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CONFERENCE PROCEEDINGS

Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing (ICEDAHHW-2021)

Editors:
Dr. Pori Devi
Dr. Bijoy Barman
Dr. Santanu Konwar

Keynote Speaker

Prof. Ramesh 'Zimbo' Boonratana,
Mahidol University International College, Bangkok, Thailand

Title: **Ecosystems and Human Well-Being: Linkages and Gaps**

Plenary Speakers

Prof. Stuart R. Milligan,
Visiting Professor of King's College London

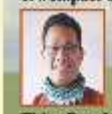
Title: **Biological Dysfunction in a Fog of Man-Made Chemicals: "Endocrine Disruption" in Humans and Wildlife**

Prof. Achintya N. Bezbaruah,
North Dakota State University, NDSU, USA

Title: **Nano, Micro and Macro Interventions to Minimize Anthropogenic Environmental Degradation**

Prof. Prakash Lohar,
Head, Dept of Zoology & Biotechnology MGSM's ASC College, Chopda
Chairman, BoS in Zoology, KBC North Maharashtra University, Jalgaon

Title: **Plight of the Pollution in River Patalganga and It's Impact on Animal Life**



Prof. Hillol Jyoti Singha,
Professor & Head, Dept. of Zoology, Bodoland University

Title: **People's participation in Wildlife Conservation: Opportunities and Challenges**

Prof. Krishna Gopal Bhattacharyya,
Retd. Professor & Head, Dept. of Chemistry, Gauhati University

Title: **Heavy Metals in the Environment and their Ecological Impacts**

Dr. Diganta Bhusan Das,
Department of Chemical Engineering, School of AACME, Loughborough University Leicestershire, UK

Title: **Two Phase Flow in the Context of CO_2 Sequestration, Storage and Monitoring**

Prof. Arun S. Kharat,
Professor, School of Life Sciences, Jawaharlal Nehru University, New Delhi.

Title: **Antibiotic: An Environmental Burden**

Dr. Bidyut Bikash Goswami,
Research Professor, Irreversible Climate Change Research Centre (IRCC) Yonsei University, Seoul, South Korea

Title: **Indian Ocean Warming and It's Impact on the Indian Summer Monsoon**

Dr. Bibhav Kr Talukdar,
CEO, Aaranyak, Guwahati, Assam, India

Title: **Building Environmentally Conscious Citizens for Balance Between Economic Development and Environmental Safeguards to Ensure Human Well-Being**

Three Day Virtual International Conference on

"Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing"

2nd to 4th September, 2021

Organized by

Abhayapuri College

In association with

Department of Zoology, Gauhati University and Aaranyak, Assam

Aaranyak

Our sponsor

IOCL Bongaigaon Refinery

About the Conference:

The conference intends to provide a platform to bring together academicians, scientists, young researchers from different parts of the world for discussion of their findings, views and suggestions on the adverse effects of environmental pollution, particularly of anthropogenic origin on human and animal health.

Conference Sub-themes:

- Threats and Impacts of Environmental Pollution.
- Impacts and Consequences of Climate Crisis on the Environment
- Sustainable technology and Environment protection
- Waste management.
- Over-population, the Environment and Human Health
- Indigenous knowledge Bank (ITK) and Ecosystem Protection.
- Environmental Laws: Gaps to Address.
- Roles of Educational Institution, NGOs, and Civil Movements in the Environmental protection.
- Climate Adaptation and Mitigation

WhatsApp Group:

https://chat.whatsapp.com/ECaBEsHTiGd5dOPITvYARI

Call for papers:

Call for Papers for three day Virtual International Conference on "Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing"

Registration details:

The virtual conference will be held on Google Meet platform. Researchers/ academicians/ students / NGO workers can participate.

Registration Fees:

Participants with papers:
National: a) Faculty & others: Rs. 500/-
b) Research Scholars: Rs. 300/-
c) Students: Free
International: a) Faculty & others : $ 20 (USD)
b) Research Scholars: $ 15 (USD)
c) Students: Free
Participants without paper: Free

Important Dates:

Last date of Registration: **20-08-2021**
Last Date for Full paper submission: **18-8-2021**
Notification of accepted papers: **25-8-2021.**

Registration:

Link: https://forms.gle/ZNQ23nSt3bd3aK3A8

Payment Details:

The amount for registration fee may be paid by online.

