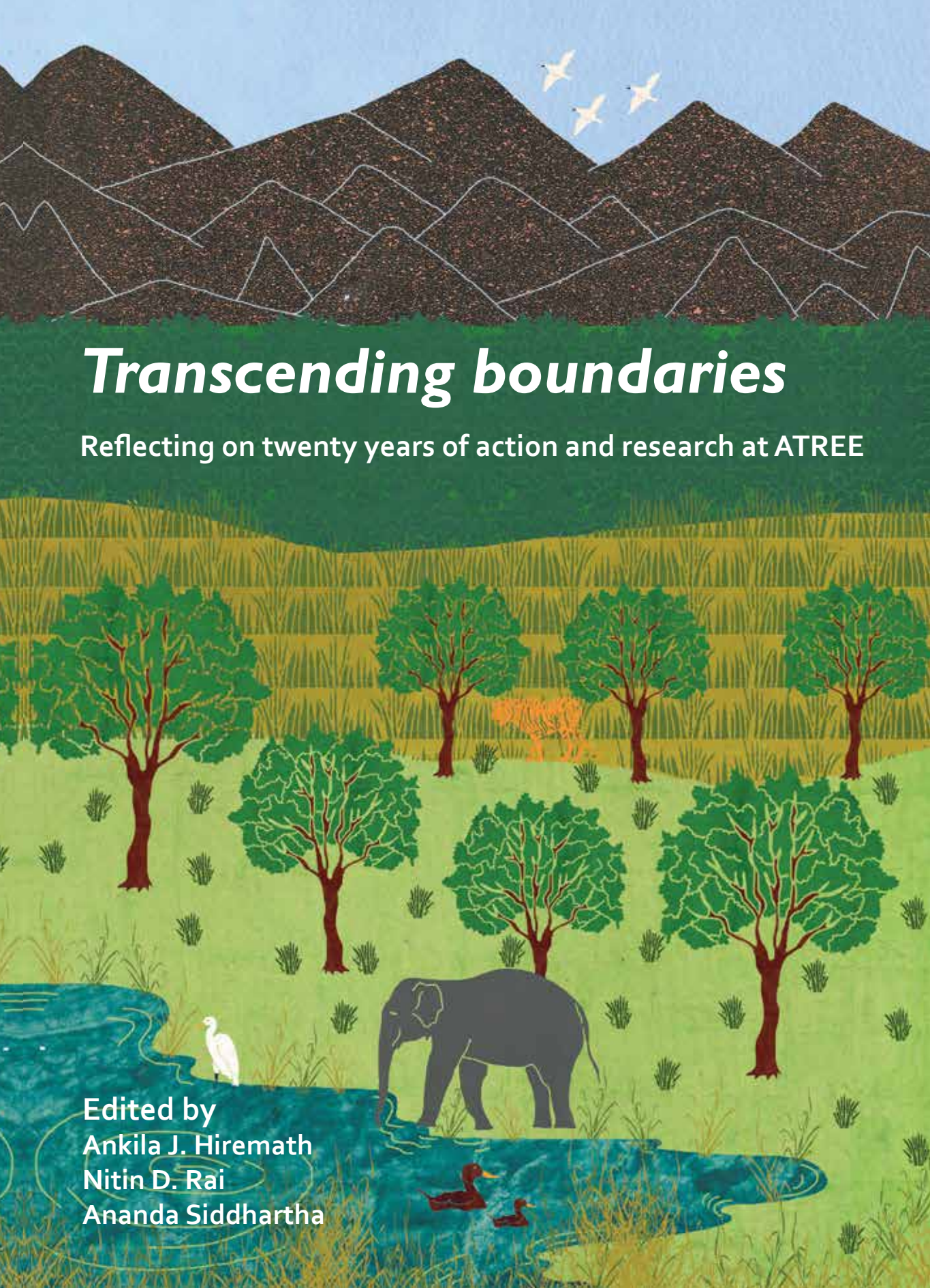

Transcending boundaries

Reflecting on twenty years of action and research at ATREE

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Conserving the less-charismatic: Making conservation inclusive for insect diversity

Dharma Rajan Priyadarsanan, Anu Radhakrishnan
and Seena Narayanan Karimbumkara

A parasitising fig wasp Apocrypta.
(Photo: Sandesh Kadur)

