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INTERNATIONAL E-SYMPOSIUM ON BIODIVERSITY (IESB-2020-SSC)

**Habitat Fragmentation and Its
Lasting Impact on Biodiversity
of Indian Subcontinent**

03rd & 04th February, 2021

**Swami Sahajanand College
Jehanabad, India**

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(IeSB-2020-SSC)

“Habitat Fragmentation and Its Lasting Impact on Biodiversity of Indian Subcontinent”

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International e-Symposium on Biodiversity (IeSB- 2020-SSC)

“Habitat Fragmentation and Its Lasting Impact on Biodiversity of Indian Subcontinent” II

**Proceedings of the Symposium Session
(03rd & 04th February, 2021)**

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Dr. Hema Somanathan, Associate Professor, School of Biology, Indian Institute of Science Education and Research, Thiruvananthapuram, Kerala, INDIA

Dr. Monimul Islam Nahid, Department of Biology, Norwegian University of Science and Technology (NTNU), Trondheim, NORWAY

Dr. Indra Acharja, Chief of Species & Habitat Conservation Division (SHCD), Royal Society for Protection of Nature (RSPN), Thimphu, BHUTAN

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Dr. Tapan Kumar Dey, Deputy Conservator of Forest (Rtd), Department of Forest, Ministry of Environment and Forests, Government of Bangladesh, Dhaka, BANGLADESH

Dr. Md. Kamrul Hassan, Associate Professor, Department of Zoology, Jehangirnagar University, Dhaka, BANGLADESH

Mr. Damber Bista, Doctoral Researcher, School of Agriculture and Food Sciences, University of Queensland, Brisbane, AUSTRALIA

Foreword

In tune with the National and International perception concerning conserving/protecting biodiversity, our institution, Swami Sahjanand College, Jehanabad, Department of Zoology, has also come up with a prospective plan and organized two days international e-Symposium to enhance the forest cover and its quality, to abet mitigation and adaptation in the context of climatic change. The perspective plan is set with a clear understanding of the vulnerability of the Indian Himalayan region, to climatic change. The intricate linkage between the livelihood of its people, availability of natural resources, sustainable developments, and the overall economy and ecological health of the nation is well established and our surrounding is extremely climate-sensitive.

The diversity of life forms, so numerous that we have yet to identify most of them, is the greatest wonder of this planet. The biosphere is an intricate tapestry of interwoven life forms. Even the seemingly desolate arctic tundra is sustained by a complex interaction of many species of plants and animals, including the rich arrays of symbiotic lichens. Biodiversity – the diversity of life on earth – is represented as the variability among living organisms from all sources, including diversity with species, between species, and in the ecosystem. Biodiversity thus includes not only the millions of different species on Earth; it also consists of the specific genetic variations and traits within species (such as different crop variants) as well as the various types of different ecosystems, marine and terrestrial, in which human societies live and on which they depend; such as coastal areas, forest, wetlands, grasslands, mountains, and deserts. Biodiversity is essential for sustainable development and human well-being. It underpins the provision of the food, fiber, and water, mitigates and provides resilience to climatic change, supports human health and provides jobs in agriculture, fisheries, forestry, and many other sectors. Without effective measures to conserve biodiversity and sustainably use its components, the 2030 agenda for sustainable development will not be achievable.

“The full enjoyment of human rights, including the rights to life, health, food, and water depends on the service spent on health and sustainability. The full enjoyment of human rights thus depends on biodiversity, and the degradation and loss of biodiversity undermine the ability of human beings to enjoy their human rights”. The submission of this e-symposium is holistic in approach and attempts to achieve the national goal of sustainable development of biodiversity through proper planning and implementation. I on my behalf and on behalf of Swami Sahjanand College, Jehanabad would like to disperse my heartiest thanks to Mr. Praveen Deepak, Department of Zoology, and all the esteemed faculty members of the college, members of the webinar committee, all the office staff for its successful accomplishment. I am sure this multifaceted-based e-symposium dealing not only with the sustainable development of biodiversity but also with an improvement in an array of ecosystem services, will make the people and land of our nation more updated to the vagaries of the ever-changing environment.

February 2021

Prof. (Dr.) Sudhir K. Mishra
Principal

Preface

The Symposium has been organized by Swami Sahjanand College, Jehanabad (A model college & constituent unit of Magadh University, Bodhgaya, India) on the theme “Habitat fragmentation and its lasting impact on the biodiversity of Indian subcontinent” in collaboration with Science for Society, Bihar and Mandar Nature Club, Bhagalpur to levitate a discussion that how it could be possible to conserve the nature, natural resources, biodiversity, and its wild habitats, and stay untouched which is still untouched without the cost of development. As we must be aware that biodiversity plays an indispensable role in human lives; it not only has a role in human survival but, also in their daily lives. However, it has not been always appreciated. Today, it is facing a lot of threats and challenges. To cope with the compelling demand of ever bursting human population, urbanization, industrialization, and an urge for development put us on the stage where we feel a necessity to think. Today, biodiversity experiences major challenges from degradation/fragmentation/spoilage of wild habitats throughout the globe that warrants an urgent need for its conservation.

Although, India has a rich tradition of conserving our habitat and biodiversity; India too stands up among other nations in recent times due to heavy demand for natural resources to deal with the need for expanding population and increased ecotourism. This leads to habitat loss and/or habitat shrinkage continuously posing a threat to biodiversity in the degraded ecosystem because of the resulting loss of shelter, loss of food, shrinkage of mating grounds, loss of other vital resources, etc., at the macro level. Due to the shrinkage of habitat, large animals often move to residential areas and/or cities, causing a human-animal conflict. The frequent human-animal confront is also one of the threats to the wild animals. India has today, at least 683 animal species listed as critically endangered, endangered, and vulnerable categories, and at least 48 plant species as critically endangered species by the International Union for Conservation of Nature (IUCN) in the 2019 report. Therefore, it is time-demanding for everyone to come together to discuss the impact of habitat shrinkage and fragmentation on the biodiversity of the Indian subcontinent and draw a cohesive and consolidated approach to protect the wild habitat as well as biodiversity without compromising the development goals of recent times.

Understanding the value of biodiversity conservation, Prime Minister of India Sri Narendra Modi also declared the theme of environment day, 2020 as biodiversity to call upon the need for biodiversity conservation as an immediate action need. All these issues compel us to organize such deliberation as an effort to take interest in this field among the youngsters in Universities and Colleges. Organizing IeSB-2020-SSC is also an effort to bring researchers in the field of habitat and biodiversity together from the Indian subcontinent to discuss present-day scenarios and prospects for the conservation of native or endemic wildlife animals and plants. Despite its too specific nature, a large number of researchers, faculty members, research scholars, and students have participated from different countries like Bangladesh, Bhutan,

Cameroon, China, Egypt, Iraq, Malaysia, Nepal, Nigeria, Pakistan, Philippines, and Sri Lanka apart from India and contributed their study reports in the form of full-length articles or abstracts in the symposium proceedings. All of these submissions went through a blind mode peer-review process.