For National Participants:

Beneficiary Name: Abhayapuri College Fund
Bank Name: SBI, Abhayapuri Branch
Account No-33933536093
IFSC No-SBIN0008462

For International Participants:

Swift Code of SBI, Abhayapuri Branch for International Participants: SBININBB159

- Registered participants/attendees will be provided the link for **e-participation.**
- Selected papers will be published in the conference proceeding with ISBN.
- **e-certificates** will be issued to all the registered participants.

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CONFERENCE PROCEEDINGS

Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing (ICEDAHHW-2021)

Abhayapuri College, 2-4 September, 2021.

Editors
Dr. Pori Devi
Dr. Bijoy Barman
Dr. Santanu Konwar

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Abhayapuri College

In association with
Dept. of Zoology,
Gauhati University
&
Aranyak, Assam

Sponsored by

IOCL, Bongaigaon Refinery

A Conference Proceedings of the three day virtual International Conference on "Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing" (ICEDAHHW-2021) is Edited by Dr. Pori Devi, Dr. Bijoy Barman & Dr. Santanu Konwar, Assistant Professor, Abhayapuri College, Abhayapuri, Bongaigaon , Assam , India, published by Dr. Sadananda Nath, Principal, Abhayapuri College, Abhayapuri .

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MESSAGE

It is indeed a matter of great pleasure to know that Abhayapuri College took part in the international conference titled "Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing" on 2nd to 4th September, 2021.

It is commendable that Abhayapuri College took the initiative and is going to publish the research papers presented in the International Conference in this proceeding book. I am sure that the book will touch upon the aspects leading to environmental degradation and provide innovative solutions.

I am delighted to be able to extend my best wishes for the successful completion of the book.

(Dr. M.S. Lakshmi Priya, IAS)
Deputy Commissioner,
Bongaigaon

Message

It gives me immense pleasure to learn that Abhayapuri College is going to publish a conference proceedings of the International Virtual Conference on "Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing".

My heartiest congratulation goes to all the members of editorial board and organizing committee of the International Conference for this laudable effort. I appreciate the endeavour of the editors for coming up with such a novel idea and I am sure this will help us to realize our vision of quality enhancement in higher education. I hope this proceeding book of the International Conference will bring together all the findings and innovative ideas of eminent scholars for exchange of new ideas in the fields of environment.

I convey my best wishes for this effort and expect that the readers will find this proceedings book informative and useful.

(Dr. Sadananda Nath)

Principal
Abhayapuri College
Abhayapuri

PREFACE

Human wellbeing is directly related to the nature of environment. It is an undeniable fact that the environment is changing gradually due to various natural and man-made phenomenon. It is inevitable that natural phenomenon like earthquakes, volcanic eruption and many other factors trigger the changing of environmental gradients. However, human interference with various destructive activities lead to gradual damage of our beautiful earth, which poses a great threat to existence of living organisms, including human being. From the industrial revolution, it is realized that developed countries have been exploiting natural resources beyond its limit for their material wellbeing, whereas developing countries use these resources for their survival. All these activities have adverse impact on environment and create serious environmental issues like pollution, global warming and climate change, degradation of biodiversity and habitat loss, increasing vulnerability of plants and animals, surfacing of new forms of diseases etc.

The anthropogenic impact on the environment cannot be controlled in a day. Although, recent technologies might help us to minimize the destructive activities upon the environment, yet, it is unfortunate that we fail to use these technologies due to lack of proper guidance or political issues. We would be able to protect our nature if we could cultivate social and moral obligation in the mind of each and every human being.We have to realize the consequences of environmental degradation and work together for environmental safety. Collaborative activities of social scientists, environmental scientists, biologists, chemical scientists, engineers as well as the people from law and politics may help us to restore or minimize the degradation that has already happened in the environment. It can also help us in taking various measures and policies for environmental health while developing modern tools and technologies to make our lives comfortable.

