasive alien species.

which was spreading fast in planted forests. I contacted colleagues in CABI, UK, who have commendable experience in managing invasive alien plants, requesting guidance on options for management. Incidentally, at the same point of time, I was awarded a post-doctoral fellowship to work at the CABI International Mycological Institute, UK. During my tenure (in 1995), the CABI colleagues joined me to develop a research project on integrated management of *Mikania micrantha* in the Western Ghats which eventually got funded by DFID, UK. That was the beginning of a series of research programs on invasive alien plants at KFRI.

■ How do you look at your efforts on the first species of research-*Mikania micrantha*?

We had an enthusiastic team to work on the project. We surveyed natural and planted forests in the Western Ghats (in the states of Kerala, Karnataka and Goa) for invasion by *Mikania* and assessed the efficacy of physical and chemical methods to manage the weed. It was a remarkable learning experience. Our studies showed that *Mikania*, a fast-growing climber, is widespread in the Western Ghats (especially in the Kerala part) and that it has the potential to spread wider within a short span of time causing huge impacts on agricultural and forest ecosystems and the livelihood of people. It was also clear that physical and chemical methods of control only have a short-term efficacy on *Mikania* and biological control would be the best option. We were amply supported in our research by Scientists at CABI, UK. First attempt at biocontrol of *Mikania* with rust fungus (*Puccinia spegazzinii*) was partly successful since the load of fungal inoculum applied in the field was insufficient to sustain infection. But we could standardize the physical and chemical methods of control.

Horizon scanning is now widely used to identify and prioritize species which has the potential to enter a new geographic region from another, prevents new invasions.

■ What are cutting edge areas of invasive species research at the global level?

Most research is focused on developing innovative techniques to predict, prevent, locate and manage IAS. For e.g., horizon scanning is now widely used to identify and prioritize species which has the potential to enter a new geographic region from another, prevents new invasions. Efforts on risk analysis, risk modelling and mapping, pathway analysis, pathway prioritization and management, species impact assessment, site prioritization, species-led and site-based management and ecological restoration.

To help early detection, surveillance and eradication of IAS, modern tools such as remote sensing, sensor networks and mobile smart traps, analyses of environmental DNA and sentinel surveillance are increasingly being used in developed countries.

Other techniques being fine-tuned and employed include ultrasound sensors to target invasive alien animals, real time genome sequencing and robotic technology to identify IAS infestation and implement management methods. Lethal control, fertility control and viral biological control of invasive alien vertebrate pests and sterile insect control and genetic control of invasive alien fishes and mussels are also being practiced in some countries.

■ What are the major knowledge gaps and impediments to implement invasive species management at the international level?

Knowledge gaps exist on the global distribution of IAS especially on some of the plant and animal groups, invasive alien fungi and other microorganisms including chromists, bacteria, archaea and viruses. Moreover, available information on distribution of most IAS is far from complete in some geographic regions (for e.g., Africa and the Asia-Pacific) probably due to lack of research efforts. It is evident from literature surveys that terrestrial ecosystems have been more thoroughly explored for IAS compared to marine and freshwater systems. Also, there are gaps in our understanding of the direct and indirect drivers of invasion and in assessing all the impacts of invasion by alien species. These data gaps have a huge bearing on prevention and management of IAS across regions, taxonomic groups and ecosystems. Impediments to management efforts are daunting especially in the developing world. Some countries still lack a policy framework to deal with IAS, their biosecurity regulations are inefficient to prevent invasions and management of IAS may not be a priority item for them to tackle urgently. Also, most developing countries lack sufficient skills, knowledge and expertise in modern tools used to locate, identify and manage IAS. Lack of awareness, poor stakeholder participation in management and negative attitude towards certain methods such as biocontrol also frustrate opportunities for management.

■ How sensitive are the global trade platforms to the issue of biological invasions?

There is an increased awareness now and appropriate preventive measures (especially sanitary and phytosanitary measures) are being implemented in tune with international agreements.

