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Habitat Fragmentation and Its Lasting Impact on Biodiversity of Indian Subcontinent

03rd & 04th February, 2021

Swami Sahajanand College
Jehanabad, India

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International e-Symposium on Biodiversity

(IeSB-2020-SSC)

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

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

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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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Keynote Speakers

Dr. Govindhaswamy Umapathy, Senior Principal Scientist & Group Leader, Laboratory for the Conservation of Endangered Species, (LaCONES), Centre for Cellular and Molecular Biology (CCMB), Hyderabad, India & Professor, Biological Sciences, Academy of Scientific & Innovative Research (AcSIR), New Delhi, INDIA

Dr. Harini Nagendra, Professor of Sustainability, Department of Development, PES Institute of Technology, Azim Premji University, Bengaluru, INDIA

Dr. Sudipta Chatterjee, HOD & Associate Professor, Department of Natural Resources, TERI School of Advance Studies, New Delhi, INDIA

Dr. Narayan Sharma, Assistant Professor, Department of Environment Biology and Wildlife Sciences, Cotton University, Guwahati, INDIA

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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

Dr. Sandun J. Perera, Assistant Professor, Department of Natural Resources, Sabaragamuwa University, Belihuloya, SRI LANKA

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

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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 fund, 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, Bhapal, 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 Brahmputra 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.) 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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Keynote Speaker Abstract

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

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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.

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Keynote Speaker Abstract

Urbanization: A new frontier for conservation

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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.

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Keynote Speaker Abstract

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

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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.

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Keynote Speaker Abstract

Foraging behavior and pollination services provided by Indian bees

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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.

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Keynote Speaker Abstract

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

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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 are 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 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

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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-belled 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.

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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

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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.

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Full-length Paper Presentation

Estuarine biodiversity of India – Status, and challenges

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Abstract

India is rich in enormous bounding coastlines and vast stretches of estuaries and backwaters. Indian estuarine waters have a number of classic research records, most of which are historically important. However, the belated development of estuarine biodiversity as a field of systematic research has been the outcome of growing concern about the immense societal importance of these ecosystems. The varied and increasingly complex problems created through man-made and also natural processes have been instrumental in the rapid depletion of estuarine biodiversity resources in India. Due to obvious reasons, the estuaries need to have focused attention on the issues like status evaluation and stress quantification of the individual system for conservation and protection against further deterioration in the future.

Keywords: Ecology, Estuarine habitat, Anthropogenic activities, Biodiversity, Flora, Fauna.

Full-length Paper Presentation

Habitat fragmentation: Human's selfish and unethical nature betrays the nature

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Abstract

Although human beings are very intelligent creatures, they have a highly selfish nature at the same time. To fulfill their ambition, many times human society adopts unethical ways as well. They cross the borders, occupy other territories, capture the habitats, disturb the ecosystem, and finally destroy the biodiversity. Enriched biodiversity is most needed to achieve improved ecosystem productivity and to support the healthy growths of all the interrelated species. Various natural and human-made factors are responsible for habitat loss vis-a-vis biodiversity loss. Natural factors include but are not limited to floods, earthquakes, fire, volcanism, and climate change. Human activities like infrastructure construction especially transportation routes within the habitats or expansion of cities are the major threats to habitats, leading to their fragmentation and biodiversity loss. This article is a systemic attempt to understand the impact of human-derived activities on habitat fragmentation and provide guidelines for designing the project with environmental and ethical values.

Keywords: Habitat, Human-derived activities, Biodiversity loss, Infrastructure, Ecosystem

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Full-length Paper Presentation

Mitigation of immediate damage from tropical cyclones on the coastal forest ecosystem: The case of Balukhand Wildlife Sanctuary

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Abstract

The Indian State of Odisha has been the hotspot of extreme weather conditions, such as heat waves, cyclones, severe droughts, floods, and extreme cyclones throughout history. The state is witnessing natural calamities at alarming frequency challenging sustenance of all sorts. There have been cases of 30 cyclones hitting the state in the last 11 years. Even though the coastline of Odisha constitutes 17% of the eastern coastline of India, it has witnessed damage and destruction of almost 35% of all cyclonic storms which crossed the east coast of the Indian subcontinent. Coastal Orrisa has been the battleground for survival from dreadful cyclones in all these cases. Wherever the cyclones make landfall, there are substantive alterations in the dynamics of landscape and wildlife.