The need of the hour is to address some of the cross-cutting issues of environmental degradation such as pollution, climate adaptation and mitigation, global warming, indigenous traditional knowledge (ITK), waste management and sustainable development. With this realisation and objective, Abhayapuri College has taken an initiative to organize an International Virtual Conference on "Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing". Keeping the scenario discussed above in mind, along with the main theme, a few sub-themes are also carefully chosen. These are: Threats and Impacts of Environmental Pollution, Impacts and Consequences of Climate Crisis on the Environment, Sustainable technology and Environment protection, Waste management, Over-population: the Environment and Human Health, Indigenous Traditional knowledge Bank (ITK) and Ecosystem Protection, Environmental Laws:Gaps to Address, Roles of Educational institution, NGOs, and Civil Movements in the Environmental protection and Climate Adaptation and mitigation. Eminent scientists from India as well as abroad highlighted various aspects of environment. The conference has received unprecedented response to our request for submission of papers. After a careful process of editing and review from experts, 24 numbers of research papers are selected for publication in the proceedings, which cover most of the theme of the conference.

We would like to extend our sincere gratitude to Dr. Sadananda Nath, Principal, Abhayapuri College for his continuous support and advice in publishing this proceedings. We would like to offer our sincere thanks to the patrons : Dr. MS. Lakshmi Priya, IAS, Deputy Commissioner, Bongaigaon. Assam, India and Mr. Rohini Kr. Choudhury, President G.B, Abhayapuri College, Rtd Joint Secretary, Minority Affairs, Govt. of Assam & President (i/c), G.B, Abhayapuri College; Chief Adviser,-Prof. Jogen Chandra Kalita, Head, Dept. of Zoology, Gauhati University and Secretary, ZSA; Keynote speaker,-Prof. Ramesh 'Zimbo' Boonratana, Mahidol University International College, Bangkok, Thailand; Plenary Speakers, Prof. Stuart R. Milligan, Visiting Professor of King's College London, Prof. Achintya .N. Bezbaruah, North Dakota State University, NDSU, USA, Prof. Krishna Gopal Bhattacharyya, Retd. Professor & Head, Dept. of Chemistry, Gauhati University, Dr. Diganta Bhusan Das, Department of Chemical Engineering, School of AACME, Loughborough University Leicestershire, UK, Prof. Prakash Lohar, Head, Dept of Zoology & Biotechnology MGSM's ASC College, Chopda Chairman, BoS in Zoology, KBC North Maharashtra University, Jalgaon, Prof. Arun S. Kharat, Professor, School of Life Sciences, Jawaharlal Nehru University, New Delhi, Dr. Bidyut Bikash Goswami, Research Professor, Irreversible Climate Change Research Centre (IRCC) Yonsei University, Seoul, South Korea, Prof. Hilloljyoti Singha, Professor & Head, Dept. of Zoology, Bodoland University, Dr, Bibhuti Prasad Lahkar, Scientist, Aaranyak and Chairpersons and moderators of various sessions. We would also acknowledge our deep sense of appreciation to the Zoology department, Gauhati University and Aaranyak, Assam (an International NGO) for their kind collaboration. We owe our special thanks to the learned contributors, members of editorial committee and advisers. We would like to make a special mention of the members of Governing body and faculty members of Abhayapuri College and faculty members of Zoology department, Gauhati University, Dr. Manas Das, Dr. Bulbuli Khanikor and Dr. Banashree Mech. Our deep sense of gratitude to IOCL, Bongaigaon, Assam who came forward with their generous help in making the conference a grand success. We also offer our sincere gratitude and thanks to Micro Computer Print, Bongaigaon.

We hope, readers will be benefited by the research papers of this proceedings. In spite of our sincere efforts, mistakes may have occurred in the proceedings for which we beg apology to readers and authors.

