

A photograph of a person walking away from the camera on a dirt path in a lush green forest. The person is carrying a large, thick coil of light-colored rope on their back. To the left of the path is a large, exposed tree stump with many roots hanging down. The forest is dense with various green plants and trees.

CENTRE FOR  
ECOLOGICAL SCIENCES,  
Indian Institute of Science,  
Bengaluru



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## ABOUT IISc

The Indian Institute of Science, located in the heart of Bengaluru on 400 acres of lush scrub and plantation forest, is a premier research and education centre for science and engineering in the country. The Institute comprises of six divisions, consisting of 43 departments, and over 450 faculty. Having recently celebrated its 100th year since inception in 1909, the IISc continues to evolve. The Institute now offers a 4-year undergraduate B.Sc. programme, in addition to Master's degrees, an Integrated Ph.D. programme, and a Ph.D. programme.

In the century that has passed since its inception, IISc has grown to become India's premier centre for research and postgraduate education in science and engineering. The Institute continues to advance science and technology in India, establishing new departments and new areas of research, many of them for the first time in India. The faculty and alumni of the Institute have been responsible for establishing and spearheading many new institutions and programmes across the country, reflecting in a real sense, a major contribution of this centre of learning to national growth and development.

The research laboratories at the Institute are extremely well equipped. Many national facilities are housed at the Institute. The library and computational facilities at the Institute are amongst the best in India. The Institute hosts hundreds of visitors from India and abroad every year and is the venue for many major national and international academic events.

The Institute engages in interactions with society and industry through a variety of outreach programmes. The Centre for Scientific and Industrial Consultancy (CSIC) and the Society for Innovation and Development (SID) promote collaborative interactions with industry, while the Centre for Continuing Education (CCE) provides an opportunity for working scientists and engineers to enrich themselves academically. The Institute actively promotes programmes that encourage bright young school and undergraduate students to undertake research careers. The Institute administers the Kishore Vaigyanik Protsahan Yojana (KVPY) programme of the Department of Science and Technology (DST). The Institute's commitment to socially relevant research is specifically emphasised by the activities undertaken at the Centre for Sustainable Technologies (CST), together with the Karnataka State Council for Science and Technology (KSCST), which is housed on the campus.

Adapted from a write-up by Prof P. Balaram, former Director of the IISc.

**Centre for Ecological Sciences** at the Indian Institute of Science was set up in the year 1983. This was the first Centre of Excellence that was established under the Ministry of Environment and Forests of the Indian Government. Since then, the Centre has offered exciting opportunities for research in the diverse areas of ecology, evolution, behaviour and conservation. Research programmes are often integrative in nature, exploring scientific questions using multiple approaches, from theoretical and laboratory studies to field-based experiments.



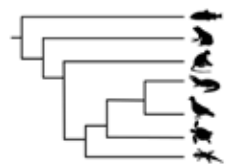
**Ecology**



**Conservation**



**Behaviour**



**Evolution**

Exciting new areas are on the horizon for CES. The Centre aims to establish long-term monitoring programmes at critical biodiversity areas across the country, to monitor responses to anthropogenic impacts and climate change; and to provide bases for capacity building, training, and outreach. Extensive collections by the members of the department have been catalogued, and a Natural History Museum showcasing these collections to educate and entertain the public is on the way. In the coming decades, CES will continue to evolve, expand, and diversify its activities in teaching, research, outreach, and conservation, while maintaining its standards of academic excellence.





## BEHAVIOUR

Faculty and students at CES address behavioural questions from both mechanistic and functional perspectives, using multi-disciplinary and integrative approaches.

Topics of research include animal communication across multiple modalities, behavioural and physiological responses to environmental stressors, mating systems and strategies, the balance between natural and sexual selection, and plant-animal interactions. Study of animal behaviour scales from individuals to higher levels of organisation, such as groups and even super-organisms, to understand how populations and communities function. Evolutionary theory forms the unifying theme in the study of animal behaviour.

## ECOLOGY

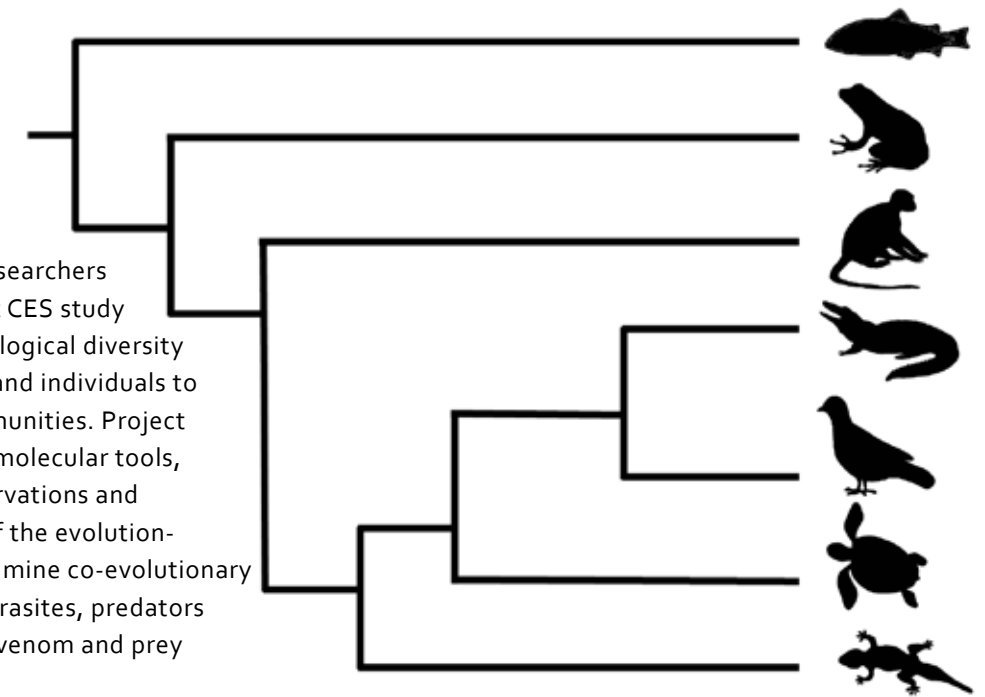
The study of Ecology at CES is central and focuses on a wide range of frontier areas, such as the dynamics of plant and animal populations and communities. Researchers are interested in how different scales and levels of biological organisation interact with environmental drivers to generate and maintain patterns of biodiversity in space and time. Many studies from the Centre involve a combination of field approaches and laboratory experiments; which include biogeochemical processes, trophic dynamics, ecophysiology as well as the quantification of biological diversity across the country. Many of the faculty and students use quantitative techniques (statistical, computational and mathematical) to build synthetic models of complex ecological systems that enhance the predictive power of the ecological theories.