On the third and fourth of May 2019, cyclone 'Fani' made landfall in Odisha's coastal forest areas comprising Balukhand wildlife sanctuary and caused catastrophic destruction to its landscape and wildlife resources within only a few hours. The sanctuary previously considered to be an important physiological barrier to the nearby agrarian community because of its dense plantation for controlling soil erosion has turned into a barren land with most of the trees severely damaged.

Many studies and strategies have been developed to safeguard the interest of man and society during such extreme weather events. However, the development of proper strategies for the conservation of biodiversity and wildlife, which could have prevented loss and extreme damage to ecology considerably, has not been formulated so far. The objectives of this paper are to (1) study the pattern of damage to the existing vegetation, (2) analyze the destruction of wildlife concerning vegetation, and (3) propose biodiversity management and mitigation measures and to increase preparedness for such cyclones in the coming future.

Keywords: Natural disasters, Cyclone, Fani, Balukhand Wildlife Sanctuary, Tropical cyclones, Biodiversity

Full-length Paper Presentation

Effect of unsustainable development on the riparian zone of Ganga Basin

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Abstract

River Ganga is one of the most important river systems in India. It covers 2525 km in length and supports the densely populated river basin in the world. For any River, the riparian zone is very important for environmental and ecological management because of its role in biodiversity, soil conservation, and the influence they have on fauna and aquatic ecosystems, including grassland, woodland, wetland, or even non-vegetative. Despite its importance, it is depleting due to urbanization, unsustainable practices, and development. The loss in biodiversity, flora and fauna, forest cover, and habitat of many endangered species can be seen in recent times. Concrete development, religious activities, and industries contribute to the increase in the level of heavy metals in the riparian zones of the river, which is affecting the local fauna.

This paper reviews the importance of the Ganga River basin and riparian forest along the Ganga River and the factors affecting the riparian forest. Due to anthropogenic activities, the current condition of the riparian forest has degraded drastically affecting the population of many endangered species like Gangetic Dolphins. Human activities also lead to a decrease in the area of forest cover that consequently results in the degradation of the flora of the region. Measures are required to be taken by the government to protect the Riparian zone of the river Ganga. It should be a part of the protected area of the river basin. Further, awareness should also be spread among the people regarding the importance of managing and maintaining the ecosystem of the River basin.

Keywords: Ganga River, Riparian zone, Ecology, River basin, Biodiversity.

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Full-length Paper Presentation

Chital (*Axis axis* Erxleben, 1977) as prey base in Mukundra Hills Tiger Reserve, Rajasthan, India

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Abstract

Chital (*Axis axis*) is one of the most important prey species of top carnivores, as evidenced by studies in the wild**.** The national animal, Tiger (*Panthera tigris*), is confined to the Tiger Reserves in India, which are the only safe site for the survival of the wild population of this big cat. The Mukundra Hills Tiger Reserve (MHTR) in Southeast Rajasthan was notified in 2013 as the site to establish a third home for the tiger in Rajasthan. Thirty villages outside the tiger reserve were to be rehabilitated to create a large natural habitat for tigers free from anthropogenic. Chital was found as the most abundant wild prey species in this tiger reserve. The study was carried out during 2017-18. In most of the sightings, Chital was observed in small groups of 4-10 individuals of mixed age and sex in a herd.

It was found that most of the tiger reserves in India had a low total available wild ungulate prey base compared to the total number of wild prey reported in other studies. While this prey base can support a small, reintroduced population of 6-10 tigers, it was recommended that efforts to develop a sufficient wild prey base be given the highest management priority. In a bid to improve its prey base, at least 500 Chitals were translocated during the study period from different captive sites of India. Hence, the Chital population is steadily increasing in MHTR and has been proved to be a major part of the diet for already reintroduced four tigers in this fascinating forest.