Dr. Pori Devi
Dr. Bijoy Barman
Dr. Santanu Konwar

Contents

Ecosystems and Human Well-Being: Linkages and Gaps

Ramesh 'Zimbo' Boonratana
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Now, what if that massive comet that hit Earth about 65 million years ago did not hit Earth? Also, what if the comet did not cause the dinosaurs' extinction and give rise to the age of mammals? Fortunately, or unfortunately, depending on one's perspective, that did not happen. Our mammal ancestors had a fantastic time - they evolved, they diversified, and they multiplied. But, unfortunately, one species, in particular, multiplied at an alarming rate. The population explosion of this species and the Industrial Revolution of the mid-18th century and from the 19th to the 20th century have resulted in severe environmental degradation and contributed directly to the climate emergency, ultimately with disastrous impacts and consequences on that species' well-being. We are a bizarre species - probably the only one that is driving itself to extinction.

Looking across the conference's theme and sub-themes, I see several commonalities. However, despite the commonalities, experience informs me that there is a danger that both the participants and audience might lose vision of the conference aims and objectives and their significance as we dive into the presentations.

Hence, firstly, my keynote address aims to draw our attention to the common denominators of the conference and highlight the fact that we are all cogs in agiant wheel we call the environment. Humans, however, have been shaping the environment to meet our needs, and unfortunately, our greed, resulting in several undesirable consequences that affect the quality of the environment, the biodiversity, our economies, our livelihoods, our food security - essentially our well-being. Secondly, I hope you can bear the overall picture of this conference at the back of your mind and not treat each conference sub-theme and paper presentation in isolation.Thirdly, I want you to envision the linkages or potential linkages across the different disciplines and presentations. Fourthly, I hope you can identify the individual and collective gaps in our knowledge and practices and formulate the needs and strategies to bridge those gaps. Finally, I hope you will identify individuals and agencies to network with and establish a multi-disciplinary approach or further strengthen your efforts by applying a transdisciplinary approach to address the dire state of our environment.

I have grouped the first set of words that jump out from this conference's theme and sub-themes as assets. Why assets? A short definition of an asset is a property, a person or quality that is valuable or useful. Well, there is no doubt that the environment is a critical asset. So here, our environmental assets include naturally occurring living and non-living entities of our planet Earth. Together, they comprise the bio-physical environment that delivers ecosystem services that directly and indirectly benefit us through their normal functions.

A healthy environment maintains our well-being. It, therefore, deserves every possible protection. But the environment cannot protect itself from its biggest threat – and that's us, humans. Humans are a strange lot. We tend to abuse and destroy the very thing that sustains us. But who or what is going to protect the environment from humans? There is no one else – except again, us humans. Hence, humans are also an asset –we are crucial for protecting the environment from other humansand other threats, such as natural disasters. In addition, we also need to protect and manage this vital asset.

Protecting and managing the natural and biodiversity assets also include safeguarding the ecosystem services they provide. Ecosystem services are those quantifiable 'services' that ecosystems provide to sustain and fulfil human life. Essentially ecosystem services are the essence upon which human civilisation depends. History has already informed us that once we take that away, civilisation collapses. These ecosystem services can be grouped into supporting, provisioning, regulating, and cultural. However, I shall not be talking about something that I believe all participants are already aware. I'm nevertheless highlighting it here, as this aspect of the environment is something, I believe,that can be used both as a linkage and leverage to convince the beneficiaries and gain support for your works.

When we again look at the conference's theme and sub-themes, we also see the threats and impacts to our assets and the need to deal with the consequences of degraded or losing our valuable assets. To protect and manage our assets effectively and sustainably, we need to acknowledge, identify,and understand the type and nature of these threats, their impacts, consequences, and underlying drivers. For clarification, I here highlight two major threats – linear infrastructure and biological resourceuse. Examples of linear infrastructure include roads, railways, gas pipelines and power cables, and examples of biological resource use include hunting, logging, and harvesting non-timber forest produce. The impacts of these threats include biodiversity loss, habitat loss, habitat degradation, and fragmentation. These threats can be driven by poverty, failing crops, food insecurity, market demands, poor policies and weak legislation. In addition, one threat can be the driver to several other threats. Moreover, these threats and impacts can enter a feedback loop and exacerbate new and existing threats. At the meta scale, all threats and impacts to biodiversity, the natural resources, and whole ecosystems will bring about severe environmental degradation.