The mighty Indian banyan tree (*Ficus benghalensis* L) is pollinated by a tiny wasp, *Eupristina masoni*, which lives inside the ovaries of its miniscule flowers. The banyan tree, like every other species of fig (genus *Ficus*), hides its flowers inside the chamber of an urn-shaped inflorescence, which can be accessed only by fig insects (family *Agaonidae*). Similarly, each of the approximately 900 known *Ficus* species all over the world depends on a fig insect that is specific to that particular *Ficus* species, to reproduce. The fig insects lay eggs inside a few fig ovaries, and the larvae develop there. The *Ficus*, thus, provides food and accommodation to the developing fig insects by sacrificing several of their own offspring. Apart from providing food and space for these pollinators, and for other wasps that parasitise these pollinators, *Ficus* also provides food and shelter for a wide range of other animals—from thrips and ants, to apes and elephants—and therefore qualifies to be called a 'keystone' genus of tropical forests. Local extinction of fig insects due to habitat disturbance, changes in weather patterns, or for other reasons, can cause a breakdown of such a mutually beneficial relationship, which might lead to the extinction of Ficus species, thus triggering cascading effects on tropical forests. The 'Ficus–fig insect mutualism' best epitomises the importance of insects in the sustenance of the biosphere.

Insects form a major part of the biodiversity, and assume a critical part in ecosystem functioning. About 90% of flowering plants depend on an insect to get pollinated; insects consume more vegetation mass than all other herbivores; through predation, parasitism, and scavenging, they kill more animals than any other carnivores; and they are a vital prey base for many species, including humans. The morphological, ecological, and behavioural adaptations attained over a relatively long period of time, and the genetic versatility and diversification attained through co-evolution with flowering plants, make insects the most abundant and speciose organisms on earth.

Although many people are averse to the very idea, insects are a part of the human diet

Moth pupa being sold along with fruits at a market in Jaintia Hills, Meghalaya.
(Photo: Rajkamal Goswami)

all over the world. More than 300 species of insects are consumed in different parts of India, while more than 3,000 species of edible insects are recorded around the globe. Considering the growing human population, depleting natural resources, and strained environment, the Food and Agriculture Organisation (FAO) foresees a protein famine in the near future, and recommends insects as a viable alternate source of protein for humans.

Recent studies show that insects could even play an important role in mitigating the effects of climate change. For example, livestock are the largest source of anthropogenic methane, which is an important greenhouse gas. Methane formation is attributed to the growth of methyl forming bacteria in cattle manure, which need optimum temperature and moisture conditions. Dung beetles, belonging to the families, Geotrupidae and Scarabaeidae, bury dung pats into the soil, reduce the volatilisation of ammonia, and thus reduce methane emissions.

More than a million species of insects have been described after Carl Linnaeus, an 18th century Swedish biologist, who suggested the system of biological nomenclature—the system for naming, ranking, and classifying organisms, that we follow even today. It is estimated that there could be 5–30 million insect species, perhaps 85% or more of which still remain unknown to science; scientists are grappling to get a better estimate of the dimension of global insect diversity. Because of their small size and modest needs, most insects and other invertebrates—such as nematodes (round worms), spiders, molluscs (snails, clams, etc.)—occupy ecological niches that are more numerous, smaller in all dimensions, and more sensitive than those of vertebrates. Many species of insects are highly endemic, are sensitive to habitat disturbances, and even to microclimatic changes. Unprecedented loss of insect diversity across biomes is now widely acknowledged. Rapid habitat loss or alteration, and hazardous pollutants, are recognised as important causes for this decline. The situation is particularly serious in the tropics, where invertebrate diversity is poorly documented. Currently, in the tropics we have reached a situation where we do not even have a rough estimate of how many invertebrate species are threatened, or have already become extinct in the last few decades. This is largely due to our poor documentation and understanding of invertebrate diversity and ecology. This state of affairs is amply reflected in the peripheral treatment of invertebrates in our conservation policies, laws, and management practices.

A rare fungus feeding dung beetle Delopleurus parvus.
(Photo: Seena Narayanan Karimbumkara)

KNOWLEDGE OF A THING PERISHES IF THEIR NAMES ARE UNKNOWN (CARL LINNAEUS)

Sound taxonomy is fundamental to the conservation of biological diversity. If an organism cannot be identified, we cannot understand the consequences of environmental changes and habitat degradation on that species; nor is the conservation of that species or group possible without proper identification (see Ganesan et al, this volume). Approximately 60,000 species of insects are identified and named in India, and it is estimated that at least 400,000–600,000 or more species are yet to be discovered. Somehow, in the post-independence era, insect studies have largely been biased towards control of pests to increase agricultural productivity, rather than focusing on diversity, or the ecological importance of insects. Today, species extinction is occurring faster than species discovery, and the loss of insects can impact ecosystem goods and services, and thus human wellbeing.

Since gene flow is largely restricted within it, the species is the natural taxonomic rank that forms the basis for both conservation assessments and management. Fundamental observations of the species or populations that require conservation attention are translated into some kind of population monitoring programmes, which lead to species conservation. Such systematic characterisation and quantification of biodiversity forms an essential pre-requisite for its conservation, management, and sustainable utilisation. Moreover, correct identification of the species forms the foundation for the formulation and implementation of national and international legislations. Without correct taxonomy, the lists that globally drive species conservation efforts, such as the International Union for Conservation of Nature (IUCN) Red Lists prioritising species for conservation, or The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) lists of species prohibited in international trade, are nugatory.