Keywords: *Axis axis*, Prey base, Mukundra Hills Tiger Reserve, Anthropogenic activities, Wild, Diet

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Full-length Paper Presentation

Urban biodiversity with special reference to the survival of stray animals in towns and cities of India

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Abstract

Animals are an inseparable part of Mother Nature and play a vital role in human survival on this planet Earth. Being an important and major part of food chains and food webs, these animals still depend on human society for care and food in urban and rural areas of our country. These animals live in the forest - with no care and survive on their own, secondly, as pets under the care and training of the owner, and thirdly, as stray animals surviving on the mercy of human inhabitants. The most vulnerable section is the stray animals as they have no shelter, no regular food supplies, and face different behavior of human beings. On the one hand, they are helpless in alien habitats dominated by human beings, while on the other hand, exposed to extreme weather conditions like heat waves during summer and cold waves during winter. In other cases, they get killed in road accidents, and also incidences of man-animal conflicts have been reported. The present study deals with the identification of hotspots with a large number of stray animals and their related issues of survival with special reference to micro-climatic changes.

Keywords: Stray animals, Human inhabitants, City, Towns, Microclimatic changes, Survival issues

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Full-length Paper Presentation

Assessment of human intervention on the biodiversity of the Ganga River, Patna

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Abstract

As we humans grow in numbers, we tend to modify our surroundings by changing land-use patterns, therefore changing the dispersal patterns of plants and animals by creating new barriers like roads, railways, bridges, canals, high-tension power lines, etc. Alteration in dispersal patterns can severely disturb the balance of the ecosystem. India is a developing country hence, it is shifting towards urban infrastructure growth. We create our habitat by degrading other habitats; to balance both, we need to change the paradigm. Habitat loss and fragmentation due to anthropogenic intervention are the main causes of today's biodiversity crisis. In megacities, the division of habitat into smaller and more isolated patches is likely to sustain fewer species and increase the risk of extinction of many wildlife species. In this paper, we will assess the impacts of human intervention on the biodiversity of the Ganga River in Patna, Bihar.

Keywords: Biodiversity, Urban infrastructure, Habitat fragmentation, Conservation, Marine Life.

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Full-length Paper Presentation

Assessing land cover land use pattern and associated NDVI pattern of the selected area of the Indian Ganga River Basin using satellite imagery

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Abstract

The Ganga River Basin is facing continuously a constant land transformation through the ages. Particularly the north of the basin, draining the region of one of the tributaries of River Ganga i.e. Koshi submerged with flood water every year. Heavy flooding in this region not only causes upheaval in agricultural practices but also causes more land degradation due to water erosion and waterlogging. The forest cover is mainly found in the western region of Bihar, including the Chhotanagpur district, Munger, and Shaibganj area of Jharkhand, which is witnessing escalated urbanization and urban growth. The forest area is also the site of heavy forest destruction of deforestation nowadays. Therefore, the present study aims to understand the impact of natural and anthropogenic factors on the land degradation pattern and thus habitat degradation of this region.

Keywords: Land Cover Land Use (LCLU), Normalized Difference Vegetation Index (NDVI), Indian Ganga River Basin (IGRB), Land degradation, Urbanization.

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Full-length Paper Presentation

Effect of Electromagnetic Radiation on the House sparrow (*Passer domesticus* Linn, 1758): State-of-Art Review

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Abstract

In the contemporary era, cell phones are an integral and indispensable appliance to human civilization. However, according to some research investigations, cell tower antennas with CDMA technology transmit electromagnetic fields, and radiation in the frequency range of 869-894MHz, and those with GSM 900 and GSM 1800 technology transmit electromagnetic radiation with a frequency range of 935-960MHz and 1810-1880MHz respectively. Unfortunately, electromagnetic radiation (EMR) has a negative impact on several animal species including humans. But EMR released from the cell tower masts have a mortal effect on the bats, bees, birds, etc. as reported in scientific research.