Symposium program featured a rich and diverse session topics by distinguished high-profile keynote speaker; Dr. Govindhaswamy Umapathy, CCMB, Hyderabad, India shed light on the loss of biodiversity due to human activities in human-dominated landscape of Western Ghats of India using lion-tailed macaque as a model species, and Prof. Harini Nagendra, Azim Premji University, Bengaluru, India discussed the need of conservation measures in the city under increasing urbanization pressure, Prof. Sudipta Chatterjee from TERI School of Advance Studies, New Delhi, India explained “Biodiversity conservation in India in face of global changes”, Prof. Vinita Gowda, IISER, Bhopal, India spoke about “Ecological landscaping: Why is revisiting the biology in urban and rural planning critical today?”, Prof. Hema Somanathan, IISER, Thiruvananthapuram, India beautifully explained “Foraging behavior and pollination services provided by Indian bees”, Prof. Sandun J. Perera, Sabaragamuwa University, Belihuloya, Sri Lanka explained “From Wallace’s Ceylonese sub region to the Western Ghats and Sri Lanka Biodiversity hotspot: A biogeographic tale”, while Prof. Narayan Sharma, Cotton University, Guwahati, India outlined the “Impact of habitat loss and fragmentation on the primate assemblages of Upper Brahmaputra Valley, Northeastern India”, Dr. Indra Acharja, Chief of Species and Habitat Conservation Division (SHCD), Royal Society for Protection of Nature (RSPN), Thimphu, Bhutan explained about “White-bellied Heron *Ardea insignis*, the indicator of health of Himalayan fresh water river system”, Dr. Monimul Islam Nahid, Norwegian University of Science and Technology, Trondheim, Norway spoke about “How human disturbance can affect the brood parasitism and nest predation of the hosts inhabiting in a highly fragmented habitat”, Dr. Vinutha R. Bhatta, Jyoti Nivas College, Koramangala, India beautifully explained “Distribution and abundance of native bee species in an Urban Green Space in Bengaluru with an approach to sustainable urban development and diversity conservation, while Ms. Kalpana Ghimire spoke about Diurnal activity pattern of Assamese macaque (*Macaca assamensis* McClelland, 1840) in Nagarjun Forest, Shivapuri Nagarjun National Park, Nepal. Many more participants also presented their doctoral studies during the symposium session. Unfortunately, our eminent keynote speakers Dr. Kamrul Hassan, Jehangirnagar University, Dhaka, Bangladesh due to an educational tour with Forest Department Staff, Dr. Tapan K. Dey, Deputy Chief Conservator (Rtd), Department of Forest, Government of Bangladesh due to unknown reason, and Mr. Damber Bista, Wildlife Science Unit, School of Agriculture and Food Science, University of Queensland, Brisbane, Australia due to his busy fieldwork in remote bushy terrain could not join the symposium.

Organizing such a deliberation requires contribution from all quarters. This symposium, too, enjoys the support from the Mandar Nature Club, Bhagalpur, India (an all-time active NGO dedicated to the conservation of biodiversity and well engaged in environmental education for several decades), Science for Society, Bihar, and the Department of Zoology, Magadh University, Bodh Gaya which it might not have been possible to organize in such a large spectrum. We are indebted to the Principal, Swami Sahjanand College, Prof. Sudhir K. Mishra for his acceptance and immediate nod for going ahead. We are equally indebted to Prof. (Retd.)

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Arun Kumar, President, Science of Society, Bihar, and Sri Arvind Mishra, Founder and Member of Executive Council, Mandar Nature Club, Bhagalpur for bringing all organizations under one umbrella for the purpose. The publications chair added prestige to the symposium by inviting the Chairman, Journal of Wildlife and Biodiversity, Dr. Morteza Naderi for publication of the proceedings of the Symposium. I am fortunate to have a dedicated organizing committee who were always there to ensure the smooth and quality execution of the symposium. We would like to thank everyone who contributed to this effort including authors, session chairs, keynote speakers, committee(s) members, journal house, volunteers, and sponsors. Without their support, the event would not have been successful event.

February 2021

Praveen Deepak

Organizing Secretary, IeSB-2020-SSC

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Understanding biodiversity loss in a human-dominated landscape in the Western Ghats-Lion-tailed as a model species

Govindhaswamy Umapathy

Laboratory for the Conservation of Endangered Species (LaCONES), CSIR-Centre for Cellular and Molecular Biology (CCMB), Hyderabad – 500 030, Telangana, India
E-mail: guma@ccmb.res.in

Abstract

Habitat fragmentation is the most serious threat to biological diversity and is the primary cause of the present extinction crisis. This is particularly true in the tropics. Studies on the management of small populations, therefore, occupy a central place in conservation biology. The Western Ghats, especially tropical rain forests there, are well known as a center of very high biodiversity. Nearly a century of human activities in this area has removed vast areas of forests. The remaining rainforest occurs as several isolated small forest fragments. Even between 1920 and 1990, there was a 40% loss of forest cover and a four-fold increase in the number of forest patches in the Western Ghats. Studies in the last three decades have revealed that substantial changes have occurred in the animal communities in rainforest fragments in the Western Ghats, with the endemics being adversely affected. One of the most adversely affected species is the lion-tailed macaque, *Macaca silenus*. The lion-tailed macaque is an ideal model to examine the factors that affect the survival of small populations isolated in forest fragments. We examined the impact of these factors on the long-term survival of small populations of lion-tailed macaque concerning regulation dynamics, demography, genetic variations, host-parasite interaction, behavioral reproductive physiology. We will discuss these results and their implication for the conservation management fragmented lion-tailed macaque population.

Keywords: Habitat fragmentation, Biological diversity, Lion-tailed macaque, Genetic variation, Population dynamics, Western Ghats.

Keynote Speaker Abstract

Urbanization: A new frontier for conservation

Harini Nagendra

Department of Development, PES Institute of Technology, Azim Premji University,
Bengaluru – 560 100, Karnataka, India
E-mail: harini.nagendra@apu.edu.in

Abstract

India's cities are on a breakneck path to growth. Cities are engines of prosperity and promise, but also concentrations of pollution, stress, and disease. Episodes of flood, drought, heat waves, and smog tell us why we must begin to think ecologically about our urban future in Indian cities. Many Indian cities were built on a firm basis of local ecology, drawing on the rivers, lakes, forests, grasslands and coastal areas around them for food, water and building material. Yet over centuries the human population has grown and transformed the ecology of our cities beyond recognition. This talk will discuss how we need to learn from our past urban history, to re-design cities to accommodate ecology, ensuring human wellbeing as well as resilience to climate change.

Keywords: Urbanization, Climate change, Ecology, Re-design city, Conservation.

From Wallace's Ceylonese subregion to the Western Ghats and Sri Lanka Biodiversity Hotspot: A biogeographic tale

Sandun J. Perera

Department of Natural Resources, Faculty of Applied Sciences, Sabaragamuwa University,
P.O. Box. 2, Belihuloya – 70140, Sri Lanka
E-mail: sandun.perera@appsc.sab.ac.lak; sandun.perera@gmail.com

Abstract

Stemming from the global zoogeographic regionalization by Wallace in 1876 based on the mammalian distribution patterns, Sri Lanka showed biogeographic links with the wetter hills of southern India. Biodiversity Hotspots, being one of the most successful mechanisms in channeling conservation funds in the past two decades have reinstated the links between the Western Ghats and Sri Lanka in its identification as a hyper-hot biodiversity hotspot, within which vastly endemic biodiversity is facing an imminent threat of extinction. Nevertheless, recent advancements in molecular phylogenetics have suggested unique evolutionary lineages sister to each other being isolated in the Western Ghats and Sri Lanka. Hence, this area emerges with a great potential for evolutionary biological and historical biogeographic studies as two isolated biogeographic entities sister to each other, while being recognized together as a priority area in conservation biology. Here I discuss some of the known insular speciation patterns and evolutionary radiations within this area and its historical processes being conferred as drivers of making it a biodiversity hotspot, touching upon various hypotheses presented over the past. I present the phenomena of mainland-island dispersal events and insular speciation of taxa driven by alternative plio-Pleistocene glaciation cycles with an emphasis on the continental island of Sri Lanka, suggesting similar patterns of historical zoogeography in wet montane islands of the Western Ghats in xeric lowlands of India and further collating emerging evidence for an 'out of Sri Lanka' hypothesis in addition to the established hypotheses for explaining the biogeographic links and higher levels of endemism in the Western Ghats and Sri Lanka.