Onthophagus jwalae* *(Photo: Seena Narayanan Karimbumkara & Dharma Rajan Priyadarsanan)*

Due to realisation of the importance of biodiversity after the Convention on Biological Diversity (CBD) came into effect, taxonomy is at the threshold of a revival all over the world. The practice of taxonomy is making rapid strides, by imbibing energy from developments in molecular and computational techniques. Existence of a taxonomic impediment for conserving biological diversity, underscored by the CBD, is explicit in India. Irrespective of growing demand for taxonomic expertise, the number of taxonomists are dwindling all over the world. In recent years, research in insect systematics has dwindled at an alarming rate in India, and the number of practising taxonomists has come down drastically, with only a few trained taxonomists engaged in active research. The number of people available for systematics needs to be increased several times to fulfill the primary task of inventorying our insect fauna. Unfortunately, national policies are further impeding taxonomy and biodiversity research in India. For example, legislations such as the Biodiversity Act (2002), instead of promoting taxonomy, are bringing in new obstacles to taxonomic research, by impinging upon the freedom of researchers for exchange of specimens between countries for comparative studies, and even to safely deposit type specimens in museums of their choice[1]. Quality taxonomic research requires extensive collaboration and cooperation among specialists and institutions across continents, as the type of specimens of even closely related species may be held in museums in different continents (see Ganesan et al., this volume). No country has ever possessed enough expertise to identify all biological groups, and this gap was traditionally addressed through collaboration and collegiality of taxonomists. Species and genera with extensive geographical distributions breaching political boundaries of nation states make biological systematics truly international in theory and practice[2].

Onthophagus pithankithae* *(Photo: Seena Narayanan Karimbumkara & Dharma Rajan Priyadarsanan)*

Onthophagus tharalithae* *(Photo: Seena Narayanan Karimbumkara & Dharma Rajan Priyadarsanan)*

[1] Prathapan, KD., DR. Priyadarshanan, TC. Narendran, CA. Viraktamath, KA. Subramanian, NA. Aravind, and J. Poorani. 2006. Biological Diversity Act, 2002: shadow of permit-raj over research. *Current Science* 91(8): 1006–1007.

[2] Priyadarshanan, DR., and P. Divakaran. 2009. Shared ownership of biological resources. *Science* 324(5930): 1014–1015.

** new species described by the lab in 2016*

BOX 1: THE TRUE DUNG BEETLES IN THE WESTERN GHATS

Dung beetles have recently received a great deal of attention from ecologists and conservationists, due to the range of ecological roles they play, and their high sensitivity to many kinds of human activities and habitat disturbances. They have therefore, been identified as an ideal focal group for biodiversity monitoring and inventory. Our studies have revealed that, dung beetle diversity increases with proximity to human settlements, owing to the high concentration of resource in the form of cattle dung, or human excreta.

India has a rich dung beetle fauna of around 400 species, belonging to 30 genera and nine tribes. According to our ongoing studies, the Western Ghats has an exceptionally rich dung beetle fauna of 194 species, belonging to 29 genera. Apart from this, nine more new species of dung beetles have been described from the Western Ghats, and two from North East Himalayas.

-Priyadarsanan Dharma Rajan and Seena Narayanan Karimbumkara.

"Your job in the dung is not easy. You have your own unique skills. Be of service and help others." -Elise Icten. Considering the ecological importance, dung beetles (Scarabaeinae) are a focal group for ecological studies for entomologists at ATREE. Image: Proagoderus pactolus *(Fabricius, 1787) (Photo: Anu Radhakrishnan)*

DEMOCRATISING TAXONOMY FOR CONSERVATION AND HUMAN WELLBEING

A reliable and comprehensive taxonomic treatment of most insect taxa of India is lacking, and this is impacting conservation, and other insect-based enterprises in the country. This is why ATREE has deliberately chosen insect taxonomy as one of the areas of its focus. The Insect Taxonomy and Conservation Laboratory (CITAC, ATREE) has initiated several national and regional-level programmes for advancing insect taxonomy in India by integrating taxonomy with modern techniques, and linking it to conservation and sustainable management of natural resources. Taxonomists here are undertaking inventory and taxonomic revisions of several lesser known, and functionally important, insect taxa such as dung beetles (subfamily Scarabaeinae), fig insects (family Agaonidae), ants (family Formicidae), etc. The insect lab team has published two monographs, several research papers, and described several species new to science over the past few years. This research team, in collaboration with the India Biodiversity Portal, is leading an effort to compile information on insect resources of India into a multi-relational database, to be disseminated through the portal. The team has already compiled and published two national databases, one for Orthoptera (grasshoppers, crickets, etc.) and the other for Scarabaeinae (true dung beetles; see Box 1) of India[3]. These databases contain an information page for every species so far reported from India. Each species page is a compilation of curated systematic information of that species, high quality images depicting key features, habitat, and associated ecological, evolutionary, and ethno-biological information. The species pages also contain digitised data and images of specimens maintained in different museums within and outside India, including type specimens (i.e., specimens on which the species description is based).