The present study focuses on a detailed review of the effect of EMR on the house sparrow (*Passer Domesticus*). The House sparrow is a small bird of 14- 16 cm in length and prefers to build its nest near urban settlements or farms. During the past few decades, with the increase in the number of cell phone towers, the population of house sparrows around the world has declined significantly. Presently, they are sighted rarely and are found declining at an alarming rate. The House sparrow has been listed as endangered species in 2012. According to the researchers, there are several reasons for the disappearance of this bird, such as the use of non-lead petrol, EMR from cell tower masts, pesticides, and urbanization resulting in loss of habitat. The radiations emitted from the base stations usually cause irritation among the birds causing them to change their habitat to far-off places where the radiation intensity is nil or low. The mortality noticed in the house sparrow probably can be acclaimed to behavioral changes followed by loss of determination of communication signals and direction and ultimately affecting the central nervous system to its extreme. Cell tower antennas with CDMA technology transmit electromagnetic fields and radiations in the frequency range of 869-894MHz and, antennas with GSM 900 and GSM 1800 technology transmit electromagnetic radiation, with a frequency range 935-960MHz and 1810-1880MHz, respectively. Unfortunately, electromagnetic radiation (EMR) harms several animal species including, humans. But EMR released from the cell tower masts increase mortality among bats, bees, birds, etc., as reported in scientific research. Thus, it can be concluded that an effective study should be designed to develop new technologies which make the earth safe for all life.

Keywords: Electromagnetic radiation (EMR), Cell tower mast, CDMA, GSM, *Passer domesticus*, Endangered.

Full-length Paper Presentation

General overview of the medicinal plants used by traditional healers of northern Kerala, India

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Abstract
The present study focused on the traditional medicinal practices of the Kannur and Kasaragod districts. Traditional medical systems and Ayurveda were the two practices in the study area which use locally available medicinal plants. Acanthaceae, Apocynaceae, Euphorbiaceae, Asteraceae, Lamiaceae, and Orchidaceae were the families with more medicinal plants. While comparing the habit of these medicinal plants most of them were herbs. Among the 96 medicinal plants used by the traditional healers, 46 were herbs, 14 were shrubs, 20 were trees, 7 were climbers, 8 were creepers, and 1 epiphyte.

Keywords: Traditional medicinal practices, Indigenous, Medicinal plants, Herbs, Kerala

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Full-length Paper Presentation

Mercury in e-waste: Environmental and human health hazards

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Abstract

The generation and accumulation of electric and electronic wastes (e-waste) are increasing worldwide due to the high demand for information technology in every aspect of life. However, the recycling industries, on the other hand, are very active in their business; nonetheless, there is also an informal recycling sector that collects e-waste in an environmentally unfavorable manner. As a result, there are constant threats to the environment and human health.

The present study focuses on the mercury found in e-waste, and the hazards to the environment and human health associated with this heavy metal. E-waste like spent batteries, mercury vapor, fluorescent lamps, switches, dental amalgams, measuring devices, control instruments, laboratory, and electrolytic refining wastes contains mercury or mercury compounds. This mercury is released into the environment by the e-waste collectors of the informal sectors without proper. In addition, the recyclers themselves face the maximum possibility of mercury exposure. According to a recent report, the establishment of these informal recycling complexes is prominent in the slum areas, such as Dharavi in Mumbai where the hygiene and living conditions of the dwellers and workers are poor. Obsolete electrical and electronic equipment containing mercury, such as fluorescent lamps, computers, and TV sets are the primary focus of the informal collectors in developing countries with regard to earnings. Mercury-containing appliances are collected by local collectors throughout the country and ultimately sent to such recyclers for further processing together with other wastes. Fluorescent lamps, for example, are processed for reuse in a very crude manner because of the lack of awareness and the lack of a separation collection system. Such e-waste is disposed of in landfills or processed in incinerators (open burning). In this way, mercury in e-waste is released into the environment and causes mercury pollution around the sites due to mercury emissions from electrical and electronic equipment.