Keywords: Biodiversity hotspot, Ceylonese subregion, Conservation, Endemism, Historical biogeography.

Keynote Speaker Abstract

Foraging behavior and pollination services provided by Indian bees

Hema Somanathan

School of Biology, Indian Institute of Science Education and Research, Maruthamala,
Thiruvananthapuram – 695 551, Kerala, India
E-mail: hsomanathan@iisertvm.ac.in

Abstract

The most important contribution of honey bees is not the production of honey and other products, but the vital pollination services they provide to wild and crop plants. However, little is known about Indian honeybees or solitary bees. In this talk, I will first focus on the foraging tasks performed by bees and their coordination among colony members. I will then go on to present results on the foraging behavior of bees in different Indian landscapes and their role in the pollination of crops and other plants. I will conclude by emphasizing how little we know about Indian bees and the urgency with which we must seek to understand their ecology and status.

Keywords: Honey bees, Pollination, Foraging, Ecology, Indian landscape.

Keynote Speaker Abstract

Impact of habitat loss and fragmentation on the primate assemblages of Brahmaputra Valley, northeastern India

Narayan Sharma^{1,2,3}

¹Department of Environment Biology and Wildlife Sciences, Cotton University, Guwahati – 781 001, Assam, India

²School of Natural Sciences and Engineering, National Institute of Advance Studies, IISc Campus, Bengaluru – 560 012, Karnataka, India

³Nature Conservation Foundation, 1311, “Amritha”, 12th Main, Vijayanagar 1st Stage, Mysore – 570 017, Karnataka, India

E-mail: narayan.sharma@cottonuniversity.ac.in

Abstract

The fragmentation of unbroken tracts of wildlife habitat mediated by human action is a critically important conservation problem, especially in the tropics. As tropical forests are increasingly being converted to other land-use forms, habitat fragments are becoming ubiquitous features of any tropical landscape. Most of these fragments, now located in intensely-modified production landscapes, are crucial in supporting regional biodiversity as considerable biota continue to persist in them. These fragments are, however, facing growing threats from various developmental activities as the marginal populace depends heavily on them to fulfill their daily resource needs. Understanding the process of habitat fragmentation and its various ecological consequences on species residing in such fragments is, therefore, essential in developing conservation strategies to mitigate the adverse impacts of habitat fragmentation. My study examines the causes and consequences of habitat fragmentation on the wild primates of the upper Brahmaputra valley of Assam, a rich landscape with eight primate species that has witnessed severe habitat fragmentation over the last century. The upper Brahmaputra valley of Assam, particularly the region south of the river, is extremely rich in biodiversity that includes eight primate species, comprising a loris, a langur, four macaques and two species of apes. It is, however, severely fragmented due to various historical and current socio-economic processes, and continuously sculpted by geological processes such as periodic earthquakes and seasonal floods. I analyze the historical socio-economic drivers during three watershed periods of upper Brahmaputra valley located these changes within the political economy and demographic milieu of each regime. The pre-colonial period (5th century AD–1826)—with its sparse population, agriculture-based economy and regional markets—appears to have had relatively little impact on the valley’s forest cover. During the colonial period (1826–1947), however, forest cover began to decline against the backdrop of unprecedented population increases and the emergence of new settlements in the valley. This followed colonial policies and institutions geared to extract and exploit the natural resources of the region, and linked the local economy to the demands of global markets. The post-colonial period (1947– present),

considered by some as an extension of the policies of the colonial regime, continues to see an intensification of natural resource extraction, leading to further shrinkage and degradation of forest cover in the valley. By the end of the last century, most of the valley's forest cover not only reduced to one fourth of its original extent but also became highly fragmented with several isolated habitat fragments, punctuated in a seemingly endless swathe of human settlements, agricultural fields and tea plantations, all crisscrossed by roads, railway tracks and electric power lines. Consequently, the once extensively distributed populations of several mammalian species, including primates, have become completely fragmented and a few of them already locally extinct; some of these splintered populations, however, continue to linger tenuously in a few of these rapidly shrinking fragments. The time has now come to ask whether it is worthwhile to invest scarce resources in conserving these habitat remnants situated within some of the most densely-populated production landscapes of the country. Are these fragments fated to lose their species anyway? If not, do other ecological, anthropogenic and species-related factors mitigate the effect of fragmentation and offer conservation opportunities for these habitats and their last primate populations? I answer these questions by evaluating the local- and landscape- scale factors that influence the richness, abundance, distribution and local extinction of six primate species in 42 lowland tropical rainforest fragments in the upper Brahmaputra valley. These forest fragments appear to have lost, on average, at least one species in the last 30 years but still retain half their original species complement. Primate species richness has declined with the proportion of habitat lost by these fragments but seems not to be significantly affected by fragment size and isolation. The occurrence of western hoolock gibbon and capped langur in these fragments was inversely related to their isolation and habitat loss respectively. Fragment area determined stump-tailed and northern pig-tailed macaque occurrence, Assamese macaque distribution was influenced negatively by illegal tree felling while rhesus macaque abundance increased with increasing habitat heterogeneity. Primate extinction in a fragment was primarily governed by the extent of divergence in its food tree species richness from that in contiguous forests. These results underline the high conservation value of these last rainforest habitat remnants, which collectively retain the entire original species pool and individually retain significant fractions of it, even a century after fragmentation. These snapshot studies were, however, not sufficient to highlight the actual trends in primate population persistence and extinction in these fragments. I therefore, monitored the population of six diurnal primates in one large (2,098 ha) and three small (< 500 ha) fragments over a period of seven years and compare our observations with those from earlier studies. Our results suggest two different trends in population persistence and extinction in these fragments. There was a dramatic decline in the population of the six primate species in all the three small fragments, Borajan, Bherjan and Podumoni, over the observation period. Primate abundance has, however, increased significantly in the large fragment, the Hollongapar-Gibbon Sanctuary, over the last decade. This fragment is, therefore, unusual in exhibiting a high diversity and abundance of primates; an understanding of how these primate species coexist here could thus be valuable in developing management strategies for the other fragments in the valley that continue to retain a healthy complement of its original primate assemblage. Finally, I examined the ecological mechanisms that have enabled the co-existence of three closely related macaque species, the rhesus macaque *Macaca mulatta*, the northern pig-tailed macaque *M. leonina* and the stump-tailed macaque *M. arctoides* within this fragment. I specifically asked whether and how, if at all, the three sympatric congeneric macaques in such a fragmented, resource-limited habitat could partition themselves along two major niche dimensions—space and food. I found significant differences in both horizontal and vertical space use among the three species of macaques, which were able to segregate themselves in space and differentially use the specific food resources available in the sanctuary. Our results, therefore, support the classical niche theory, providing clear evidence of niche partitioning being able to promote the

co-existence of congeneric macaques in this fragment. More proximally, at the fragment level, such partitioning of resources may have allowed primates to persist in this fragment even after being isolated for over one hundred years. My study has, thus, established the high conservation value of the last fragments of the upper Brahmaputra valley, which collectively retain the entire original primate species pool and individually retain significant fractions of it, even a century after fragmentation. It is important to point out also that as the original primate species pool is variably represented in the different fragments, all these fragments are in urgent need of conservation. Strict protection measures appear to have been effective in at least one of the fragments, Hollongapar, which has witnessed an increasing abundance of primates over the last decade. There, nevertheless, continues to be a number of uncertainties involved, particularly with regard to our comprehension of the responses displayed by species to increasing habitat fragmentation. The fragments of Upper Brahmaputra are undoubtedly critical for the conservation of regional biodiversity while many of these tracts may have to continue to support the livelihoods of the local human populations. It is, therefore, essential to introduce scientifically sound strategies that could aid in the management and conservation of the threatened, but unique, primate assemblages of the valley and, at the same time, establish socio-economically viable practices that will protect the livelihoods and aspirations of the people so as to make these fragments ecologically and socially sustainable in the future.