■ How do you evaluate the invasive species research and management at the global, national and State levels?

Developed countries are in the forefront of fighting invasive alien species by employing new tools and techniques and enacting

There is an increased awareness of the problem now but stakeholder engagement in detection and management of IAS is in its infancy.

updated biosecurity polices based on cutting edge research. At the national level, we are yet to develop an exclusive national policy to deal with IAS. Also, invasion by alien species is yet to be identified as an important national issue to be dealt with thorough action plans and by promoting research. Some research is underway which are led by a few Universities and Research institutions. However, most of this research are on surveying and identifying new IAS especially terrestrial species. Research on marine and aquatic IAS is scarce. There is an increased awareness of the problem now but stakeholder engagement in detection and management of IAS is in its infancy. Early detection and rapid response, surveillance, monitoring, eradication, pathway management, species led and site-based management and restoration are activities yet to be attempted at any scale. At the state level, Kerala Forest Research Institute has taken commendable initiatives to survey, identify and manage IAS, especially plants, through physical, chemical and biological methods. Attempts are also being made by the Institute to detect invasive snails and other organisms and manage their impacts. I note that they have also started restoration of IAS impacted sites. The University of Kerala has contributed significantly to the knowledge of aquatic IAS especially fishes.

■ Invasive species create two problems. First, the problem caused by them and secondly the problems caused by the methods we use to manage them. How prospective is the use of biological control agents in the management of invasive alien species?

Biological control is the most sustainable and efficient method to manage IAS since the agents can suppress the proliferation of specific alien species, especially plants and invertebrates, for a long-term. Internationally applicable guidelines and methods are now available to avoid probable non-target effects due to the introduction of biocontrol agents. India has a long history of introducing biocontrol agents (mainly insects) to manage invasive alien plants. The most recent being the release of a rust fungus to manage the weed *Mikania micrantha* as discussed earlier. Though India still has excellent opportunities to adopt biocontrol, a general lack of awareness on the benefits of biocontrol, the fear of non-target effects and lack of motivation and paucity of experience in implementing biocontrol frustrate new attempts. However, it may be added that future endeavors on

biocontrol of IAS may be hampered by the enactment of ABS (access and benefit-sharing) by CBD and Nagoya protocol which restrict access to biological control genetic resources.

■ With your breadth of experience on working with invasive alien species, what is your advice to researchers and managers towards their efforts in managing invasions?

Identification of the stage of invasion is critical before we plan management strategy. Prevention of invasion through pathway management and the scrupulous implementation of biosecurity regulations at the pre-entry and points of entry is the most cost-effective method. If this fails, the next option at the post-border point is to detect the species early and eradicate it (before it spreads) which calls for constant surveillance to detect the species. The correct identity of the species is critical especially at this stage and eradication may be carried out using all available techniques. This method has high success rates since it is usually implemented at the early stages of establishment of the species.

Beyond this stage, containment can be attempted but it may be successful only when applied at the early stages of spread. If the species becomes widespread, the only option would be to implement species or site/ecosystem-based adaptive management measures. Biocontrol is one of the best options at this stage. Integrated management is another option at this stage of invasion.

The focus of management and the methods and tools required for management may vary between terrestrial, aquatic and marine ecosystems. In all cases, restoration of invaded sites following management is crucial to avoid re-invasion but in practical terms it is possible mainly in terrestrial ecosystems. The success of all management actions relies heavily on the engagement of stakeholders at all stages of the process.