## EVOLUTION

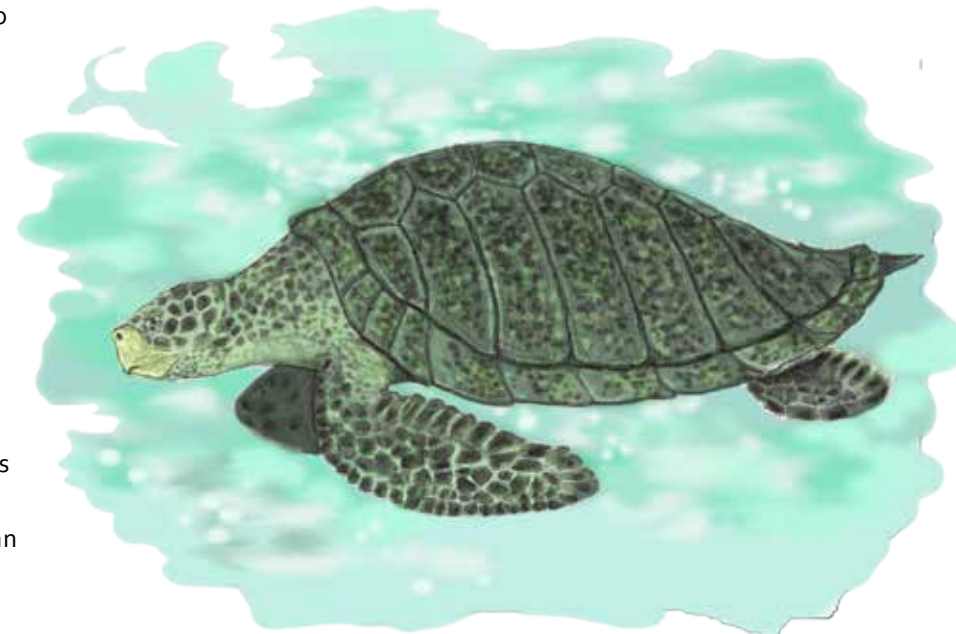
Evolution forms the unifying theme of all research at the Centre for Ecological Sciences.

The study of evolution cuts across scales, which is also the research approach for many researchers at CES. Faculty and students at CES study evolutionary processes and biological diversity at multiple levels, from genes and individuals to groups, populations, and communities. Project approaches include the use of molecular tools, behavioural studies, field observations and mathematical models. Some of the evolution-centric projects at CES also examine co-evolutionary patterns between hosts and parasites, predators and prey, and the evolution of venom and prey responses.



## CLIMATE CHANGE AND CONSERVATION

At CES, diverse approaches are used to understand and address conservation challenges in the context of climate change and other human-induced pressures. They use foundational principles of ecology such as patterns of species diversity and distribution to help prioritise areas for conservation. Many also reconstruct past climate and the ecology therein to infer the potential impact of ongoing climate change on ecological communities. A major focus of research at CES involves understanding and mitigating environmental challenges for the Indian subcontinent, such as human-wildlife conflict, urbanisation and land-use transformation.





# ACADEMIC PROGRAMMES

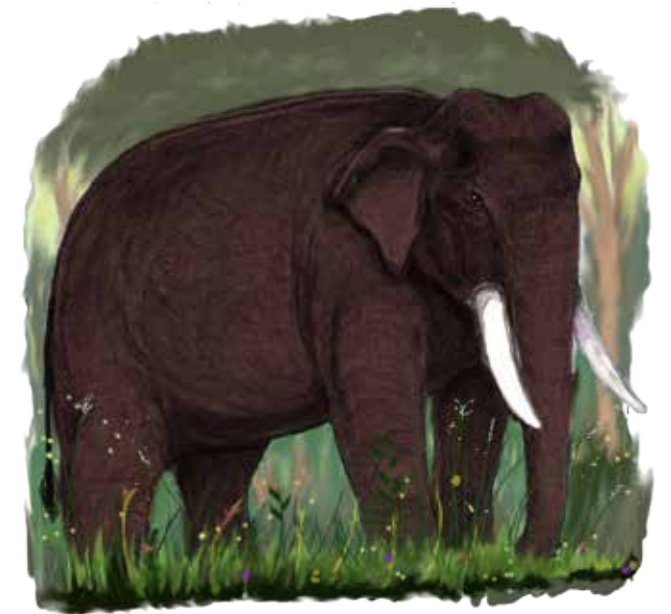
## PHD PROGRAMME

The CES PhD programme is centred on empirical laboratory and field studies that are aimed at addressing fundamental issues in ecology, evolution, animal behaviour and climate change. CES encourages and fosters an environment of learning and creativity. Graduate students have the freedom of using a multitude of techniques and approaches ranging from molecular biology to sophisticated computational methods to address scientific research questions. The Biological Sciences Building where CES is housed fosters interactions with other laboratories in the neighbouring departments within the institute. Students are also encouraged to interact with ecology laboratories in research institutions in Bengaluru and across India, thus promoting collaborative and interdisciplinary scientific inquiry.



## INTEGRATED PHD PROGRAMME

The Centre for Ecological Sciences, through the Division of Biological Sciences, admits students with a B.Sc degree into an Integrated PhD Programme. This competitive entrance exam is ideal for motivated students wishing to pursue research soon after their Bachelor's degree. During the first two years, the students take some core and elective courses that expose them to a wide array of basic as well as advanced topics in biological sciences. During the first year of the programme, students also take up short-term projects in three or four research labs in different departments of the Biological Sciences division. This brief stint in each lab provides them first-hand experience of the nature of research work, lab ambience and work culture. Most students select the laboratory and supervisor they want to work with, by the end of the first year.