Key words: *Habitat fragmentation, Upper Brahmaputra valley, Macaques, Population persistence, Biodiversity conservation.*

Keynote Speaker Abstract

White-bellied Heron *Ardea insignis*, the indicator of the health of the Himalayan freshwater river system

Indra Acharja

Species and Habitat Conservation Division (SHCD), Royal Society for Protection of Nature (RSPN), Thimphu, Bhutan
E-mail: ipacharja@rspnbhutan.org

Abstract

Asia is one of the most biodiverse regions on the planet that hosts 9 biodiversity hotspots. It is home to 3495 avian species which is about 31.3% of the global total avian species of which 431 (12.3%) are threatened by extinction (Birdlife International, 2020). At present, almost 100 percent of the threats to wildlife and the environment are human-caused that is resulting from habitat loss, habitat fragmentation, deforestation, poaching and hunting, and climate change. South Asia, as one of the fastest-growing nations with exploding human population growth and urbanization, is no exception. Here too, wildlife, in particular birds, is mainly threatened by three major challenges. 1) Habitats are being lost to infrastructure development, agriculture expansion, hydropower dams, extractive industries, and climate change, 2) most of the few remaining habitats are increasingly under pressure due to incautious eco-tourism and recreation, diminishing food resources, pollution, fragmentation, forest fires, and both man-made and natural calamities, 3) the small population is under crises with increased mortality and declining breeding success.

Bhutan, globally recognized as a carbon-neutral nation, is one of the most forested countries with more than 81% of the area under forest and shrub cover and 51.4% of the total area protected as national parks, wildlife sanctuaries, strict reserves and biological corridors, is also facing challenges in protecting some of the most significant wildlife species and pristine natural heritage.

Just 30 years ago, forests and river systems in Bhutan were pristine and undisturbed. Most people practiced subsistence farming and sustainable harvesting of natural resources, living an environmentally friendly life. Today, keeping in pace with the global change, Bhutan is rapidly urbanizing. The demand for natural resource, infrastructure, energy, transportation, and services has increased with increase in population. Bhutan has opted for hydropower as the primary source of energy and revenue and increasingly new dams are being built along the fast-flowing rivers. In



An adult White-bellied Heron (Photo: Indra Acharja, RSPN)

the process, riverine habitats are being destroyed, the fish population is declining, and threatened wildlife species are displaced. Bhutan is home to 770 plus bird species of which 22 are endangered. The White-bellied Heron *Ardea insignis* is one of them, critically endangered with less than 60 known global populations distributed in less than 165,000 sq. km of inner Himalayas, Bhutan, northeast India, and northern Myanmar. In 2003, the Royal Society for Protection of Nature (RSPN), recognizing the plight of the bird, initiated nationwide conservation and research. Over the past two decades, habitats and populations have been mapped and monitored, protected key habitats, conducted research and preliminary genetic assessment, conducted education and advocacy programs and supported local communities and livelihoods reducing both direct and indirect threats to birds and their habitats. However, the population size remains critically low and there are no signs of improvement despite consistent conservation efforts. The decline in the population of the WBH is a major environmental concern because it is not hunted at least in Bhutan, is not a common pet, it does not have value in illegal wildlife trade like hornbills, parrots, or any other songbirds, it is not a pest, or predator, at least to human or the crops, it is barely known to many people, you hardly get to see them, neither it lives in cities or towns or villages, nor it lives in farmlands, yet it is going extinct. So, something is going wrong in the environment in which, WBH survives. So, what does the extinction of such species means to the health of the ecosystem, river system or environment? WBH is elusive and specific in its feeding, nesting, and food selection. It is endemic to freshwater river systems in the inner Himalayas. They are the indicators of our freshwater river systems. Their presence in our rivers indicates the health of the rivers, the fish population, water quality, the health of associated freshwater biodiversity, level of disturbances, pollution, and above all intactness of our nature. They are predators, they are prey and they are players in a food chain. They are our natural wealth, our pride, and our heritage. By protecting them and their habitats, we protect our rivers, waters, landscapes, biodiversity, food, and local communities. It is not for the wildlife we care the nature, but for the environment, for ecosystems and for our own survival.

Keynote Speaker Abstract

How human disturbance can affect the brood parasitism and nest predation of the hosts inhabiting in a highly fragmented habitat

Monimul Islam Nahid

Department of Biology, Norwegian University of Science and Technology (NTNU), Trondheim Area, Norway
E-mail: nahid1511@gmail.com

Abstract

Human disturbance represents a considerable challenge for the conservation of living organisms and has profound negative impacts globally. There is substantial variation in how species respond to human disturbance. The main aim of the present study is to examine how human activities influence the risk of brood parasitism and nest predation for three passerine species living in a highly fragmented landscape in Central Bangladesh. We use data collected from 518 nests over nine breeding seasons for three host species of the Asian koel (*Eudynamys scolopaceus*), a non-evicting brood parasite: i) long-tailed shrike (*Lanius schach*), ii) common myna (*Acridotheres tristis*) and iii) house crow (*Corvus splendens*). Two sources of disturbance were considered: i) houses and buildings inside the study area, the Jahangirnagar University campus and ii) the highly urbanized area outside the campus boundary. Additionally, we regarded iii) nest height, iv) a number of days after egg laying until discovery (time unmonitored), v) distance to nearest fruit tree and vi) distance to a nearest conspecific neighbor, as important habitat and nest characteristics. We found significantly lower predation risk with increasing time unmonitored in all three host species, thus more regular nest checks by fieldworkers lead to more predation. Moreover, we found that the distance to the nearest fruit tree was the most important factor for the risk of parasitism. Although we could not find any significant impacts of distance to boundary or buildings on either predation or parasitism risk, we found a trend both in common myna and house crow that nesting success was higher closer to the boundary. Ultimately, increased monitoring time had the most consistent negative impact on nesting success among the host species. This study highlights the effect of disturbance caused by nest monitoring, exceeding the impact of permanent structures in and around the university campus i.e. boundaries and buildings.

Keywords: Human disturbance, Brood parasitism, Nest predation, Asian Koel, Urbanization.