Mercury emission can cause air as well as water pollution. The mercury vapor inhaled by an individual will develop asthma and lung cancer to its extreme. On the other hand, when the mercury starts contaminating groundwater followed by ponds and rivers, it gets converted to methyl mercury (an organic form of mercury). Methyl mercury is a very toxic compound, and it enters the food chain through the fish and gradually to birds and human beings. The mercury contamination in the environment can be curbed by adopting various strategies. First, the informal and illegal collecting and recycling of e-waste should be stopped by establishing public-private cooperation within a legal framework and investing in environmentally sound technologies. Second, public awareness campaigns should be initiated, followed by the development and investment in research projects aimed at de-mercerizing soil or water by chemical and microbial processes.

Keywords: Mercury, e-Waste, Health hazards, Environment, Remediation

Full-length Paper Presentation

Ethnomedicinal survey of anti-diabetic plants of Jammu & Kashmir

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Abstract

Diabetes mellitus (DM) is a chronic disorder of carbohydrate metabolism characterized by increased blood sugar levels. It is a complex metabolic disorder caused by either insulin deficiency or insulin dysfunction. Insulin is a hormone produced in the pancreas and is needed to transport glucose from the bloodstream into cells in the body, where it is used as energy. The lack, or ineffectiveness, of insulin in a person with diabetes means that glucose remains circulating in the blood. Over time, the resulting high glucose level in the blood is known as hyperglycemia, which damages many tissues in the body leading to the development of disability and life-threatening health complications. There are two types of diabetes; Type I diabetes, also called insulin-dependent, is due to a lack of functional beta cells in the pancreas, and Type II diabetes, also called adult-onset diabetes, is due to the resistance of muscle cells, fat cells, and the liver to insulin. Patients with type I diabetes require an external source of insulin to live. Type 2 diabetes, also called insulin-independent diabetes, is characterized by an inability to respond to insulin and is managed by dietary changes, exercise, and medication. Type II diabetes is the most common type of diabetes, accounting for 90% of the diabetic population. Symptoms for both types of diabetics include high blood sugar, unusual thirst, frequent urination, extreme hunger, weight loss, blurred vision, nausea and vomiting, extreme weakness and fatigue, irritability, mood swings, etc. India comprises various traditional cultures and tribes and follows different customs and medical practices. India has 15 Agroclimatic zones and 17,000–18,000 species of flowering plants, of which 6000–7000 are estimated to have medicinal usage in folk and documented systems of medicine, like Ayurveda, Siddha, Unani, and Homeopathy.

Keywords: Diabetes; Insulin, Ayurveda, Herbal formulations, Medical practices.

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Full-length Paper Presentation

Contribution of Indian women farmers in the conservation of biodiversity and agrobiodiversity

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Abstract

Biodiversity is essential to life. Women farmers contribute to biodiversity and agrobiodiversity in a variety of ways. The forest is regarded by Indian women farmers as a gift from Mother Nature to mankind, providing them with food, fodder, fuel wood, honey, resins, gums, and other minor forest products. They have learned from their forefathers about the economically important plant species in their area. Seeds, grains, medicinal plants, rhizomes, tubers, and seedlings of various cereals, vegetables, fruits, trees, spices, sauces, and other items are collected by women farmers. They flourish on their plot of land, which serves as a nursery for local biodiversity species. These practices of Indian women farmers arouse a feeling of love and devotion toward the plant, which play a significant role in the domestication and conservation of varied native plant species. In the present study, we investigated the role of Indian women farmers in conserving endemic and native plant species in native animal diversity. In a true sense, they are the custodian of culture and biodiversity.

Keywords: Indian women farmers, Culture, Traditional knowledge, Agrobiodiversity, Biodiversity, Conservation, Livelihood.