## UNDERGRADUATE PROGRAMME

IISc offers a four-year Undergraduate programme leading to a Bachelor of Science (BS) degree and a five year BS-MS programme. An attractive feature of this programme is that students learn fundamentals of physical, biological, mathematical and chemical sciences; while it also offers a large number of electives. After an exciting broad-scope view of the sciences, students from the fourth semester onwards begin focusing on their majors. Many UG students take the higher-level courses offered at CES and conduct their final year honours projects in the Ecological Sciences, under the guidance of faculty in this department. Graduates of the IISc Undergraduate programme have gone on to various exciting and prestigious MSc and PhD programmes in India and around the world.



# FACULTY



## ROHINI BALAKRISHNAN

*"Causes and consequences of animal behaviour using acoustic communication as a model."*

Research projects in this lab span bioacoustics, animal behaviour, community and habitat ecology, and systematics. Theoretical, experimental and observational approaches are used in an integrated manner in most of the projects, which often involve both laboratory and field studies.

The primary research focus is on understanding sender and receiver strategies for communication in complex natural acoustic environments, ranging from the cacophony of a tropical rainforest to small choruses of males of a species producing similar songs. The group also studies habitat structure and acoustics to understand how signals get transmitted, and degraded in different habitats. These studies provide insights into the functioning of natural communication networks and the evolutionary forces that do (or do not) drive them. The current focus is on the role of predation as a selection pressure, driving the evolution of signals and signalling behaviour. Crickets and katydids are used as the primary model systems to study acoustic communication.

A second research focus is to understand decision-making and orientation behaviour in the context of mate choice in natural environments. Under this theme, the lab studies the physiological processes that underlie decision-making, and the ecological framework that constrains or enables different strategies of mate sampling and mate choice.

A third research area is systematics and phylogenetics, where the focus is on understanding species boundaries, acoustic signal evolution and developing acoustics as a tool for identification and monitoring of species diversity.



## RENEE M BORGES

*"The evolutionary ecology of species interactions."*

This research group is interested in mutualistic, symbiotic, and parasitic interactions between species, and the functional ecology of traits involved in interspecies interactions. The focus is on the sensory biology, especially the visual and chemical ecology of these interactions and integrates behavioural ecology at the organism level with mechanisms influencing such behaviour.

The highly species-specific mutualism between figs and their pollinating fig wasps is one study system. Parasitic galling and parasitoid wasps also use the fig receptacle, giving rise to a complex system where wasps compete for egg-laying space and hosts within the fig microcosm. The lab also investigates the flight ecology of fig wasps including wasp metabolic rates, and adopts a transcriptomic and proteomic approach to study wasp olfactory genes.

When studying fungus-farming by termites, the group found that termites prevent parasitic fungi from invading their crops of mutualistic fungi by sniffing out the parasitic ones and burying them. The engineering aspects of termite mound construction, specifically the nature of the biocementation that termite architects provide to build a stable mound, and whether the cement is of termite or microbial origin, are also being investigated. The lab also studies the mutualism between ants and plants and uses stable isotopes to establish that both parties feed each other essential nutrients.

Another theme is the differences between the day and the night in plant signal–animal receiver systems. The lab investigates the sensory ecology of communication between plants and pollinators at a community level and examines diurnal and nocturnal pollination networks.



## RAGHAVENDRA GADAGKAR

*"The evolution of social life in insects."*

The lab has been pursuing empirical and theoretical, field and laboratory, work on a single species for over 30 years – the primitively eusocial wasp *Ropalidia marginata*. Research involves a variety of approaches, including experimental, biochemical and molecular techniques.

Over the years, research in the lab has shown that queens mate multiply and mix sperm from different males; workers rear rather distantly related brood and are unlikely to discriminate between different classes of relatives, and that all individuals are not equally fit for social or solitary life. The research has led to the "Assured Fitness Returns" model, which explains how group living can confer advantages over solitary life, which are independent of genetic relatedness.

Another research theme focuses on proximate questions of social organisation and queen-worker interaction in the species. The wasps show behavioural caste differentiation like age polyethism, though there are no morphological castes. Queens of *R. marginata* are behaviourally docile, meek sitters, but still manage to assert dominance, probably by starting their career as aggressive queens and switching to the pheromonal control of worker reproduction. Though human observers cannot predict the identity of the successor, the wasps themselves appear to know who the successor would be in the event of the death or loss of the queen.

Prof Gadagkar is also the Chair of the Centre for Contemporary Studies at IISc, Bengaluru, which aims to forge meaningful interaction between the natural and human sciences, with a particular focus on exposing graduate students to the diverse research methodologies of different disciplines.



## RAMAN SUKUMAR

*"Conflict, conservation and climate change."*

This group researches four broad themes: wildlife ecology, tropical forest ecology, climate change and conservation biology. Starting with Prof Sukumar's PhD in the 1980s, ecology, and social and reproductive biology of the Asian elephant has been a primary topic of research in the group. Since 1988, permanent plots in the forests of the Nilgiri Biosphere Reserve have acted as natural 'laboratories' for research on forest dynamics, seed dispersal, fire ecology and the effect of invasive species. The numbers of large

mammals – elephants, gaur, spotted deer, sambhar and the dhole – have also been estimated in parallel at Mudumalai, allowing for the study of interactions between flora and fauna.

With the ever-increasing human population, the conflict between humans and the animals they share space with has been increasing. The lab has been working to find strategies to minimise and mitigate human-wildlife conflict. An overarching research theme is conservation, including the long-term monitoring of elephant populations in southern India to understand demography and track ivory poaching, and radio telemetry of elephants in Bengal to get a better idea of elephant movement, need for space and the ecology of human-elephant conflict in the area. The behavioural ecology of elephants in the context of male-male competition and female choice of male phenotypes has also been studied in Kaziranga.

The kind of data collected in the lab also allows for the development of complex models that can predict the impact of climate change on the forests and biodiversity of India.





## PRAVEEN KARANTH

*"Biology in an evolutionary framework, using phylogenies."*

The lab is primarily concerned with trying to find answers to exciting problems in biology in an evolutionary framework. To this end, genetic variation both within and among the species is characterised, and these data are in turn used to address questions in ecology, evolution, behaviour and conservation biology.

Research involves using molecular tools and computational techniques to arrive at interrelationships between species, typically pictured as a phylogenetic tree. Using phylogenetic trees in combination with morphological, behavioural, and ecological data, research in the lab has resolved the taxonomy of problematic species such as the Hanuman langur and identified cryptic species in centipedes and lizards.