His latest publication can be read at http://journal.frontiersin.org

Forthcoming Webinars | Seminars | Conferences

Native Plant Materials Virtual Conference

2022 Native plant materials virtual conference , Jan 12,13- https://www.ser.org/events/EventDetails.aspx?id=1573998&group=

2022 5th Annual north east regional invasive species and climate change(RISCC) management symposium, Jan 19,20 : https://www.risccnetwork.org/symposia

2022 20th Annual river restoration symposium, Feb 8-10, https://www.rrnw.org/symposium-welcome/

2022 42nd Annual Midwest Aquatic Plant Management Society Conference, Feb 27- Mar 3, , 2022 42nd Annual Midwest Aquatic Plant Management Society Conference

2022 National Phragmites Conference , Jan 20, https://canadainvasives.ca/registration-is-now-open-for-canadas-1st-national-phragmites-conference/

2022 invasive species annual forum- action, innovation and outreach Feb 1-3, https://www.invasivespeciescentre.ca/events/ontario-invasive-species-forum/

2022 National Invasive Species Awareness Week (NISAW), Feb 28- Mar 04, 2022 National Invasive Species Awareness Week (NISAW)

2022 10th International IPM Symposium, Feb 28-Mar 03, 2022 10th International IPM Symposium

To join us to map the invasive alien species in your locality:

- Download and install the mobile app iNaturalist from Google Play Store.
- If you are using a computer, visit the site https://www.inaturalist.org/
- Create a user account in your name.
- Click photographs of the species (make sure the location button of your camera is on) and upload photos to the app (by clicking the + sign in the home page of the app or the share photos option in your image gallery).
- If you don't know the name of species, simply add plant or animal in what did you see box.

For any doubts in installing and adding observations see the tutorials: https://www.inaturalist.org/pages/video+tutorials

To see the distribution of invasive alien species distribution in Kerala visit:https://www.inaturalist.org/projects/invasion-watch-kerala

All are welcome to join this initiative!.

Invasion Watch

Invasion Watch is a new citizen science initiative to map the distribution of invasive alien species by the Nodal Centre for Biological Invasions and the Centre for Citizen Science & Biodiversity Informatics at KFRI. The long-term goal of this initiative is to prepare atlases of invasive species at local level to national level and educate the general public about the impacts of invasive alien species on our ecosystems.

Recently Published Scientific Papers

Bueno, M. L., Magalhães, A. L. B., Andrade Neto, F. R., Alves, C. B. M., Rosa, D. de M., Junqueira, N. T., Pessali, T. C., Pompeu, P. S., & Zenni, R. D. (2021). Alien fish fauna of southeastern Brazil: species status, introduction pathways, distribution and impacts. In Biological Invasions (Vol. 23, Issue 10, pp. 3021–3034). Springer Science and Business Media LLC. https://doi.org/10.1007/s10530-021-02564-x

Yuan, L., Li, J.-M., Yu, F.-H., Oduor, A. M. O., & van Kleunen, M. (2021). Allelopathic and competitive interactions between native and alien plants. In Biological Invasions (Vol. 23, Issue 10, pp. 3077–3090). Springer Science and Business Media LLC. https://doi.org/10.1007/s10530-021-02565-w

Woodell, J. D., Neiman, M., & Levri, E. P. (2021). Matching a snail's pace: successful use of environmental DNA techniques to detect early stages of invasion by the destructive New Zealand mud snail. In Biological Invasions (Vol. 23, Issue 10, pp. 3263–3274). Springer Science and Business Media LLC. https://doi.org/10.1007/s10530-021-02576-7

Raj, S., Kumar, A. B., Tharian, J., & Raghavan, R. (2021). Illegal and unmanaged aquaculture, unregulated fisheries and extreme climatic events combine to trigger invasions in a global biodiversity hotspot. In Biological Invasions. Springer Science and Business Media LLC. https://doi.org/10.1007/s10530-021-02525-4

Oshi, S., Bhaskar, H., Poon, V. S. A., Mala, B. R. J., Jayanthi, P. D. K., Pai, S. G., Thite, S. V., Sood, A. K., Kedar, S. C., Sridhar, V., Deepthy, K. B., Navik, O., & Rachana, R. R. (2021). Occurrence and spread of *Ceroplastes cirripediformis* Comstock (Hemiptera: Coccomorpha: Coccidae) in India. In Zootaxa (Vol. 5039, Issue 4, pp. 561–570). Magnolia Press. https://doi.org/10.11646/zootaxa.5039.4.7

