PROJECT LIFESCAPE

1. An Invitation

Introduction

Along with his many scientific contributions, Salim Ali will be remembered for a whole series of superb books on Indian birds, books that played a key role in stimulating popular interest in India's rich living heritage. In celebration of his birth centenary the Indian Academy of Sciences has launched project '**Lifescape**' as a part of its initiative to enhance the quality of science education. This project aims to publish illustrated accounts of 1500 Indian species (and higher taxonomic categories such as orders and families) of microorganisms, plants and animals. These accounts would help high school, college and postgraduate students and teachers of biology to reliably identify these taxa, and thereby constitute a basis for field exercises and projects focussing on first hand observations of living organisms. The information thus generated could feed into a countrywide system of monitoring ongoing changes in India's lifescape to support efforts at conservation of biological diversity, as well as control of weeds, pests, vectors and diseases. These accounts would also help create popular interest in the broader spectrum of India's biological wealth, much as Salim Ali's books have done for birdlife over the last fifty years.

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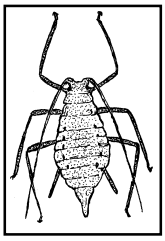
The setting

India is a land of great natural diversity. A total of 1,26,656 species of living organisms have been described from our subcontinent; probably another 400,000 are waiting to be described. India is also one of the global centres of diversity of crops and livestock. This biodiversity and its knowledge are now assuming great significance, for the second half of twentieth century belongs to sciences and technologies of life. Beginning with the elucidation of the chemical nature of heredity, life sciences have made rapid strides in understanding of the working of the machinery of life. Knowledge is power; and this understanding has

Our roots are deep in the woods,
Among the mosses, close to the springs,
Our spirits soar high in the sky,
Among the birds and butterflies.

Madhav Gadgil, after Emil Galle, c. 1884

Species so far described from India.	
Bacteria	850
Algae	6500
Fungi	14500
Lichens	2000
Bryophytes	2850
Pteridophytes	1100
Gymnosperms	64
Flowering plants	17500
Protista	2577
Other invertebrates	8329
Arthropods	60383
Mollusca	5050
Protochordata	116
Fishes	2546
Amphibia	206
Reptiles	485
Birds	1228
Mammals	372



Specimens of only 10% of described species of aphids, an important group of crop pests are available in India. (Illustrated by Sapna Rawat)

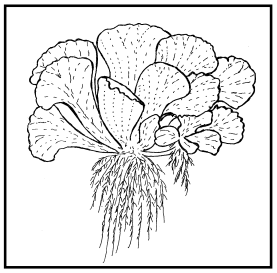
been translated into evergrowing sophistication in manipulating living organisms. This has opened up many novel possibilities of application, and it is expected that the resulting biotechnologies may account for as much as 40% of the world economy in the coming decades. The stupendous diversity of life is the raw material for these applications and an understanding of this diversity must go hand in hand with a deepening understanding of the working of life to reap fully the fruits of modern advances in biological sciences.

Unfortunately, India's scientific base of knowledge of this diversity of life and ways of adding value to it is very weak. Only some 20% of the species we harbour are likely to have been scientifically described; but even of these a large proportion has been described by western scientists. Their specimens are often located abroad but are absent from Indian collections. Thus of 82000 described species of animals, specimens of only 51000 species are located in the Indian Museum in Calcutta. Specimens of an additional 1000 animal species may be available with other institutions; that leaves 30000 species for which the specimens reside only abroad. In case of animal groups like aphids, India holds specimens of only about 10% of the described species. Aphids are important crop pests and now foreign agencies holding Indian material are charging heavy fees of thousands of rupees for help in identifying a single specimen.