Species phylogenies across multiple taxa can also be used to get a better understanding of past climatic and geological changes that might have shaped current distribution of both fauna and flora. In this respect, the research in the lab is directed toward understanding how the Indian biota was assembled. Studies from the lab have explored the origins of select groups and their diversification within India.

Genetic variation within a species, and how the variation is spread over space, can provide insights into isolation and gene flow between populations. The group is using a variety of model systems with different life history traits, breeding biology and habitat requirements to understand the intrinsic and extrinsic factors that determine how genetic variation is distributed across a species' range. Results from these studies can, in turn, be used to address conservation issues.



## KARTIK SHANKER

*"The distribution of diversity across space and time"*

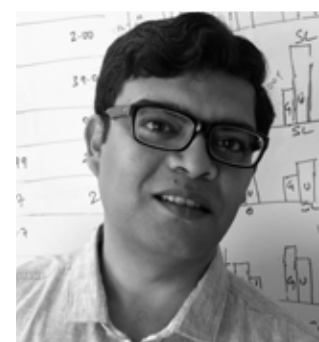
The research group combines field ecology, phylogenetics and ecological modelling to understand the evolutionary ecology of both marine and terrestrial taxa.

The lab works on the systematics and historical biogeography of vertebrates, particularly frogs, lizards and snakes. Work in terrestrial habitats is mainly in the Western Ghats, extending to other parts of peninsular India, including the Eastern Ghats, and Northeast India for some groups.

Another focus of the lab is on large-scale altitudinal and latitudinal patterns of distribution and diversity using models which integrate neutral theory, ecology and evolution. These include studies of amphibians, reptiles, birds and plants at the scale of the Western Ghats. The lab also works on coastal and marine systems, both along the mainland as well as in the offshore islands.

Research on community ecology includes studies on the costs and benefits of hetero-specific grouping in diverse systems, from bird flocks in tropical forests to schools of marine reef fish. Marine turtle biology and conservation studies include long-term monitoring of leatherback turtles in the Andaman Islands, olive ridley turtles in Odisha, and green turtles in the Lakshadweep islands, on aspects of population biology, genetics and foraging ecology. This research also explores the potential impact of climate change on the sea turtle populations through its effects on sex ratios.

Kartik Shanker is also involved with the Dakshin Foundation on projects that involve local communities in research, monitoring and conservation. He is currently on deputation as Director, Ashoka Trust for Research in Ecology and the Environment, Bengaluru.



## SUMANTA BAGCHI

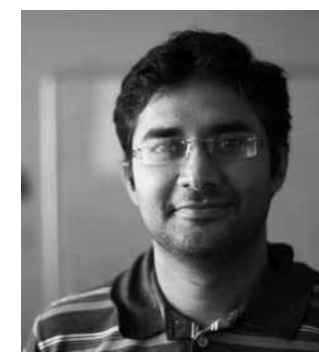
*"Ecosystem function and services, human influence, and conservation."*

Research in this lab covers topics related to how natural and human-modified ecosystems respond to disturbance and change in climate, and whether these responses would likely mitigate climatic effects, or enhance them.

The lab has been working in the Trans-Himalaya, studying the impacts of grazing by domestic livestock and native herbivores. A related research theme is to quantify how plants and animals interact to influence soil fertility in these semi-arid shrub-steppe rangelands.

Rangeland vegetation, due to their long evolutionary history with large-bodied grazing mammals is often thought to be resilient and capable of absorbing chronic and periodic disturbances. To understand if this is true, the lab has been studying data on vegetation composition collected over decades, to see how historical dynamics are influenced by climatic patterns.

Conservation in multiple-use landscapes is another research theme. Human-wildlife conflict is a recurrent theme across the country, sometimes arising from predators preying on domestic livestock. The team is also working to determine whether ecosystem function and services can lead to incentives for conserving biological diversity.



## VISHWESHA GUTTAL

*"The dynamics of ecological systems"*

A running theme of the lab is to build predictive mathematical models of ecological systems. The lab works on understanding patterns of moving animal groups such as the locust swarms and fish schools. These organisms often have access only to the local information of their environment. As a group, they exhibit patterns and perform tasks as if they have a collective mind. How do they do this?

There is also a focus on ecosystems such as forests and grasslands that may exhibit unexpected and dramatic changes. These systems are often subjected to human and other environmental stressors. The lab is interested in developing methods to predict their dynamics.

To understand these wide-ranging systems the group uses an interdisciplinary approach and develops mathematical and statistical methods to predict future dynamics of ecological systems. To validate and test predictions of the models, the group uses data from laboratory experiments, field observations and satellite imagery of forests. The unifying principle behind these works is that of scale, how local interactions between organisms produce remarkable large-scale dynamics of ecosystems.



## KAVITA ISVARAN

*"The evolutionary ecology of behaviour"*

Animals display a bewildering diversity of solutions to problems such as how to attract mates, whom to mate with, how many offspring to have, and how much resource to allocate to each offspring. The lab works on understanding the ecology and evolution of such diversity in behaviour and life history traits, particularly in social and reproductive traits.

Research in the lab is largely on wild populations. Current work focuses on (a) the dynamics of male and female mating strategies in the blackbuck antelope, a species with unusually variable social and reproductive behaviour; and (b) reproductive strategies, sexual selection, and animal personalities in a rock lizard.

Apart from the detailed studies of individual populations to dissect ecological and evolutionary processes, the group also investigates the generality of such processes in nature. The team uses phylogenetic comparative methods and meta-analyses to examine patterns of sexual selection across mammals and how this variation relates to ecological conditions, behaviour and sex-differences in life history and morphological traits.

Another research theme is to apply approaches from behavioural ecology and evolution towards conservation. To this end, the group studies decision-making by endangered antelope in fragmented grasslands and their consequences for conflict with agriculturalist, the adaptiveness of egg-laying behaviour in mosquitoes and their implications for population dynamics; and the mechanisms by which invasive plants influence native butterfly communities.