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Full-length Paper Presentation

Toxicological impact of endosulfan in *Caenorhabditis elegans* at the molecular level – An *in-silico* approach

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Abstract

Organochlorine pesticides are highly persistent environmental pollutants that have been frequently used worldwide. Among the organochlorides, endosulfan is an extensively used insecticide to control edible and non-food crop-damaging insects in the Indian scenario. It has long been known that it has several adverse health effects on humans—like endocrine disruption, infertility, immune system disturbances, and premature abortion. However, few studies are available regarding its toxicological effects on *Caenorhabditis elegans*. In the present study, we used an *in silico* approach to evaluate the toxic effects of endosulfan at the molecular level. For this, the toxicogenomics database was searched, and studies related to the target species were conducted. Further, functional enrichment of targeted genes was carried out using PANTHER software. Results showed that endosulfan increased the apoptotic process by regulating 167 genes and decreased the hatching process, adult life span, and reproductive processes. Pathway analysis showed the involvement of endosulfan in angiogenesis, inflammation, EGF, FAS, and PI-3 kinase pathways. Among them, the most affected pathway was found to be the p53 pathway which is involved in both apoptosis and the life span process of *Caenorhabditis elegans*. Moreover, biological process annotation shows the role of endosulfan in various metabolic and cellular processes. In conclusion, this study sheds light on the unexplored molecular pathways of *Caenorhabditis elegans* regulated by endosulfan. It also highlights the importance of in silico approaches to explain the toxic effects of harmful chemicals in poorly studied species.

Keywords: Endosulfan, *Caenorhabditis elegans*, Comparative toxicogenomics database, p53 pathway, PANTHER

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Full-length Paper Presentation

Lost connectivity with nature

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Abstract

The principle of culture in the ancient Indian subcontinent was entirely based on the concept of nature in its entirety. They took as much from nature as they could without imposing any disturbance or harm, and thus they were able to maintain equilibrium within nature. However, the present time is witnessing heavy exploitation of natural resources, which is not only intentional but also unethical. Therefore, the present study aims to look into scripture and religious literature and what they suggest to human being as far as the matter of nature and environment is concerned so that everyone can become aware of ancient thoughts and ideas about nature and its conservation.

The most ancient literature of the world, i.e., the Vedas of Indian culture, has been taken into consideration to discuss whether the human beings of the modern era are going far away from nature in the name of a developed world or the people of the ancient times were more sensible and somehow understood the importance of a healthy environment. This study has not claimed that people of yore were more intelligent and developed and possessed the knowledge of keeping a healthy environment for the safety, benefits, and growth of human beings, but it is undoubtedly established in this study that the old practices were pro-nature and environmentally friendly. They were not destroying nature and the environment and were also not treating the entity of nature as different and unrelated to their entity. They had this understanding of co-existence with nature, and they were also aware of the importance of nature for the welfare of human beings.

Keywords: Ancient Vedic literature, Vedas, Panch Mahabhootas, Nature, Conservation.

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Oral Presentation

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

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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 Megachilid. 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.

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Oral Presentation

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

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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 Damaiphal (*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 = 0.01and 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.

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Oral Presentation

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

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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.

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

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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.

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

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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.

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

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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.

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Habitat loss and insect biodiversity: An Indian perspective

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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.

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

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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.

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Endangered biodiversity of Jammu and Kashmir, India

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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 endemicity. 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.*

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

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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.

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

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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.

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Habitat fragmentation: A threat to biodiversity

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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 aa s robust wildlife protection plan, needs to be urgently implemented.

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

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Tigers – Striving to survive

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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.

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

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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 km^2 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.

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

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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, 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 levels and low DO levels. The excessive nitrogen in the water causes ammonia toxicity due to the accumulation of ammonia. 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.

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

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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.

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Khushigram's approach to restoring and reviving biodiversity sustainably

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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 populations 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 intentionally, 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.

Although Nature needs thousands or millions of years to create a new species, man needs only a few dozen years to destroy one.

~ Victor SCHEFFER (1906 – 2011)

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