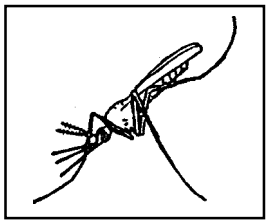
We are equally unfavourably placed in terms of scientific capabilities of identifying, working with and adding value to biodiversity resources. Every year more than 100,000 students get a bachelor's degree in one of the Life Sciences. But only a very small fraction of these get an exposure to India's living wealth. Practically none of them are able to name more than 5 to 10 species of plants or animals put together. This is because they are rarely encouraged to look at living creatures abounding around them, their training being confined to identifying a few dead specimens, or dissecting a still living cockroach or a dead pigeon. Given such a training programme few teachers of biology know much of the living wealth of India either.

Monitoring biological populations

Identification of the great diversity of living organisms around us is a challenging task that calls for a high level of professional training and infrastructure. But equally significant is a task which can be undertaken without sophisticated technical inputs - this is the task of countrywide monitoring of ongoing changes in the populations of living organisms. We need to do so for a variety of reasons- to appreciate if populations of medicinal herbs are on decline through overharvests, or if wild relatives of cultivated plants are being eroded through habitat transformations; to appreciate if populations of weedy species such as Water Hyacinth are exploding and choking our wetlands, or whether new species of insects are assuming pest status for our crops; and to keep track of populations of vectors of human diseases such as mosquitoes. This is a task which can be effectively discharged by developing the capability to reliably identify a few thousand species for the country as a whole. Only a few hundred out of this set of a few thousand may be present in any given locality. It is quite possible for students and teachers of biology to acquire the competence to properly identify these taxa, each for their own locality, given adequate support in terms of literature, and given the motivation to acquire this knowledge.



Pistia, along with Water Hyacinth and Marsilea are important water weeds. (Illustrated by Sapna Rawat)



Anopheles mosquito, a vector of malaria, needs to be controlled through ecological management

Two facets of Biology

To assess this proposition, we must take a second look at the teaching of biology. Teaching and research in biology are addressed to two facets of life:

(a) Functioning of life based on a machinery largely held in common by organisms as different as bacilli, moulds, trees and birds, and
(b) The resulting diversity of living organisms and their associations.

The functioning of life is the subject matter of the disciplines of biochemistry and molecular biology, physiology, developmental

biology and genetics. The diversity of life is the subject matter of disciplines of morphology, taxonomy, evolution, ecology, ethology and biogeography. The former set of disciplines may be termed functional biology, the latter organismic biology. In teaching functional biology the emphasis has to be on the underlying commonalties; genetic code is the same whether taught in Mumbai or Mombasa, Madurai or Massachusetts. In teaching of organismic biology, however, the focus should change. The variety of birds or butterflies is indeed very different and much greater in Madurai than in Massachusetts. To teach functional biology in Madurai on the basis of text books and laboratory experiments designed in Massachusetts can be sensible; to teach organismic biology in a similar fashion does little justice to the wealth of life in and around Madurai.

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There is yet another significant difference. Our understanding of functional biology is rapidly advancing. But this calls for probing into the machinery of life with sophisticated instruments, with expensive chemicals. Given our limited financial resources, Indian universities and colleges are at a disadvantage in arranging laboratory exercises for teaching many aspects of functional biology. Our understanding of organismic biology is also advancing. Twentyfive years ago, it was estimated that there were around 3 million different species of living organisms, of which some 1.6 million had been described. Subsequent studies have led to an upward revision of this estimate to somewhere between eight to twelve million. This implies that most of the diversity of life has not even been documented in terms of a simple description and naming of species, let alone taken further in understanding of the ecological role, geographic distribution, evolutionary relationships of that species. Most of these unknown species are believed to occur in tropical forest and coastal habitats. They must be identified, their distribution, their ecological role investigated where they occur in their natural setting; that means a tremendous opportunity for us in India in adding to the store of biological knowledge.