## KARTIK SUNAGAR

*"Molecular evolution of animal venoms and the next-generation snakebite therapy"*

This lab investigates venomous animals, and their venoms, as model systems to address basic but broad questions in ecology, evolutionary biology, and genetics. The group uses state-of-the-art technologies across multiple disciplines, such as transcriptomics, proteomics, genomics, antivenomics, molecular biology and bioinformatics to examine the fascinating evolutionary histories of the lineages of venomous animals and their venoms.

A particular emphasis is placed on characterizing the composition, toxicity profiles and evolutionary dynamics of venoms of the 'big four' snakes in India, as the lab will strive to deliver the Next Generation Antivenom with a commensurate improvement in safety, specificity and affordability of treatment. The protein composition, and hence the pathogenic potential of venoms, can exhibit dramatic geographical variation, with different populations of the same species having starkly distinct venom profiles and, consequently, resulting in a significantly reduced antivenom efficiency. Therefore, the lab will unravel intra- and interspecific venom variability in medically significant Indian snakes and utilise this information for the molecular design of effective snakebite therapy.

The lab will also investigate genomes, transcriptomes and proteomes of neglected venomous lineages such as sea snakes, scorpions, spiders, centipedes, jellyfish and Hymenoptera to understand the molecular basis of venom production, regulation, and evolutionary diversification. Such work can also help unravel the evolutionary forces that have shaped the current distribution of venomous animals in the Indian subcontinent. The lab also focuses on elucidating the genetic basis of venom resistance in the venomous animal and its prey and predators, and the therapeutic potential of venom proteins.



## MARIA THAKER

*"Physiology and behaviour at multiple scales"*

This research group studies animal behaviour at multiple spatial and temporal scales, using an integrative approach that draws from the fields of behaviour, physiology, ecology, and evolution.

The lab is particularly interested in ecological challenges, such as urbanisation or fire, and uses both field and laboratory studies to understand social and survival strategies of wild animals. Most of their experimental work on behaviour and endocrine mechanisms involves herpetofauna, whereas the landscape-level studies of animal movement strategies focus on mammals.

At the local scale, the lab examines the ecological and evolutionary drivers of variation in phenotypic trait complexes of multiple lizard groups. This work has been focussed on understanding how human-induced habitat changes, such as urbanisation or wind farms, affect animal colouration, social behaviour, health and immunity, diet, cognition, and many other functional phenotypic traits. The aim of this work is to understand the flexibility of phenotypes. The lab has now begun to utilise a nutritional geometry approach to examine defence strategies of lizards in response to predation risk.

At a larger spatial scale, the lab is interested in competition, coexistence, and decision making of animals. The team uses a movement ecology approach to examine landscape-scale movement decisions of African elephants in South Africa, as well as mesocarnivores in India.



## FARAH ISHTIAQ

*"Disease, ecology and conservation"*

The lab examines the effects of infectious diseases on the ecology and evolution of wild animals. The concept of 'disease ecology', or the idea that host-pathogen interactions can be studied within the context of their environment, which is central to understanding epidemiology and to preventing future outbreaks, has remained neglected in India. The group uses avian malaria as a model system to understand the ecology, evolution and epidemiology of emerging infectious diseases in natural bird populations.

Birds are susceptible to similar diseases as humans. For example, both avian malaria and human malaria are caused by protozoans of the genus *Plasmodium*. However, birds are not subject to the complexities of human socio-economic and cultural patterns, thus providing a better model system to directly examine the host-parasite interactions at various ecological and spatial scales. The work encompasses many aspects of biology, including molecular parasitology, ecology, evolution, and conservation genetics.





## T V RAMACHANDRA

*"Energy, wetlands and urban ecology."*

The research goal of this group is to achieve environmental sustainability in the context of diverse environmental challenges: from rapid population growth, deforestation, energy scarcity and climate change to livelihoods of people and natural resource management.

The group has developed an innovative and implementable energy plan for the Kolar district in Karnataka, based on mathematical modelling and optimisation. The theme is to prepare regional energy plans to meet energy needs and the development of alternate energy sources at least cost to the economy and environment. As part of its renewable energy focus, the group developed an ecologically sound alternative model for the Bedthi Hydroelectric Project in Karnataka, which reduces the submergence area. The team has developed the Geographic Resources Decision Support System (GRDSS), an open source decision support system that uses both Geographic Information Systems (GIS) and local field data to make decisions at various hierarchical levels.

A comprehensive biodiversity survey of the Sharavathi River Basin yielded 289 species of fish, of which 119 are endemic. The survey also yielded two new species of fish and one new species of frog. The lab has also designed and developed the Western Ghats Biodiversity Information System, a web-based system documenting the biodiversity of the region.



## MADHAV GADGIL [Retired]

*"Human ecology, natural resource management, ecological history and conservation."*

Prof Gadgil founded the Centre for Ecological Sciences in 1983. Over a long career that commenced in 1973, Gadgil has worked on ecology and evolutionary biology, conservation biology, human ecology, natural resource management and ecological history; collaborating with historians, sociologists, anthropologists, economists and linguists, apart from ecologists and biologists.

Among his many research contributions, Madhav Gadgil worked with the Karnataka Government to better manage the state's bamboo resources, resulting in the withdrawal of perverse subsidies to forest-based industries in the country. He initiated field studies in the newly established Bandipur Tiger Reserve in 1974 and was instrumental in the establishment of India's first Biosphere Reserve in the Nilgiris. A series of studies by his group in Uttara Kannada investigated plant and bird communities in the area and the interrelation of diversity levels amongst a range of organisms. He has also worked on the revival of sacred groves in Manipur. These studies are notable for considering human impact as an integral part of moulding ecosystems. Gadgil was part of the committee that drafted the Biological Diversity Act 2002 and has developed the methodology and database for People's Biodiversity Registers that has been recommended for country-wide adoption by the National Biodiversity Authority.



## NIRANJANA V JOSHI [Retired]

*"Mathematical modeling and analysis of interdisciplinary data."*

As a scientist interested in the modelling and statistical analysis of biological systems, N V Joshi has worked on a wide variety of topics. Starting with a fully computational PhD from the Molecular Biophysics Unit at the IISc, he was a mathematical programmer at the Centre for Theoretical Studies. He has set up mathematical models and analysed data from many disciplines – meteorology, ecology, animal behaviour and molecular biology. He is also one of the associate editors of the journal Current Science.