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Mungi, N. A., Qureshi, Q., & Jhala, Y. V. (2021). Role of species richness and human impacts in resisting invasive species in tropical forests. In Journal of Ecology (Vol. 109, Issue 9, pp. 3308–3321). Wiley. https://doi.org/10.1111/1365-2745.13751

Biju Kumar, A.,Nisanth, H.P. ,Vishnuraj, R.S. & Dipani Sutaria.(2021). Records on Stranding Events of Cetaceans and Illegal Trade of Dolphins in South Kerala, India. In Journal of Aquatic Biology & Fisheries (Vol.9, Issue 1,pp.1-11). University of Kerala, India.

Heger, T., Jeschke, J. M., & Kollmann, J. (2021). Some reflections on current invasion science and perspectives for an exciting future. In NeoBiota (Vol. 68, pp. 79–100). Pensoft Publishers. https://doi.org/10.3897/neobiota.68.68997

Jayachandran, P. R., Radhika, R., Aneesh, B. P., Santu, K. S., Jima, M., & Bijoy Nandan, S. (2021). Biological Invasion of Medically Important Bladder Snail Physella acuta Draparnaud, 1805 (Gastropoda, Physidae) in the Freshwater Habitat of Kerala, India. In Proceedings of the Zoological Society. Springer Science and Business Media LLC. https://doi.org/10.1007/s12595-021-00419-w

Recent talks delivered by NCR

All India Co-ordinated Research Project on Weed Management
Kerala Agricultural University, Thrissur

College of Agriculture, Vellanikkara

NATIONAL WEBINAR on WEED SCIENCE

10 AM – 12:30 PM February 16, 2021

Inaugural address

Dr. R. Chandra Babu
Hon'ble Vice Chancellor
Kerala Agricultural University

Key note address

Dr. I.S. Mishra
Director
ICAR-Directorate of Weed Research
Jabalpur

Presidential address

Dr. Madhu Subramanian
Director of Research
Kerala Agricultural University

Welcome address

Dr. Anita Cherian K.
Dean, College of Agriculture,
Vellanikkara

Technical Sessions

Dr. C. R. Chinnamuthu
Professor & Head
Department of Agronomy
Tamil Nadu Agricultural University
Coimbatore

"Nanotechnology applications in weed management"

Dr. T.V. Sajeev
Senior Principal Scientist,
Department of Forest Entomology
Kerala Forest Research Institute
Peechi, Thrissur

"Alien weeds – An imminent threat to forest biodiversity"

Participants

- Scientists from various AICRP (WM) Centres
- Faculty of KAU
- PG and Ph. D Scholars

zoom

For further details, contact:

Dr. P. Prameela
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വന്യജീവി വാരാഘോഷം 2021

വെബ്ബിനാർ

കേരളത്തിലെ അധിനിവേശ ജീവജാലങ്ങൾ

zoom

Meeting ID: 849 5239 4413
Passcode : 648049

സെപ്റ്റംബർ 18 ശനിയാഴ്ച

സമയം : 11.00 AM -12.30 PM

വിവരങ്ങൾക്ക്: +91-9605008158
competition.dmz@gmail.com

scan QR code for fb live

LIVE @ Natural History Museum, Thiruvananthapuram FB page

വക്താവ്

ഡോ. ടി. വി .സജീവ്
സീനിയർ സ്റ്റേ
ഫോറസ്റ്റ് എന്റമോളജി വിഭാഗം
KFRI

പ്രേക്ഷകർ

- കർഷകർ ഗൈഡ് വർക്കുൾ, തിരുവനന്തപുരം
- S. N വനിതാ കോളേജ്, കൊല്ലം

തിരുവനന്തപുരം നാച്ചുറൽ ഹിസ്റ്ററി മ്യൂസിയം, മൃഗശാല വിനോദ വിഭാഗം

മ്യൂസിയം മൃഗശാലാ വകുപ്പ്

Clubhouse
DISCUSSION SERIES

Biological Invasions in Kerala

Dr. T.V. Sajeev

Senior Principal Scientist
Kerala Forest Research Institute (KFRI)