Addressing environmental degradation is what this conference is all about. We have already started seeing the worsening consequences of environmental degradation over the past several decades.They include drought and floods, extreme weather events and climate instability, crops failure and food shortages, widespread diseases and failing health, rising costs of goods and supplies, loss of incomes and unemployment, financial crisis and global recession, to name some.

For this conference, I use the term "tools" in a broader sense to include techniques, mechanisms, steps, procedures, approaches, and strategies, among others. Among this broader umbrella of tools, we have actions and activities that include management, indigenous knowledge bank, adaptation, mitigation, protection, laws and legislations, research and monitoring, local ecological knowledge, co-management, resource use management, rehabilitation, restoration, poverty alleviation, alternative livelihoods, policy and governance, education and awareness, avoidance, reduction, repair, offset, connectivity, protected areas, protected species, rules and regulations, and law enforcement.

I'm listing these actions out because I expect to hear tangible lessons learned and best practices over the conference's duration. Also, I'm hoping to see clear proposals of specific actions and activities that will guide relevant parties better - not just another recommendation that we need to save and protect the environment for our future generations. We are past that.We are at a critical juncture of human evolution. The decisions and actions that we take now will determine the course that human evolution will take.

Whilst on tools, I wish to highlight an important tool that has not received much attention - environmental resilience. Environmental resilience here refers to the capacity of an ecosystem to respondto a disturbance. Firstly, by resisting damage and secondly, by recovering quickly. Such disturbances can be both natural or anthropogenic in origins. As we all know, severe disturbances can profoundly affect the ecosystem and ultimately, the environment. Therefore, we also ought to be looking beyond protecting pristine and intact ecosystems. Protection alone cannot guarantee the ecosystems' persistence. Hence, we ought to be proactively reinforcing these ecosystems to allow for resilience to be built up against unforeseen stochastic events, especially in the face of the ongoing climate emergency.

The mitigation hierarchy is another tool to assist in determining which tool to employ under what circumstances. Hence, you might consider using this when dealing with development projects that may result in environmental degradation.The four main categories in the mitigation hierarchy include avoidance, minimisation, rehabilitation and offset. Avoidance refers to options to avoid impacts on biodiversity, associated ecosystem services and people - essentially, the total environment. Avoidance is the best option but is not always possible. Where environmental and social factors give rise to unacceptable negative impacts, the development project should not occur.

Minimisation refers to consideration to alternatives in the project location, siting, scale, layout, technology, and phasing to minimise impacts on biodiversity and ecosystem services. In cases where there are environmental and social constraints, every effort should be made to minimise the impacts. Rehabilitation refers to the rehabilitation or restoration of areas where impacts are unavoidable, and measures are provided to return the impacted areas to the near-natural state after the development project has been achieved.

Offset refers to measures over and above rehabilitation to compensate for the residual adverse effects on biodiversity and the associated ecosystem after every effort has been made to minimise and then rehabilitate the impacts. Thus, offsets can provide a mechanism to compensate for significant residual impactson biodiversity. Here is a simplified version of the mitigation hierarchy and the decision-making pathways. Avoidance and minimisation can be grouped into preventive, our primary goaland restoration and offsets can be grouped into remediation when our primary goal cannot be achieved to satisfaction.

Now that we know we need to protect our assets from various threats, impacts, and consequences, and we know the tools that we need to use to protect and manage our assets; therefore, the next step is to identify the actors with whom we are to entrust the tasks and responsibilities. Traditionally, much of the protection, conservation and management work falls with the relevant government agencies, and educational institutions and NGOs' roles typically backstop the government agencies with research, monitoring, and outreach work. However, of late, we see more overlap in their roles, tasks, and obligations. Sometimes this marriage is complementary. At other times, there are conflicts and duplications of efforts.