# FACILITIES



## MUSEUM

Over the years, the Centre for Ecological Sciences has built up a considerable museum collection of flora and fauna, particularly from the Western Ghats, and also from other regions of India. The collections include an extensive herbarium, insects, fish, amphibians, and reptiles. It is envisioned that the establishment of a Natural History Museum housed in IISc would serve two important purposes: to inform the general public about scientific research and the rich biodiversity of India, as well as to make available the specimens for further study. In addition, CES is also establishing an accessible tissue repository, which when coupled with the morphology of specimens, will greatly advance the study of evolutionary patterns of India's biodiversity.







The **Lotka Volterra Mathematical Ecology Lab** in the Centre for Ecological Sciences has state of the art facilities for teaching courses in qualitative methods in ecology. Twenty five Linux-based computers, each of which can be projected on a screen, make learning an interactive process. This assembly also allows for parallel processing, making research analysis and simulations an easier and faster task

The **Molecular Ecology Laboratory** is well equipped for basic molecular biology work such as extraction of DNA, polymerase chain reaction (PCR), Amplified Fragment Length Polymorphism (AFLP) and microsatellite work.



The **Environmental Chemistry Laboratory** is equipped with elemental analyser, TOC-TN analyser, photosynthesis gas-exchange analyser, and continuous-flow auto-analyser, for work on plant, soil, and water samples.

## HERBARIUM AND DIGITAL FLORA OF KARNATAKA



CES houses a herbarium with a fairly large collection of native and naturalised plants, collected by several taxonomists and researchers from India and abroad. The collection consists of more than 14,500 specimens from approximately 4000 flowering plant species, ferns and allies and lichens.

The Herbarium at CES has emerged as the only plant resource information repository

for the entire state of Karnataka. Recent efforts have added further collection of specimens from the states of Maharashtra, Tamil Nadu, Andhra Pradesh, and Odisha.

One important research activity in the herbarium has been to generate and organise vast amounts of information on the floral wealth of different regions of the country and then package it to suit the requirements of an online information system.

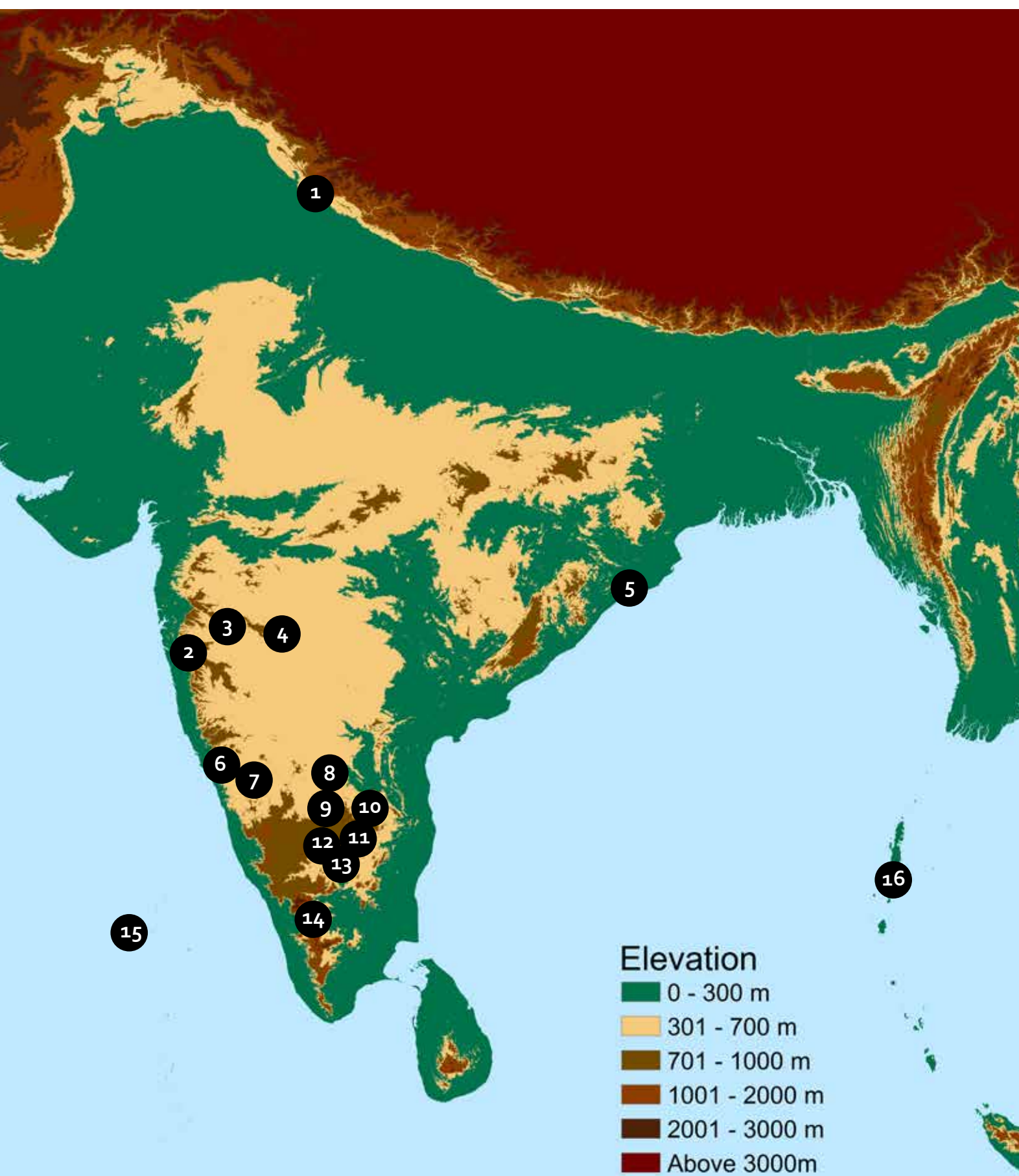
A long term goal is to build a plant resource Information Portal and outreach at CES that can be effectively used for ecological research among a multitude of other applications. Towards this goal, the herbarium team has developed an open access information system, a digital database, for the vascular plant flora of Karnataka State. Further to launching this Digital



Flora of Karnataka database (<http://florakarnataka.ces.iisc.ernet.in>), the team has embarked on a broad regional study towards developing an online plant information system for the Eastern Ghats biogeographic region as well.