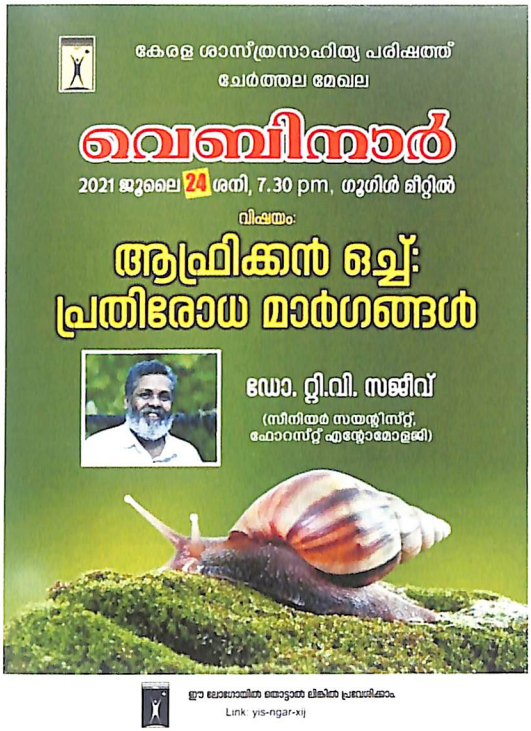
- Flora and Fauna
- Identification of the species, Management protocols and Restoration programmes
- When pets become pests
- Ecological disturbances on native biodiversity

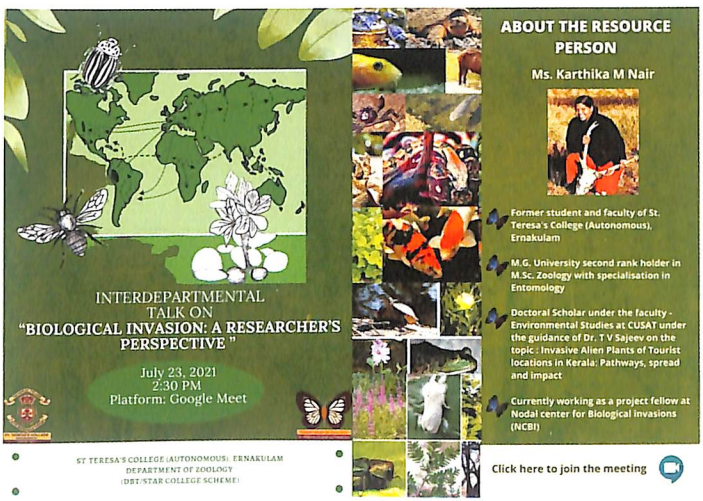
Saturday, 2nd October 2021 - 8:30 PM
www.clubhouse.com/join/caf

Clubhouse Room will be open for discussion on Saturday @ 8.30 PM and the same will be moderated by Adv Sajin Kollara.

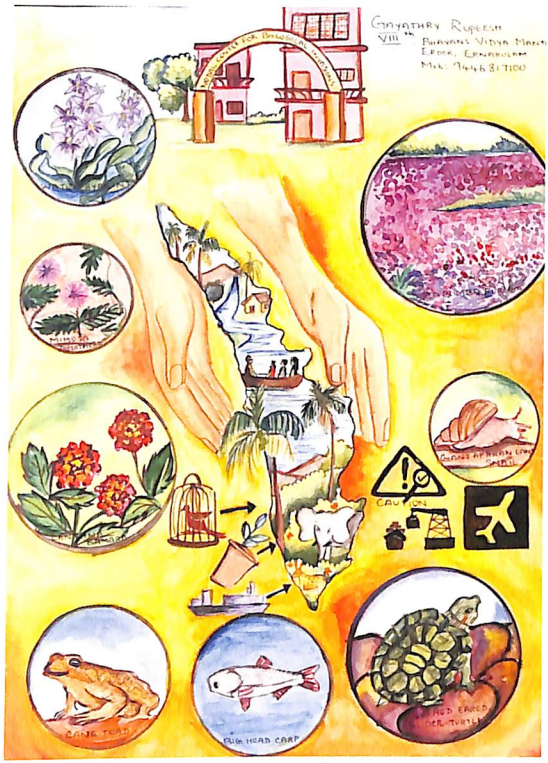
COCHIN ADVENTURE FOUNDATION
www.cochinadventure.org