The expected or possible actions from the different actors can broadly be divided into two groups, those that implementand those that are supportive. While the goals are common to all actors, their motivations may be different. For some, it is an obligatory duty. For others, a commitmentor a necessity, a moral or spiritual obligation and a civic sense. Development banks, for example, should ensure that they have stringent environmental safeguards tied to their financing mechanism and the mechanisms to ensure borrowers' compliance with the safeguards. What about businesses and corporations?

Some are fulfilling their corporate social and environmental responsibility. Others may be simply green-washing. But if they realise their impacts on the environmentand the benefits and services they obtain from healthy ecosystems, they are likely to take a proactive role in achieving the common goals. Well, maybe not all - but I believe many would. What about you and me? Some of us are the actors, while others are the matchmakers showing the linkages between livelihoods and food security to

environmental well-being or guiding different parties to work together and showing where their efforts can be complementary.

Let's take a closer look at businesses, corporations, and, sadly, most governments. Because development is typically measured in terms of economic development, we tend to operate as if the economy is the foundation of everything else. So with this mindset, you can see how shaky our practices are; because everything –the economy, we humans, our joys, our happiness – all depend on a healthy environment. Remove the environment from the equation, and there's nothing left—unfortunately, this is our ongoing mindset and the practices. Hence, if we want to achieve a prosperous and sustainable economy, we should change the desired mindset and practice. First, we have to view that the economy is only a tiny fraction of the overall picture. The economy depends on human capital, and both economy and human well-being are dependent on a healthy, thriving environment.

We finally come to a critical but often ignored aspect of protection, conservation, and management, i.e., the gaps. We may come up with the best tools and actors, but if gaps persist, even the best implementation and efforts will not allow us to achieve the intended goals to satisfaction. Essentially, gaps are the thorns that will cause our well-planned actions to become less effective and even vulnerable. Hence, when we talk about gaps, we are talking about the issues and constraints that will act as barriers or obstacles to a successful implementation of ourtools. Similarly, we will need to predict threats and impacts during the planning stage and identify the issues and constraints if the action is in place. Then, we have to formulate a strategy that addresses the identified issues and concerns and consider existing constraints or limitations.

I have listed some examples of issues and constraints typical to environmental protection, biodiversity conservation and ecosystem protection. They include issues and regulatory constraints, such as weak management, conservation tools, legally binding instruments, compliance, coordination and cooperation implementation and enforcement, penalties and punishments. In some cases, we still lack the baseline data. In most, however, we still have poor knowledge of our rich biodiversity, detailed knowledge of the functions and services of the various ecosystems, detailed understanding of the direct threats, underlying drivers and stressors and type, nature and severity of those threats, of the underlying drivers, and stressors. Also, those that relate to the capacity and nature of the human actors. Such as their competence level, level of education and awareness, their interestin identifying and prioritising needs and probably the most significant challenges to effective protection and conservation - greed and corruption.

By now, I hope my keynote address and my expectations of the conference's outcomes have

become more apparent to all participants. To summarise, we started by talking about our assets. Then we talked about the threats and impacts to these assets and the importance of correctly identifying these threats. Similarly, understanding the significance of the associated impacts and correctly identifying the threats are consequences of an earlier set of threats. We also saw that correctly identifying the threats will, in turn, assist us in identifying the correct conservation responses and prioritising the threats, the impacts, and the responses. However, we also acknowledge that to achieve sustainable protection and conservation, we also need to identify and understand the underlying drivers of the threats. Only then we can hope to develop the appropriate conservation actions to mitigate the underlying drivers, threats, and stressors.

To conclude, I'd like to emphasise the biodiversity contribution to our well-being- both directly and indirectly. Biodiversity essentially is the building block of life. Biodiversity ensures that the ecosystems function normally. These normal functions, in turn, allow the ecosystem to provide the services that all of us are benefiting from. Moreover, healthy and intact ecosystems also ensure there is environmental resilience, especially in the face of the climate crisis. With that, I like to wish the organisers and hosts a hearty dhoinnobad. Also, I like to wish all participants a successful conference, a successful deliberation of their findings and ideas, and fruitful post-conference networking and collaboration that will positively impact our collective efforts to mitigate the ongoing environmental crisis.