# WHERE WE WORK



Centre for Ecological Sciences has long-term field stations and projects in many parts of India (numbered below). Many students and faculty also study biodiversity all over the country, with a particular focus on the Western Ghats.

1. Spiti, Himachal Pradesh
2. Chalkewadi, Maharashtra
3. Baramati, Maharashtra
4. Nannaj, Maharashtra
5. Rushikulya, Odisha
6. Anshi, Karnataka
7. Sirsi, Karnataka
8. Anantpur, Andhra Pradesh
9. Ullodu, Karnataka
10. Rishi Valley, Andhra Pradesh
11. Kolar, Karnataka
12. Bengaluru, Karnataka
13. Kadari, Karnataka
14. Mudumalai, Tamil Nadu
15. Agati, Lakshwadeep
16. Wandoor, Andaman and Nicobar islands





# STUDENT PERSPECTIVES

*"I study pair formation strategies in a katydid species that has a unique multimodal duetting system among Orthopterans, wherein males and females use signals in different modalities. I am trying to understand how sexes communicate in the complex canopy environment within and across trees."*

Aswathy Nair (RB lab)

*"Oviposition site selection in Aedes mosquitoes is shaped by multiple selection pressures. By studying how wild populations respond to environments that vary in multiple risk factors, we can better understand and explain the large diversity of behavioural traits in the natural world."*

Manvi Sharma (KI lab)

*"I study inter-species interactions, focusing on behavioural roles of different species and the formation of mixed-species associations in insectivorous forest-bird communities."*

Priti Bangal (KS lab)

*"While comparing the colour changing rock agamas from urban and rural habitats, I found that urban lizards are duller in colour but faster in their learning abilities compared to their rural counterparts."*

Anuradha Batabyal (MT lab)

*"Understanding the dynamics of nutrient cycling is important to understand our present climate and predict the future. I study how microbial processes regulate soil nutrient cycle and what implication this could have for our climate."*

Shamik Roy (SB lab)

*"I study how fig wasp species disperse from one plant to another, as some wasps travel large distances to find their hosts. By investigating how they fly, I show that species differ in their dispersal capacities."*

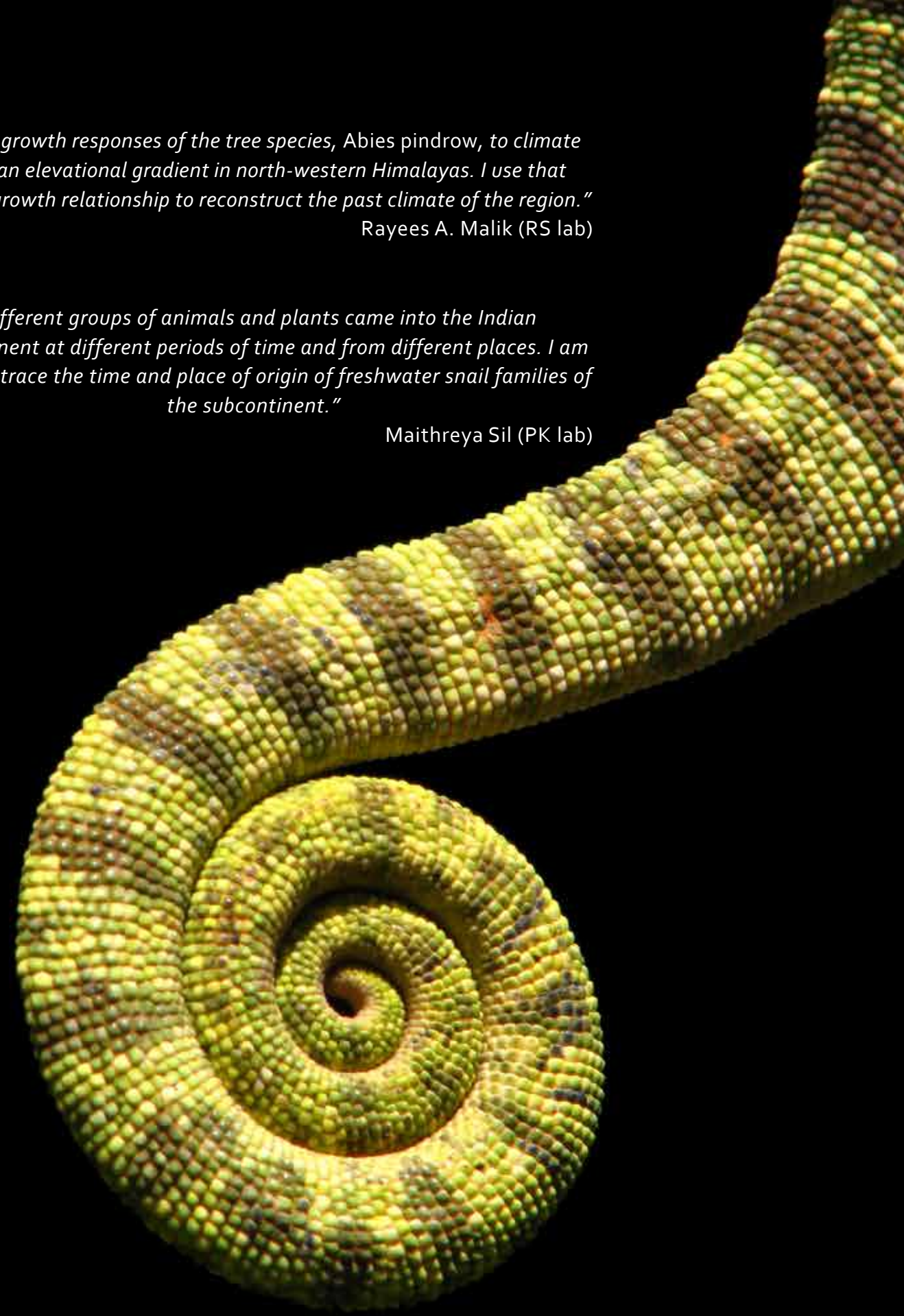
Vignesh V. (RMB lab)

*"I study growth responses of the tree species, Abies pindrow, to climate along an elevational gradient in north-western Himalayas. I use that climate-growth relationship to reconstruct the past climate of the region."*

Rayees A. Malik (RS lab)

*"Different groups of animals and plants came into the Indian subcontinent at different periods of time and from different places. I am trying to trace the time and place of origin of freshwater snail families of the subcontinent."*

Maithreya Sil (PK lab)





# REACHING OUT

CES plays an important role in promoting ecological and conservation science through training, capacity building and communication. This is done by supporting key student conferences in India and conducting training programmes for students, researchers and managers.