Awarness activities





Prize winning posters done by children in the competition conducted during Wildlife Week Celebrations organized by Natural History Museum,Thiruvananthapuram as follow up of the talk by Dr T V Sajeev on Invasive Alien Species of Kerala on18th September, 2021.



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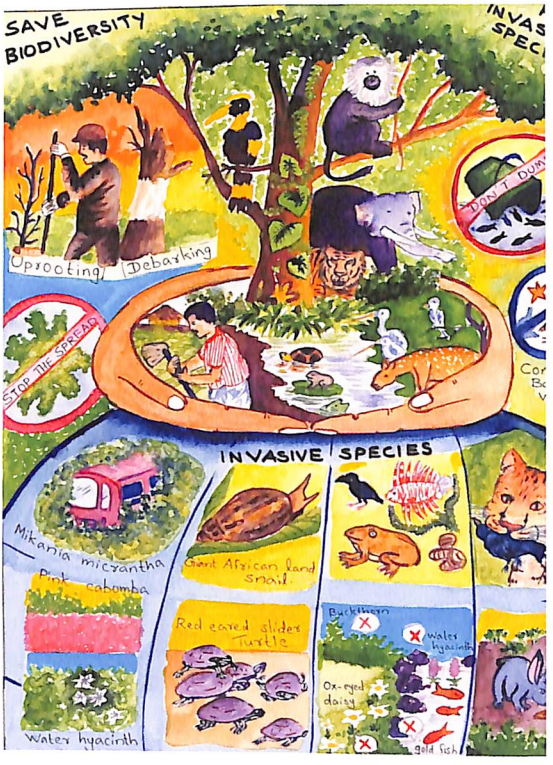

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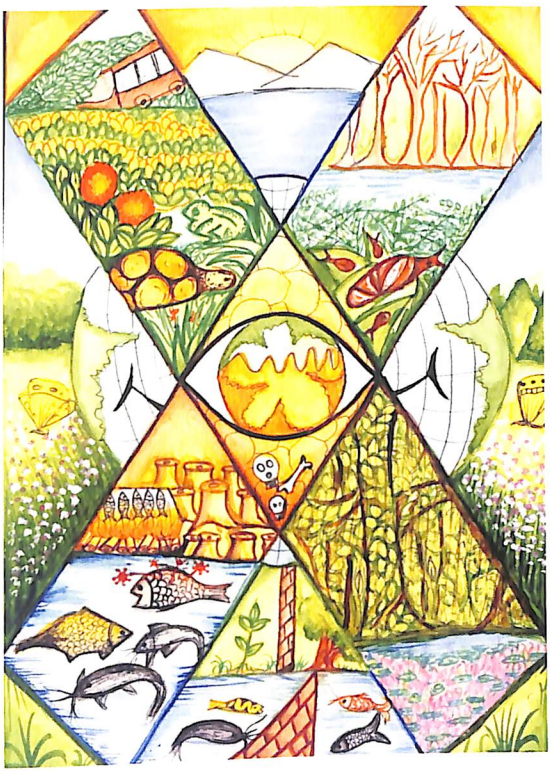