[3] http://indiabiodiversity.org/species/list

Students from pilot schools of the Vembanad Bioblitz being engaged in a Bioblitz session at ATREE-CERC, Alappuzha. (Photo: Anu Radhakrishnan)

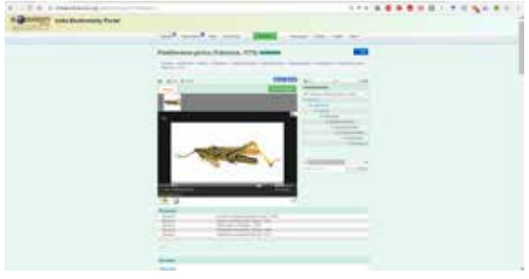
India should prioritise taxonomy as an important science, which forms the basis for the conservation of biological diversity. ATREE is attempting to revitalise insect taxonomy in India by training young taxonomists, organising capacity building and policy workshops, networking, strengthening inter-institutional collaborations, and providing taxonomic services to those who need it in an organised way.

A BOTTOM-UP STRATEGY FOR CONSERVING INSECT DIVERSITY

Recent studies show that insects in the tropics are already living at the limit of their temperature threshold, and could be among the first taxa to go extinct as a result of global warming. The prevalent trend in conservation has been to neglect insects and other invertebrates due to their smaller size, and the associated taxonomic impediment. While formulating conservation policies and legislations, insects and other invertebrates, which comprise more than 95% of all species, are overlooked. Instead of graduating to an interdisciplinary and inclusive approach, conservation is still pivoting around a protectionist paradigm[4]. Such a conservation approach focusses on 'charismatic species', such as the tiger or elephant. It is time we ended this fetishisation of charismatic species, in order to conserve biological diversity that occurs across, and outside, protected areas. Large mammals utilise an extensive variety of habitats, and may not be as sensitive to small environmental changes as invertebrate taxa. The same yardstick that applies for the conservation of tigers cannot be applicable to tiger beetles, which are a much more diverse group with different niche requirements.

Questions vital to conservation, such as how a particular species of tree is pollinated, or how the pattern of herbivory is affected due to changes in climate, largely remain unattended. Many species of insects are being discovered from extremely small areas of the tropics. The potential diversity of these life forms in the tropics is very high, and if a relatively small area is logged or disturbed, many species will disappear forever. For example, Ficus, the most revered plant group in India, and a keystone resource for several birds and mammals, are the victims of developmental activities such as road widening. During one of our recent studies on fig insects (Chalcidoidea) collected from fig trees in Bengaluru urban district, we discovered that almost a dozen out of the 40 species of wasps were new to science. The goals of the CBD cannot be accomplished by conserving a few taxa and their habitat, but by conserving habitat heterogeneity, and ensuring ecosystem functioning.

An increasing human population is projected as the reason for biodiversity loss in India, but a closer perusal reveals a different picture: a large amount of biodiversity lies in island habitats such as village forests, or farm corridors amidst human-dominated landscapes. The majority of the Indian population still lives in these villages, synergistically protecting the biodiversity which they also depend on for their livelihood. Habitat loss and fragmentation caused by large tracts being converted for various development projects, and other environmental disturbances, are the major drivers of biodiversity loss.



Orthopterans of India species page hosted at India Biodiversity Portal (IBP).

We often forget lesser-known taxa like invertebrates, which comprise more than 95% of all species. The potential diversity of these less-charismatic taxa in the tropics is very high, and most of these are endemic to very small areas. Therefore, if a relatively small area is logged or disturbed, many species will disappear forever. Hence, every ecosystem, every fragment, small or large, is important for conserving insects. Since the majority of species remain undescribed, and data on the distribution and abundance of only a very few described species are available, assessing the threat status of each species, according to current day conservation norms, may not be practical. Very little is known about the degree of loss in insect diversity, and the extent to which tropical forest management can minimise their loss. So, for effectively conserving the insect diversity, rather than a species-focussed approach, a conservation paradigm prioritising habitat heterogeneity and ecosystem health should be evolved. In short, conservation needs a 'habitat approach', conserving 'macroscapes' to conserve maximum diversity and maintain ecosystem integrity.

Further Reading

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Dung beetles, ants and general collections at AIM-B. (Photo: Anu Radhakrishnan)

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