## STUDENT CONFERENCE ON CONSERVATION SCIENCE (SCCS) - Bengaluru

aims to bring together young researchers in the science of biodiversity conservation.

As a sister conference to the prestigious and highly successful SCCS-Cambridge, SCCS-Bengaluru is the first conference of its kind in Asia. The Centre for Ecological Sciences has been co-organizing SCCS – Bengaluru since its inception in 2010 and the conference is held in IISc.

Over the past five years, CES has also conducted more than 60 concept-based and skill-based workshops on a variety of topics in ecological and conservation science, including Open Source Geographic Information Systems (GIS), phylogenetics, herpetology, wetland, terrestrial and coastal ecosystems, village biodiversity, solid waste management and environmental education.



## CONTRIBUTION TO CONSERVATION POLICY AND IMPLEMENTATION

Faculty at CES have directly contributed to conservation policy and implementation at local, regional, and national levels. CES has been involved with local and regional environmental policy, through its role in National Green Tribunal Committee for Bengaluru wetlands, Karnataka State Pollution Control Board, and Karnataka State Wildlife Board. CES has been involved with national level policy through its role in the National Board for Wildlife (NBWL), National Wildlife Action Plan (NWAP), and others.

One of the senior faculty of CES has been a member of the National Board for Wildlife (NBWL) since 2014 and contributed to the deliberations through critical inputs on several projects, including carrying out site inspections of several projects such as the Ken-Betwa river link (Madhya Pradesh), rationalizing the boundaries of Kolleru Lake Wildlife Sanctuary (Andhra Pradesh), Satkosia Wildlife Sanctuary (Odisha) and Ramgarh Wildlife Sanctuary (Rajasthan), establishing mini-hydel projects in Arunachal Pradesh, and evaluating the potential impacts of the proposed railway line between West Bengal and Sikkim.

CES has contributed to the drafting of the National Wildlife Action Plan for the period 2017-22, which was released in late 2017. It has directly contributed to the inclusion of several new aspects such as climate change and landscape approaches to conservation.

CES faculty have contributed to the expert committee on climate change of the Ministry of Environment, Forest and Climate Change (MoEFCC) on matters such as greenhouse gas inventories, preparation of the National Communication to the UNFCCC, and the science plan for the new project titled 'Long Term Ecological Observatories' that was announced at the Paris Summit on Climate Change in December 2015.

CES had in the past contributed to the formulation of the Biological Diversity Act under the international Convention on Biological Diversity (CBD). It has continued to assist the MoEFCC in CBD matters during the Conference of Parties (CoP) hosted by India at Hyderabad in 2012, India's National Report to the CBD in 2014, and the Science for Biodiversity Forum at the CBD CoP at Cancun in 2016. CES is involved in the Genetic Engineering Appraisal Committee (GEAC) which is the Apex Body in the Government of India that gives approval to research on genetically modified organisms (GMOs) or their release into the environment in any form.





## BOOKS

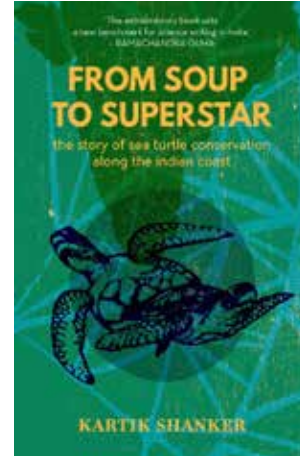
Faculty members at CES have written many books over the years, on a wide variety of topics mirroring their individual research work and interests. Some of them are listed below.



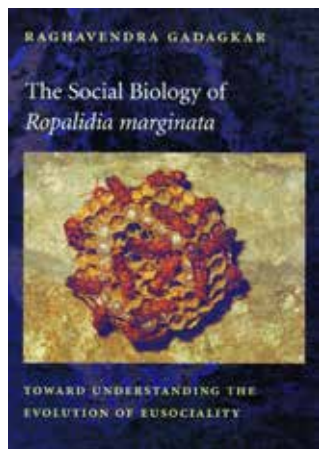
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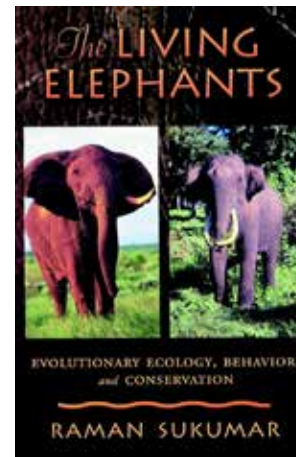
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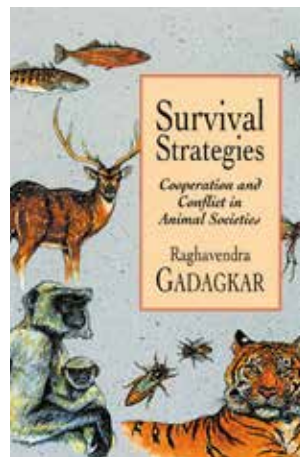
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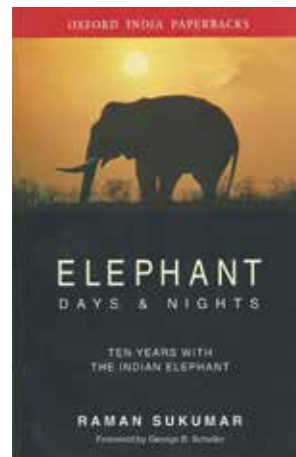
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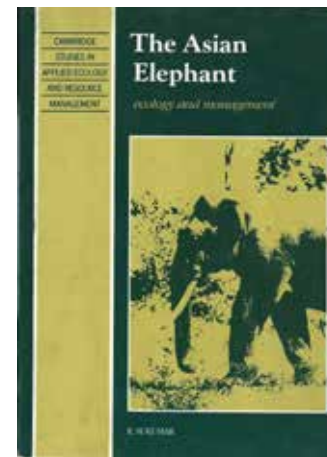
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