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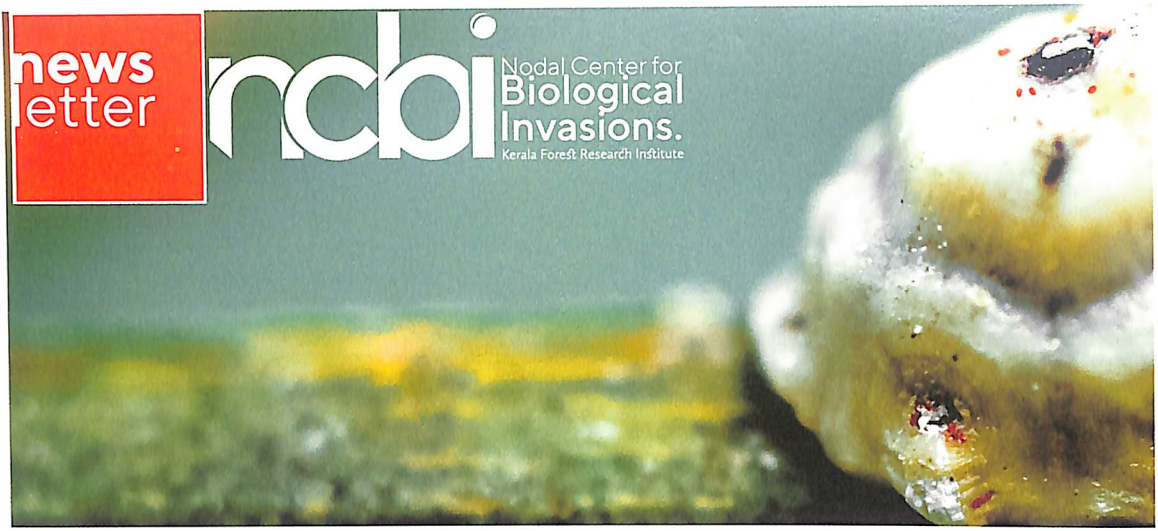

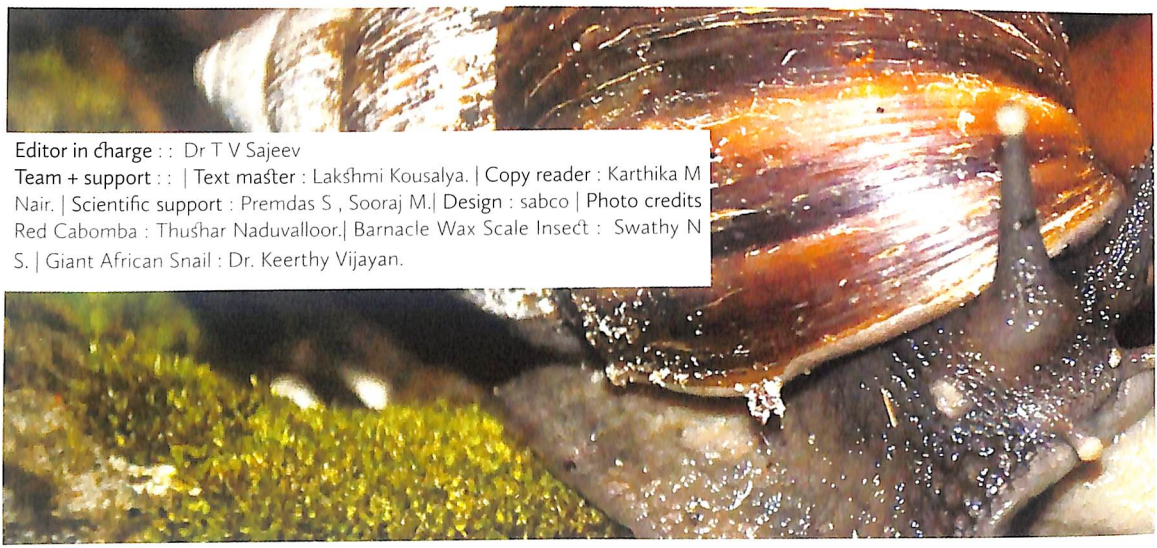

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