Oral Presentation

Distribution and abundance of native bee species in an Urban Green Space in Bengaluru – An approach for sustainable urban development and diversity conservation

Vinutha R. Bhatta^{1*}, A. Naresh Kumar²

^{1*}Department of Zoology and Genetics, Jyoti Nivas College Autonomous, Bangalore – 560 095, Karnataka, India

²Department of Zoology, Periyar University, Salem – 636 011, Tamil Nadu, India

*Corresponding author, E-mail: vinodhinibhat@gmail.com

Abstract

Rapid urbanization, expansion, and increasing human settlement in cities especially in a developing country such as India have caused a great loss and fragmentation of natural habitat, posing a serious threat to biodiversity. However, the bee community which solely depends on floral diversity has shown a promising shift in their destitution. The seminatural anthropogenically managed green spaces with diverse vegetation have therefore become an integral part of biodiversity, especially for floral specialist groups such as bees. The protection and conservation of Bees can play an important role in the urban ecosystem. Additionally, there is no documented data available on the bee status in the Indian urban habitats; therefore a comprehensive study was conducted to manage bee biodiversity and conservation in the urban habitats. A centrally located urban green space in Bengaluru, one of the fastest growing and third most populous cities in India, was surveyed for one year. The yearlong study has documented 22 species of native bees, belonging to 16 genera under 3 families, namely Apidae, Halictidae, and Megachilidae. The diversity indices have confirmed the species richness, species abundance, and uniform distribution of native bee species in the urban green space. The urban bee floral survey has indicated the availability of diverse bee flora that consisted of 51 botanical species, from 25 families that provide year-long foraging resources for bees. The urban bee flora was dominated by ornamental plants (49%) and followed by vegetables (17.6%), fruit trees (19.6%), and weeds or spontaneous vegetation (19.6%). The Bee diversity was strongly correlated to the floral resources of the habitat. The generalists and oligolectic bee species were greatly adapted to urban floral species. *Apis florea* was the key species that visited 41 flowering plants in the study area; *Tetragonula iridipennis* visited 39 and *Apis dorsata*, 36. Among the solitary bees, *Amigella cingulata* was recorded on 30 species and *Xylocopa violacea*, on 23. Although changes in the landscape were reported to adversely affect bee diversity, the present study has clearly shown the positive effects of diversity in floral composition and corresponding bee diversity in urban areas. Restoration and maintenance of plants that are potential foraging resources for bees can provide a sustainable environment for bees in fragmented urban habitats, especially in India.

Keywords: Urbanization, Bee diversity, Abundance, Floral resources, Urban Green Space.

Oral Presentation

Diurnal activity pattern of Assamese macaque (*Macaca assamensis* McClelland, 1840) in Nagarjun Forest, Shivapuri Nagarjun National Park, Nepal

Kalpana Ghimire^{1*}, Mukesh Kumar Chalise²

¹Central Department of Environment Science, Tribhuvan University, Kirtipur - 44618, Kathmandu, Nepal

²Central Department of Zoology, Tribhuvan University, Kirtipur - 44600, Kathmandu, Nepal

*Corresponding author, E-mail: kalpughimire96@gmail.com

Abstract

Macaca assamensis is one of the primate species with less distribution and least exploration. The present study was intended to investigate the diurnal activity pattern of *Macaca assamensis*, their population status, and vegetation composition in Raniban forest, Nagarjun, and Shivapuri Nagarjun National Park, Nepal. Multitudinal methods, viz. population count method, behavioral sampling including instantaneous sampling, Ad-libitum sampling along with vegetation sampling (20m × 20m plots) were applied. For data analysis, Karl Pearson Correlation Coefficient was made applicable using R software. Among a total of 900 events of *Macaca assamensis* being recorded, troop invested 27.61% in inactive, 25.30% in grooming, 23.41% in foraging/feeding, 22.90% in locomotion, and 0.75% in fighting. For foraging/feeding, locomotion, and inactive, *Macaca assamensis* were more allocated in Chilaune (*Schima wallichii*) possessing 25.55%, 36.22%, and 40.61% respectively while Kaphal (*Myrica esculenta*) was a less favored species with 1%. Altogether, 71 plant species were recorded within the established plots dominated by *Schima wallichii* and Damaiphall (*Ardisia macrocarpa*). A positive correlation was recorded between foraging/feeding and locomotion during the morning. Paired t-test recorded significant difference in foraging/feeding and inactive (df = 24, p = 0.01 and 0.03) respectively at 95% confidence interval between two time intervals (morning and day).

Keywords: *Macaca assamensis*, Distribution, Population status, Ad-libitum sampling, Shivapuri Nagarjun National Park.

Oral Presentation

An impact assessment of urbanization on the environment of the city: A case of city Lucknow

Alok Kumar Maurya^{1*}, Ravish Kumar², Ajay Kumar³

*Department of Architecture, National Institute of Technology, Patna – 800 005, Bihar, India

*Corresponding author, E-mail: alokm.phd18.ar@nitp.ac.in

Abstract

Urbanization is directly linked to population growth due to natural growth and the migration of people from rural to urban areas. It represents modernization, industrialization, and the sociological justification of the city. It includes increments for the number and degree of urban communities. Many cities, around the globe, have seen fast urbanization over the last few years. This rapid urbanization has a great impact on biodiversity. The quick extension of metropolitan regions because of ascending populace and economic development is expanding extra interest in natural resources causing over-exploitation of these resources. Unbridled urbanization leads to many negative impacts on the environment like degraded water quality, air, land, noise pollution, urban heat island, and waste disposal which ultimately affects their habitats. It is difficult to confine urbanization; there is a need to guarantee that urbanization continues correctly with minimal impact on climate. The present study is an effort to underline the impact of urbanization on ecological parts, predominantly climate, biosphere, land, and water assets. A contextual investigation of urbanization in Lucknow city has been done prompting a finish-up on the current reasons. The present investigation is descriptive and the information is assembled through secondary sources like Government Records, books, articles, and web-based journals.

Keywords: Urbanization, Urban growth, Pollution, Environment, Lucknow.

Conservation status of *Aconitum nagarum* Stapf., an endemic plant from the North East Indian region (Manipur) of Indo – Burma hotspot

Sijagurumayum Geetanjali Devi, Maibam Dhanaraj Meitei*

Department of Forestry and Environmental Science, Manipur University, Canchipur – 795
003, Manipur, India

Email: maibam.meitei@yahoo.in (M. D. Meitei)*
geetshija123@gmail.com (S. G. Devi)

*Corresponding author

Abstract

The sparsely distributed endemic population of *Aconitum nagarum* Stapf has become a threatened species in the Shirui Kashong Peak of Manipur, India in the Indo Burma hotspot due to habitat destruction, non-sustainable exploitation, unrestrained tourism, and lack of proper conservation actions from the local government. To date, no proper detailed population assessment of the endemic species has been carried out in the two localized distribution ranges found in Manipur (the other being the Dzuko valley). In the Shirui Kashong peak, *A. nagarum* represents a neglected species with all the conservation actions shifted towards the protection of *Lilium. mackliniae*. In the present population assessment carried out during 2018 - 2019, only 45 mature individuals were reported. The density varied between 1 - 8 plant m⁻², frequency 100%, abundance 4.5 and have sparse distribution pattern. The field data showed that the endemic population is not only losing its population number but also its vigor. The result directs the need for urgent continuous research on the population structure, distribution, use, and trade to develop appropriate and necessary conservation strategies for the revival of the endemic species in the natural habitat.

Keywords: Indo - Burma hotspot, *Aconitum nagarum* Stapf, Shirui hills, Endemic plant, Conservation.

Habitat fragmentation cause and consequences: A geographical study of Patna Urban Area

Vinita Prasad

Department of Geography, A. N. College (Patliputra University), Patna – 800 001, Bihar, India
E-mail: wnprsd@yahoo.co.in

Abstract

Habitat fragmentation is one of the major environmental challenges of the present century. The unprecedented anthropogenic activities have enormously damaged forest cover and have resulted in habitat fragmentation causing irreparable damage to the biodiversity across the world. The urban areas are too coping with the problem of habitat loss and consequent decline in biodiversity. Although the urban area occupies just 3 percent of the earth's surface, the location and spatial pattern of the urban areas have significant impacts on biodiversity. The intensive land use pattern in urban areas leads to habitat fragmentation, potentially resulting in generic or demographic isolation of native species. The study area, Patna, is coping with the problem of habitat fragmentation. The city of Patna is surrounded by rivers from three sides and consequently has limited scope for further expansion, Hence, every patch of land in Patna is being reclaimed for construction purposes and has resulted in a drastic reduction in green cover, filling up of wet points and engulfment of adjoining agricultural areas and in turn has given way to enormous loss of biodiversity. Against the above backdrop, the present study intends to explore the cause of habitat fragmentation in Patna. The study further evaluates the extent of loss of biodiversity and its repercussions. It addresses ways and means to protect and preserve the dwindling biodiversity in the city. The study is exploratory with a distinct methodology comprising field investigation, framing of questionnaire schedule, sampling, tabulation, and interpretation of data obtained, cartographic and statistical interpretation of the information accumulated, and the finding and conclusion of the interpretation.