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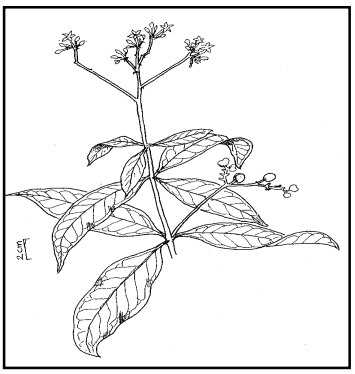
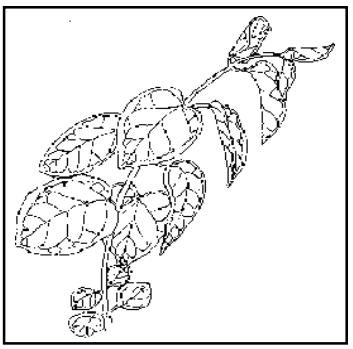
Untapped opportunities

Of course, some of these investigations require considerable support in terms of literature and museum or herbarium specimens; little of such support is available within our country. But description of new taxa is only one part of research in organismic biology; information on the distribution and abundance of many species of known significance is also of considerable relevance. As stressed above, much of this is of applied value - we need to know whether populations of medicinal plants like Sarpagandhi (*Rauwolfia serpentina)* or wild relatives of cultivated plants like Wild Rice (*Oryza nivara)*, are threatened with extinction, where and when populations of crop pests like brown leaf hopper or vectors like anopheline mosquitoes are undergoing rapid increase. Such information is vital to efforts at conservation of our rich biodiversity resources, and attempts at control of pests, diseases and vectors.



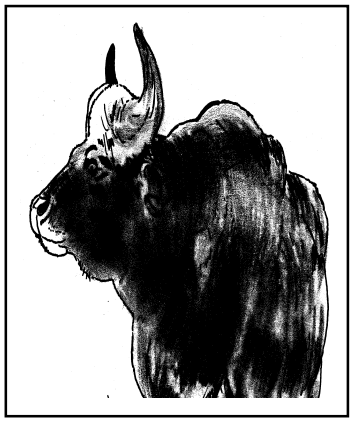
Sarpagandhi, is one of the many medicinal plants, threatened by overexploitation and habitat loss. (Illustrated by Sriganesan)

This kind of information, information for monitoring populations of thousands of species of human significance needs to be continually collected from all over the country. There are of course centralized agencies entrusted with the task of doing so, but they are unable to do full justice to this responsibility. Thus we do have a Botanical Survey, a Forest Survey, a Central Institute of Medicinal and Aromatic Plants; yet we have essentially zero information on the status of hundreds of species of medicinal plants of the country.



Gymnema sylvestre, with its wonderful capacity to regulate sugar level in the blood is much sought after by the drug industry. (illustrated by Sriganesan)

Obviously these centralized organizations must be supported by a much more widespread network of centres for monitoring the populations of a number of species of living organisms across the length and breadth of our vast country. Undergraduate science colleges along with high schools and centres of postgraduate studies are clearly the answer. These span every one of country's 500 districts, a vast source of scientific competence that has been made little use of. The Botany, Zoology, Microbiology teachers and students of these colleges could easily study and document the distribution, abundance and seasonal and



Gaur serves as the emblem of Nature Conservation Society. (Illustrated by Sapna Rawat)

annual changes in populations of a few hundred species of organisms in their own localities. Indeed, there have already been several interesting experiments along these lines. Around the Palamau Tiger Reserve in Bihar, biology teachers from some undergraduate colleges have formed a network called Nature Conservation Society for monitoring the Tiger Reserve ecosystem working in collaboration with the Wildlife Wing of the State Forest Department. The Western and Eastern Ghats Biodiversity Network co-ordinated through the Indian Institute of Science now involves botany and zoology teachers from some 60 colleges working with teams of students to map local landscapes and investigate the occurrence of species of a number of groups of plants and animals. Such studies not only would constitute a valuable learning experience, they would also generate considerable information of potentially applied value which could feed into a properly organized bioresource monitoring system of the country.