Keywords: Biodiversity, Green cover, Native species, Reclaim, Patna Urban Area.

The habitat structure of the prey alters the fitness of the predators

Gyanendra Kumar

Department of Zoology, National P.G. College, Lucknow – 226 001, Uttar Pradesh, India
E-mail: gyanendra.mail@gmail.com

Abstract

Prey-predator interactions have always been in the spotlight to assess the potential of predators against the prey. The vigor of the predator is dependent mainly upon the particular prey species on which it was feeding. If a particular prey inhabits an area encompassing diverse host plant species, it will likely switch from one to another. This switching of the prey is induced mainly by the quality of the host plant as the food of the prey. Other important factors such as reproductive rate and rate of increase in the population are known to induce this switching. The predator which encounters this prey in this particular area is going to receive varying levels of nutrients. These nutrients are the result of diverse host plants on which this prey fed. This prey while switching from one to another host plant may be another upon inadequate, beneficial, palatable, or toxic nutritive contents of the plant. These all together affect the overall vigor of the predator when it feeds upon this prey. The current study confirmed these points while evaluating the suitability of aphids as prey for Ladybird beetles as predators of them.

Keywords: Prey habitat, Host plants, Aphids, Ladybird beetles, Predation.

Habitat loss and insect biodiversity: An Indian perspective

Muzafar Riyaz*, Kuppusamy Sivasankaran

Division of Taxonomy and Biodiversity, Entomology Research Institute, Loyola College,
Chennai – 600 034, Tamil Nadu, India

*Corresponding author, E-mail: 18deri001@loyolacollege.edu

Abstract

Insects play a very vital role in divergent ecosystems and have gained great economic and medical importance as pollinators, pests, predators, parasitoids, decomposers, and vectors. The unending requirement of food for the fast-growing human population of the world has created havoc among the diversity of insects by manufacturing toxic agrochemicals including pesticides sprayed on the crops for the eradication of pests. The implementation of these toxic pesticides sprayed in crop fields not only eradicate the pests but is also directly responsible for imposing a threat to other species of insects, which are having a great value to carry out the process of pollination and being the predators and parasitoids to check the diversity of pests in the natural ecosystem. The present study is a short review of the impact of urbanization and consequent habitat change and pesticide pollution across India on insect diversity. With the much use of pesticides, forest fragmentations, and lack of conserving strategies, the diminishing rate of beneficial and pollinator insects across India is increasing on a quite larger scale. Alternative steps should be taken and management and conservation strategies should be put forward to overcome the drivers of insect decline which are the prime source of many ecological services and for mankind as well.

Keywords: Insect, Biodiversity, Habitat loss, Forest fragmentation, India.

Biowealth of Karinja Sacred Forest of South West Coast of Karnataka, India

Supreth Kadkol^{1*}, Kanivebagilu Shankaranarayana Vinayaka²

¹ Department of Zoology, Sri Venkatramana Swamy College, Vidyagiri, Bantwal – 574 211, Karnataka, India

² Plant Biology Lab, Department of Botany, Sri Venkatramana Swamy College, Vidyagiri, Bantwal – 574 211, Karnataka, India

*Corresponding author, E-mail: supreetkadokol007@gmail.com

Abstract

India is one of the 12 Mega biodiversity hotspot countries having rich biota with a diverse ecosystem. South West coast of Karnataka including Mangalore, Udupi, and Karwar is very much popular for its versatile habitat and for its distribution as it has the Western Ghats and Arabian Sea Coastal line. The present study deals with the diversity of semi-evergreen and deciduous forests of Karanjamalli which is situated in Bantwal Taluk of Dakshina Kannada District, Karnataka in India. Karanjamalli is located at 12°54'N 75°56'E/12.94°N 81.96°E. It has an average elevation of 1005 meters (34297ft). More than 85% of annual average rainfall is received during the monsoon month extending from June to September. The mean annual rainfall for Karanjamalli is about 75mm distributed over ninety-two average annual rainy days. The mean daily temperature ranges from 18°C (January) to 39°C (May) with relative humidity. Karanjamalli region is known for rich biodiversity where more than 78 species of plants, 56 species of birds, 28 species of butterflies, and many reptiles have been recorded. Many more mammals have also been recorded in this region. This preliminary study clearly shows that this sacred forest is very rich in biodiversity. However, due to a lack of awareness and large-scale tourist visits for sightseeing in this region, the ecosystem has been disturbed. Furthermore, firewood, building materials, and cattle feed are major threats to this region. Degradation in this ecosystem due to all these anthropogenic activities warrants the need for suitable conservation methods for Karanjamalli Sacred Forest aimed at securing its valuable biodiversity.

Keywords: Biodiversity, Karanjamalli Sacred Forest, Bantwal, Anthropogenic activities.

Endangered biodiversity of Jammu and Kashmir, India

Sami ul Hassan Tantray*, Amritpal Singh Kaleka

Department of Zoology and Environmental Sciences, Punjabi University, Patiala – 147 002,
Punjab, India

Email: tantraysami@gmail.com*
apskaleka@gmail.com

*Corresponding author

Abstract

Jammu and Kashmir (J&K) are the northernmost Union Territory of India located in the vicinity of the Karakoram and western Himalayan Mountain ranges. Because of its wide range of elevations, its biogeography is diverse. The rich biodiversity of J&K happens to be one of the 26 hotspots in India with high endemism. The whole Himalayan belt is one hotspot mega center having 8 critical areas which include two regions viz., Ladakh and Kashmir. The UT of J&K has a fairly rich diversity of plant life that contributes to the food and habitat needs of wild and domesticated animals in the state. On the other hand, the faunal component of biodiversity is rich with unique forms both in the forest zone and above the forest line. The variety of animal forms ranges from higher groups like vertebrates, including mammals, birds, reptiles, and amphibians, and lower groups like invertebrates including insects. The faunal diversity of J&K is diverse due to its unique location, climatic conditions, and rich proportion of natural resources. However, the natural resources of the state have, over some time, been subject to vandalism owing to various factors stemming mostly from anthropogenic activities. There are several species of animals that have either been wiped out completely or are on the verge of extinction. Bir (1987) has observed that 30 species of ferns are threatened due to various causes. According to Kaul (1977), twenty-two medicinal plants of the valley are endangered and it is believed that 80% of these will become extinct in near future. About 45% of the mammalian diversity of the State is listed as globally threatened in IUCN Red Data List and 34 percent is included in Schedule 1 of the Wildlife Protection Act, 1972. Seven species of birds are threatened. Several species of birds like a bar-headed goose, Whooper swan, and red kite have not been reported for the last several decades. The introduction of some species of fish like Silver carp, grass carp, and Catla has had a deleterious effect on indigenous fish species and resulted in the disappearance of many valuable fish species like *Schizothorax* from the Kashmir Valley.