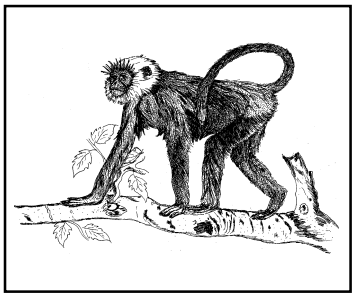
Fresh approach

It is thus feasible to take up this challenge. But to do so successfully calls for a fresh approach to the teaching of organismic biology. Functional biology has to be taught on the basis of a largely uniform curriculum focussed on laboratory experiments. Organismic biology could be taught much more meaningfully on the basis of a flexible curriculum focussing on locally occurring plants, animals and microbes, and should supplement laboratory exercises by extensive field observations. These requirements of flexibility, of scheduling field observations, and of assessing field based studies do pose difficulties, but these can surely be overcome with some effort.

Hanuman Langur is one of the best studied species of primates. (Illustrated by Sapna Rawat)

Such an approach need not however involve additional burden of course work. Thus in zoology courses we have a paper on chordates. As a part of this paper students learn of platyrrhines, the primitive monkeys found in South America, but they do not learn that Jodhpur has troops of Hanuman Langur (*Presbytis entellus)* which has been the subject of fascinating ecological

and behavioural studies in India. They are not encouraged to estimate these monkey populations or observe their social behaviour. If all zoology students in India are taught of the identity of the macaques, langurs, gibbons in their respective localities and encouraged to yearly maintain records of the monkeys troops in their own area, we could organise an ongoing monitoring of primate populations in a highly cost effective fashion. It would be no serious loss if in the process, we teach the zoology students a little less of squirrel monkeys in South America.

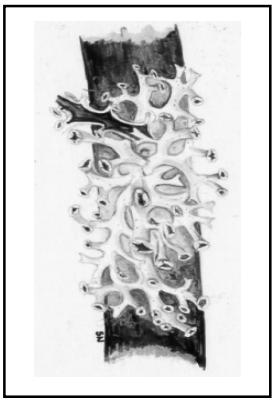


Nilgiri langur occurs only in the rainforests of Western Ghats. (Illustrated by Sapna Rawat)

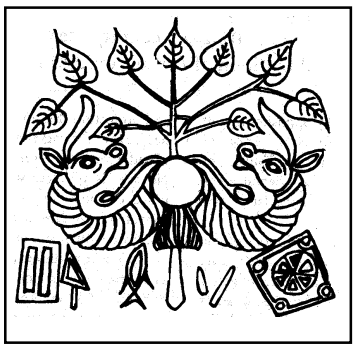
Lifescape of India

We may then aim to come up with an overall list of target species of plants, animals, and microcrobes whose first hand observations might form an important component of teaching of environmental sciences or biology - not all species everywhere, but in some part of India or other. For instance, this list may include a few of primate species - (1) Bonnet Macaque, (2) Rhesus Macaque, (3) Assamese Macaque, (4) Hanuman Langur,(5) Nilgiri Langur, (6) Hoolock Gibbon. Only one of these species may be selected for study in any given locality - for instance, Bonnet Macaque in Madurai, Hanuman Langur in Jodhpur, Hoolock Gibbon in Shillong and so on. This is not to suggest that students should close their eyes to species outside this list; the listed target species should instead serve to build a foundation for getting students involved in observing other living organisms as well. Employing the study species as an example, the students would then observe its members under natural conditions and in the process become familiar with the morphological characteristics of primates, the place in classificatory scheme and evolutionary relationships of macaques as a part of the Chordate paper. They could observe their habitat use, food preferences and estimate their numbers as a part of the ecology or environmental biology paper, observe their social behaviour as a part of the behaviour paper, look at their geographical distribution as a part of the biogeography paper, and so on. Some of their observations could also feed into a country-wide project of monitoring primate populations. Lifescape target species may contribute in-

If all zoology students in India are taught of the identity of the macaques, langurs, gibbons in their respective localities and encouraged to yearly maintain records of the monkeys troops in their own area, we could organise an ongoing monitoring of primate populations in a highly cost effective fashion