Keywords: Himalayan region, Biogeography, Biodiversity, Jammu, and Kashmir, *Schizothorax*.

Fragmentation of natural habitat and rural market: A case study of Bhojpur district of Bihar, India

Mamtisha Kumari*, Ashok Kumar Sinha

Department of Geography, Magadh University, Bodh Gaya – 824 234, Bihar, India

*Corresponding author, E-mail: mamtisha297@gmail.com

Abstract

Natural habitation, is generally, accompanied by human settlement at the riverside due to the fertile river basins and easy availability of natural resources. In addition to catastrophic events like landslides, river erosion, etc., due to overexploitation of natural habitats by human beings for various purposes such as agriculture purposes, road construction, urbanization, industrialization, etc., natural habitats are degraded and, in some cases, fragmented to several smaller patches that become a threat to the survival of many species. Many such habitats that nestle a human settlement, are a basis of rural market, where mainly local produce from the fertile land of the river basin and forest products are being sold.

In the present study, we investigated the effect of fragmentation of natural habitat on the rural market of Bhojpur district of Bihar which is situated between the river Ganges in the North and river Son in the south. However, despite of rich deposit of alluvial of river Ganges and Son an acute shortage of bio-products has been found during the study. In this stretch of both rivers, both Gangetic dolphin and crocodile appeared on the verge of extinction. Moreover, “Sonbachwa fish”, which is known as the most delicious food item, has not been found in the nearby rural market during the entire study period due to its disappearance from the Son River. A vegetable, known as Chathail or Spiny guard (*Momordica dioica*), obtained from the forest of data (river basin) is no longer found in the rural markets of the Bhojpur district. Therefore, there is an urgent need to protect our precious biodiversity in the fertile lands of the Son and the Ganges.

Keywords: Habitat fragmentation, Natural resources, Gangetic alluvial plain, Bio-products, Rural market, Bhojpur.

Earthworm diversity as bioprocessors, indicators, transformers, and imminent hopes in terrestrial ecosystem

Azhar Rashid Lone, Shweta Yadav*

Department of Zoology, Dr. Harisingh Gour Vishwavidyalaya, Sagar – 470 003, Madhya Pradesh, India

*Corresponding author, E-mail: kmshweta@gmail.com

Abstract

“Earthworms” are an essential part of terrestrial ecosystems where they perform many ecological functions. However, their significance is overlooked due to their simple body structures and detritus features. With the rise of ecosystem alterations, particularly terrestrial types, due to habitat destructions, land practices, pollution, poaching, and biodiversity loss, several floral and faunal lifeforms were used as bioindicators to monitor such changes and to perform effective management practices in these terrestrial ecosystems. Tracing earthworm diversity could be a useful, yet simple below-ground animal model in accessing the health and threats in terrestrial ecosystems, particularly, in soils, where nutrients, gases, and minerals directly affect the floral species thereby, determining the architecture of faunal diversity. Furthermore, tracking earthworms based on molecular markers that aid in their taxonomic identifications, advances the possibilities of monitoring the current status, threats, and implementation of potential conservation strategies in terrestrial ecosystems.

Keywords: Biodiversity, Earthworms, Conservation, Habitat loss, Molecular markers, Threat.

Habitat fragmentation: A threat to biodiversity

Sanjay Dey^{1*}, Ashis Kumar Panigrahi²

¹*Department of Zoology, Ananda Mohan College, 102, 1, Raja Ram Mohan Sarani, Kolkata – 700 009, West Bengal, India

²Pro-Vice-Chancellor, The University of Burdwan, Bardhaman – 713 104, West Bengal, India

*Corresponding author, E-mail: sanjaydey2116@gmail.com

Abstract

Nowadays, the main threat to biodiversity is habitat degradation and fragmentation. In most cases, degradation and/or fragmentation of habitat occurs due to extensive human activities towards agricultural practices, industrialization, and urbanization. This ambitions-driven human activity not only results in the shrinkage of habitat but also results in the formation of patchy habitat. Formation of patchy habitat experiences some sort of environmental changes which results in the loss of some sensitive endemic or native plants as well as animal species. In addition, degradation and/or fragmentation of habitat reduce the availability of food and breeding ground and thereby, decrease the mutual interaction among species. Fragmentation of habitat also leads to working of edge effect, where smooth edges of patchy habitat allow for a higher movement of species and lower flow of physical variables between habitats whereas abrupt edges reduce the chance of species movement but have a higher flow of physical variable that is detrimental to species stability and species abundance and diversity among the adjacent patchy habitats. Moreover, ecosystem functions greatly deteriorate and a risk of a novel zoonotic disease outbreak increases manifold. Rapid urbanization in many cities in India results in the shrinkage and/or complete eradication of many aquatics as well as terrestrial habitats adjacent to cities and therefore subsequent loss of biodiversity has been found after a timeline study. Therefore, proper management of industrialization and urbanization, as well as a robust wildlife protection plan, needs to be urgently implemented.

Keywords: Zoonotic diseases, Edge effects, Abundance, Productivity, Wildlife protection.

Tigers – Striving to survive

Syead Wahabuddin Nasir*, Dilip Kumar Paul

Environmental Science and Management, Department of Zoology, Patna University, Patna – 800
006, Bihar, India

Email: syeadwahabuddinnasir@gmail.com*
dkpaul.pat31@gmail.com

*Corresponding author

Abstract

Since the advent of human cultures, tigers have had a noteworthy and significant influence on the heritage of mankind. They have always been a distinguished desire of the iconography and find a place in almost every major religion of the World. Moreover, they have been a remarkable inspiration for many cave arts and paintings. The earliest known depiction of a tiger on a seal dates back to more than 4,000 years ago found in the ruins of the ancient Indus Valley civilization. Tigers from their inception have been an integral part of the literature, traditions, and cultures of many civilizations of Asia. In India too, people celebrate festivals for the Tiger Lord in many places, such as Sundarbans and Madhya Pradesh. The awe-inspiring charm of the tigers is continuing which is evident from several people visiting tiger reserves every year. Unfortunately, there is a gloomy side to this absolute reverence and fear for tigers; many tigers get killed for the great strength and charm they dominate. Their skins, bones, eye-balls, claws, teeth, blood, and even genitals are used, sparing nothing but a reminiscence of what once would be a magnificent big cat. If we let this continue by any means, tigers vanish from the Jungles then undoubtedly, we will be the saddest to lose the noblest of fauna. Historian Mahesh Rangarajan estimates that at least 80,000 tigers were killed between 1875 to 1925. Tigers have lost 95% of their historical habitats as per the estimates. Habitat destruction, fragmentation, and degradation are among the foremost causes of the rapid decline in tiger populations all over the globe. Most of these great cats were murdered not because they had turned to man-eating but primarily to please the Indian Royalties and their Colonial Lords. The first official census of tigers reported their numbers to be just 1800 far less than the believed figure of 1,00,000 at the turn of the twentieth century. This was not before 1972, the Wildlife Protection Act of 1972 was passed and Project Tiger was launched in Corbett National Park on 1 April 1973, with an additional 8 tiger reserves. Presently, India has 50 tiger reserves, which cover about 2.21 percent of India's land area and is home to 2967 tigers as per the All-India Tiger Estimation Report 2018 by the National Tiger Conservation Authority and Wildlife Institute of India.

Keywords: Tigers, Habitat destruction, Conservation, Forest, Hunting, Tiger Reserves.