Lichens, highly successful symbiotic associations of algae and fungi are excellent indicators of air quality. (Illustrated by Sanjeeva Nayaka)



At least since the time of Harappan civilization. Peepal has been a tree of great cultural significance. (Illustrated by Prema Iyer)

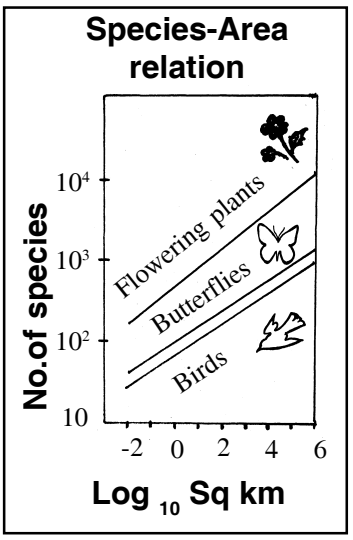
teresting material to teaching of other subjects as well. Thus the active molecules from medicinal plants may figure in biochemistry courses, or their trade in courses on sociology and economics.

Our list of target species has to be a subset of the described 1,26,656 species of India. We therefore need some criteria for inclusion in the total list. Possible candidates for such criteria include:

1. Economic significance, for instance, medicinal plants, wild food plants, plants producing minor forest products such as tendu leaves, genetic resources such as wild relatives of cultivated plants or domesticated animals, animals which may be bred under domestication with profit, such as in butterfly farming, crop pests, weeds, crop pollinators, vectors of human diseases, fresh water fishes.
2. Striking appearance and therefore ease of and attraction to observation: larger mammals, commoner species of birds, crocodiles, fireflies, dragonflies, and plants with attractive flowers, large trees.
3. Cultural significance : Monkeys, Peafowl, *Ficus* species such as Peepal.
4. Conservation significance, for instance, endemic or threatened species.
5. Desirability of having representatives available in all parts of the country, from Port Blair in Andamans to Leh in Ladakh, and from rainforests of Mizoram to concrete jungles of Mumbai.
6. Desirability of having representation of all groups of living organisms. Thus we should include seaweeds, lichens, mushrooms, ferns along with higher plants amongst wild food plants.

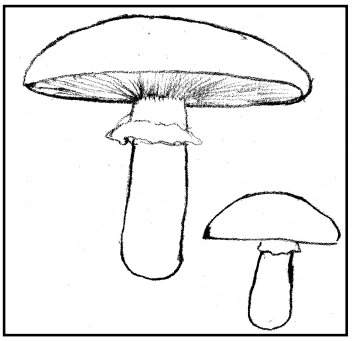
How big should such a national list be? Any educational institution could readily include an area within a radius of 3.2 km.; say a total area of 32 $km^2$for the field studies. The total area of our country is 32 lakh km^2, larger by a factor of 1,00,000. Ecologi-

cal theory tells us that depending on the group of organisms concerned the total number of species encountered increases at a power of 0.2 to 0.4 with area. This implies that a study area of 32 km^2 may harbour between 1% to 10% of the total described species; i.e. between 1260 to 12600 species of microbes, plants and animals, all put together. Students at any educational institution should then have access to several hundred species of living organisms in their close vicinity. Recent investigations in 52 village clusters distributed throughout the country indicated that villagers know between 150 to 400 different species of plants and animals. Trained biology students could surely learn to know these many species without much difficulty. Following the rule of thumb of 1% to 10% of total set being present in the vicinity of any given school or college in the country, the national list has to lie in the range of 1,500 to 40,000. For reasons of practicality it is best to aim to the lower part of this range; so we may begin with an initial national list of 1,500 species. Such a list may also serve as the list of indicator species for assessment of the status of biodiversity in the country for the purpose of Indian national reporting to the Convention on Biological Diversity.



Public Awareness

Apart from becoming an integral part of the educational system, such an effort, based on the availability of good illustrated accounts of some 1,500 significant species of living organisms of the country could trigger off popular interest in the broader spectrum of the country's living diversity. At the time of independence there were hardly any amateur bird watchers of Indian origin; today there are hundreds of bird watchers' clubs. An important cause behind this transformation is the availability of good pictorial guides beginning with Salim Ali's *Book of Indian Birds* first published in 1941. This has been followed by a series of other excellent field guides. In addition, there are the volumes of Fauna of India and a number of Floras. But much of this latter material is too technical and of little practical use to non-specialists, even to biology M.Sc's. For instance, there is no ready aid for us to identify such striking groups of plants as lichens or of



Mushrooms like Agaricus campestris serve as indicators of soil quality. (Illustrated by Sanjeeva Nayaka)

animals as dragonflies. None of this material also tells us how to go about assessing the populations of the species, or the many interesting questions that may be posed about their ecology, behaviour, distribution. The proposed material on the 1,500 species should fill these manifold gaps and make it possible for the citizens of India not only to become familiar with but ask intelligent questions about our living companions - not just birds, but butterflies and wasps, earthworms and orchids, starfishes and toads, lichens and lizards. If many of us can easily get to know them, their fate would become much more meaningful to us, contributing to a broader public concern for the health of India's environment.

An initial set of target species

Plants	
Mushrooms	20
Lichens	3
Aquatic plants	23
Orchids & Epiphytes	44
Herbs	43
Weeds	43
Shrubs	22
Trees	112
Bamboos & Rattans	18
Ficus	16
Medicinal plants	252
Animals	
Freshwater molluscs	44
Earthworms	16
Spiders	15
Aquatic insects	86
Ants	30
Insect pests	64
Insect v ectors	15
Wasps	31
Butterflies	71
Freshwater fishes	65
Amphibians	15
Reptiles	34
Birds	195
Mammals	40

Progress so far

Project lifescape took shape through a brainstorming session organised on the occasion of the birth centenary of Dr. Salim Ali in November 1996. The concept was then fleshed out through more in - depth discussions with specialists such as scientists belonging to Botanical and Zoological Surveys, CSIR labs and Universities. The project, conceived as a broad based participatory effort has successfully reached out to a large number of professionals as well as amateur naturalists through information disseminated through scientific and natural history journals and newsletters. This has evoked a very positive response with over 1200 people expressing an interest in becoming involved in the project to write accounts, to review them, to translate them in Indian languages or contribute in other ways. In consultation with this broad group of people, and with special inputs from a group of about 80 people interested in a programme of monitoring the biodiversity of Eastern and Western Ghats, we have finalised a first list of about 1500 taxa as the target groups. This list may be accessed through the website at ***http://ces.iisc.ernet.in/hpg/lifescape/***. It would also be sent by e-mail or ordinary post to anybody who requests it. We have also decided on the contents of the individual accounts. The accounts would be in as non - technical language as possible, supplemented by a glossary of technical terms in cases where their use is essential.

The purpose of this series of ten articles in Resonance is to share this material with the Indian scientific community. The articles will include examples of accounts at higher taxonomic as well as species level followed by glossaries of technical terms. We would also suggest standardised formats for the accounts.

An open invitation

The Indian Academy of Sciences would like to take this opportunity to renew the invitation to all nature lovers of the country, professional biologists as well as amateur naturalists to take part in the project. In particular we would greatly appreciate offers to submit accounts on the identified target taxa in the standard formats. We would welcome illustrative material; in particular as black and white sketches, but also as photographs from which such sketches could be prepared. We would appreciate offers to review and help edit the material with respect to specific taxonomic groups. All such help would be duly acknowledged. As of now the Indian Academy of Sciences has received no financial grants for this project; however, if these materialise in future, we would be happy to provide a modest honorarium. Apart from such specific offers, we would welcome any comments and suggestions to take this effort forward. The response may be directed to Madhav Gadgil, Chief Editor of Project Lifescape.

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Further Reading

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