Status of fish fauna in Koshi River at Khagaria district of Bihar, India

Abhay Kumar^{1*}, Chanda Jha²

¹*S. H. P. A. High School, Chandipatti, Bhagalpur – 812 001, Bihar, India

²S. S. Girls High School, Nathnagar, Bhagalpur – 812 006, Bihar, India

E-mail: abhayecologist@gmail.com*

chandajha.jha@gmail.com

*Corresponding author,

Abstract

Water is said as a liquid of life and it is the essence of all living processes. Thus water, a unique component of nature, has played an important role in life from molecules to man since time immemorial. The Koshi River System and its tributaries are the important rivers of north Bihar. The Koshi river is also called as “Sorrow of Bihar” due to the annual flood which affects a large part of North Bihar, nearly 21000 km² of area. It originates from the glaciers of Mount Gosainthan (8,013m), Mount Everest (8,848m), and the Kanchenjunga (8,579). When we speak of assessing the ecological condition of river Kosi, district Khagaria, Bihar, we focused on evaluating two critical components of aquatic ecosystems, i.e. the condition of biota and the relative importance of human-caused stressors. The ecological condition of the river is represented by the condition of their biotic communities – the living components of aquatic ecosystems that integrate many forms of human disturbances and modification of river streams and the measurements of this subject were the topic of particular interest. Stressors or the pressures that human being exerts on aquatic systems through their use of the surrounding environment are commonly the chemicals, physical and biological components of the ecosystem. These have the potential to degrade biotic integrity. Some common chemical stressors are toxic compounds, excess nutrients, etc. Most of the physical stressors are created when we modify the physical habitat of a river network – excess sedimentation, bank erosion, etc. All of these are capable of degrading the biotic integrity of the river. Water quality plays a pivotal role in riverine ecosystem health regulation so does in Koshi River too.

Keywords: Koshi River System, Biotic community, Biota, Aquatic ecosystem, Human disturbances.

Production, optimization, and application of diatom *Chaetoceros* as a safer alternative in commercial aquaculture - An ecological boon and a self-sustainable livelihood model

**Debasish Sahoo^{1*}, Virendra Kumar Vaishnav¹, Tanushree Chatterjee², Navita Gupta³,
Shailendra Kumar Sinha⁴**

¹ Department of Biotechnology, Chhattisgarh Swami Vivekanand Technical University, Bhilai – 491 107, Chhattisgarh, India

² Department of Biotechnology, Raipur Institute of Technology (RITEE), Raipur – 492 001, Chhattisgarh, India

³ Department of Life Sciences, Binod Bihari Mahto Koylanchal University, Dhanbad – 828 130, Jharkhand, India

⁴ Department of Zoology, Environmental Science and Disaster Management, Binod Bihari Mahto Koylanchal University, Dhanbad – 828 130, Jharkhand, India

*Corresponding author, E-mail: sahoodebasish3125@gmail.com

Abstract

India has a vast resource for Commercialized aquaculture. But due to this rapid commercialization, there is extensive use of chemical fertilizers, synthetic/chemical pesticides, antibiotics, synthetic hormones, formulated feed, and food additives, etc. Most of them end up as pollutants such as uneaten food, feces, dissolved nutrients, scales, mucous, dissolved chemical antibiotics, fertilizers, pesticides, etc., which enables extensive pollution in the receiving waters that badly affect the ecosystem, environment, and species in the receiving water body.

The nitrogen and phosphorous-rich feed encompass Algal bloom or eutrophication in the receiving water enabling high BOD level and low DO level. The excessive nitrogen in the water causes ammonia toxicity due to the accumulation of ammonia. The chemical fertilizers and pesticides change the physical and chemical environment of the receiving water. These can also affect the health of the main aquaculture if they are not being monitored and controlled effectively in the main culture pond/production ponds. *Chaetoceros* (Phytoplankton) grown along with the aquaculture help in efficient recycling of the nutrients and thereby maintaining the natural nutrient cycle for the growing population of aquaculture fishes, increasing DO level, decreasing the level of toxic contaminants, acting as a natural predator for different parasites and pests, promotes food chain cycle as they can be primary sources of feed for larva and many more. This will also help in reduction in dependency on chemical or synthetic entities leading to lesser generation of pollutants and increasing the healthiness of the aquaculture thereby maintaining the natural ecosystem. This in turn also helps in the restoration of the downtown ecosystem stabilizing both commercial and natural ecosystems. More important, these models can be also being helpful for farmers who can produce and supply to these large aquaculture firms resulting in a rural livelihood self-sustained model of employment and economy. This indeed will also reduce the dependency of those anthropological entities on the environment.

Keywords: *Chaetoceros*, Ecosystem, Eutrophication, Food chain, Toxic contaminants.

Antibacterial activity of two soil cyanobacteria *Anabaena sp.* and *Cylindrospermum licheniforme* isolated from agroecosystem of Chandauli district, India

Jay Prakash Singh, Nagendra Dwivedi*

Department of Botany, Uday Pratap College, Varanasi – 221 003, Uttar Pradesh, India

*Corresponding author, E-mail: drnagendra.dwivedi@gmail.com

Abstract

Two cyanobacterial strains *Anabaena sp.* and *Cylindrospermum licheniformae* were isolated from soil collected from the agroecosystem of Chandauli district, India. Strains were identified by morphological and molecular methods. Antibacterial activity of crude extracts in seven organic solvents, viz. acetone, ethanol, methanol, petroleum ether, chloroform, n-hexane, and double distilled water screened against two human pathogenic bacteria, i.e. *Escherichia coli* and *Staphylococcus aureus*. Differential variation in antibacterial response was noted against test organisms. Crude extract in ethanol, n-hexane, chloroform, and double distilled water of *Anabaena sp.* showed antibacterial activity against *S. aureus* whereas the extract in ethanol, methanol, acetone, n-hexane, and petroleum ether showed antibacterial activity against *E. coli*. Crude extract in four organic solvents i.e., ethanol, methanol, petroleum ether, and acetone of *Cylindrospermum licheniformae* showed antibacterial activity against *S. aureus* whereas the extract in only methanol showed antibacterial activity against *E. coli*. A double distilled water extract of *Anabaena sp.* showed the maximum antibacterial activity against *S. aureus*. Findings of the experiment suggest that double distilled water extract of *Anabaena sp.* can be used for mining antibacterial agents against *S. aureus*.

Keywords: Antibacterial activity, Crude extract, *Anabaena sp.*, *Cylindrospermum licheniformae*, Human pathogenic bacteria.

Khushigram's approach to restoring and reviving biodiversity sustainably

Ajit Kumar

Founder, Khushigram, Pandav Nagar, New Delhi – 110 092, India
E-mail: khushigram@gmail.com

Abstract

Evidently, with the growing population and economic development, we are witnessing a rapid degradation in our ecosystem, in our planet. Forests are continuously cut down for making room for new settlements and expansion of urban areas. Our water bodies and urban wetland are continuously being filled as well. Further, economic development and setting up of industrial units result in the production of wastes as greenhouse gases and industrial effluents discharged into the water bodies and riverine system. The domestic wastes of exploding population constantly piled up in dumping grounds creating major health hazards not only to human beings but also to entire natural habitats. Thus, knowingly or unknowingly and intentionally or unintentionally, we have created an unhealthy ecosystem, that has ultimately become a threat to the survival of wildlife and its biodiversity.

We, to conserve our mother nature, have founded Khushigram, a non-Governmental Organization. We work together to move towards a system of Sustainable Development where everyone and everything stays healthy and happy by incorporating Traditional Values which revolve around the conservation of Mother Nature and by giving equal value and respect to our flora and fauna. Therefore, these traditional values and beliefs are being promoted to a large corner of society through the organization.

Keywords: Population, Habitat degradation, Khushigram, Traditional values, Non-Governmental Organization.