Biological Dysfunction in a Fog of Man-Made Chemicals: "Endocrine Disruption" in Humans and Wildlife

Stuart Milligan, Visiting Professor of Reproductive Biology,
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"Endocrine-disrupting chemicals (EDCs) represent not just a threat to public health or indeed to global health, but to planetary health. Pervasive in our environment—in foods, packaging materials, cosmetics, drinking water, and consumer products—EDCs have been linked to a myriad of non-communicable diseases such as obesity, type 2 diabetes, thyroid disorders, neuro developmental disease, hormone-dependent cancers, and reproductive disorders": these are the opening words of the Executive Summary of the recent Series on Endocrine Disrupting Chemicals in the Lancet: Diabetes and Endocrinology (2020; https://www.thelancet.com/series/endocrine-disrupting-chemicals). How have we got into such a dire position? In retrospect, and with our current knowledge of the operation of cellular and endocrine signalling systems, it is easy to see the answer.

Biological systems have evolved over at least the last 3 billion years. The survival of these systems has depended on their ability to regulate their own internal environment and to respond to changes in the external environment. As multicellular organisms evolved, signalling systems coordinating the functions of their constituent parts also evolved. The Cambrian explosion of life forms approximately 540 million years ago was accompanied by the evolution of the nuclear receptor signalling systems regulating gene transcription and controlling critical processes like development, metabolism, homeostasis and reproduction. Many of the signals for nuclear receptors are natural metabolites (fatty acids, terpenoids, porphyrins and amino acid derivatives). With the development of vascular systems in the more complex life forms, some ligands became endocrine signals (e.g. steroid and thyroid hormones).

The biological signalling systems existing today are the end results of many millions of years of natural selection and are very sensitive, exerting a dynamic control of the web of cellular functions. But in the last 100 years or so, the normal operation of the signalling systems has been increasingly compromised by their novel exposure to synthetic chemicals. Humans have developed thousands of extraordinarily useful synthetic organic chemicals, some deliberately targeting biological systems (e.g. pharmaceuticals, pesticides, fungicides, herbicides, anti-microbials) while others have a more direct use dependent on their physico-chemical properties (e.g. plastics, plasticizers, pigments, flame retardants, surfactants, heat stabilisers, anti-oxidants, UV and light stabilisers, impact modifiers, foaming agents, fillers, lubricants, non-stick compounds etc). The chemical structure of these synthetic organic compounds is very varied,

but many are capable of interacting with varied affinities and specificities with nuclear receptors and/or the enzymes controlling the synthesis and degradation of the natural ligands. Acute effects may be inhibitory, stimulatory, antagonistic or additive on any particular molecular response, with corresponding perturbation of biological function. Long term, irreversible effects can result from exposure during sensitive periods of development when critical decisions in cellular pathways of development can be affected. Epigenetic changes induced by environmental chemicals can be responsible for effects in germ cells that pass through subsequent generations. These interactions create a variable degree of fog in the previously clear biological signalling pathways. Depending on the specific chemical and the amounts, duration and timing of exposures, the overall impact of synthetic chemical exposures on individual fitness and survival may range from negligible to lethal, but are often completely unknown.

The manufacture and use of synthetic chemicals have undergone exponential increases accompanying the growth of the human population and it's economic and technological development. Unfortunately, while the large-scale production of these compounds is relatively easy, controlling their safe use and disposal is very difficult. As a result, both land and water systems often act as uncontrolled distribution routes and sinks. Since many of the compounds are very stable and lipophilic (properties upon which their usefulness is often based), they may bioaccumulate within living organisms and biomagnify up food chains, with potential deleterious effects developing in whole ecosystems.

The end-effects of such a fog of synthetic chemicals initially came to prominence in the 1960's with the publication of Rachel Carson's "Silent Spring", and then again in subsequent decades with observations on a variety of reproductive disturbances in species as diverse as oysters, fish and alligators. Potential reproductive effects in humans (esp. testicular dysgenesis syndrome: includes low sperm counts, hypospadias, cryptorchidism, testicular cancer) provided an initial useful focus both scientists and the press, but it soon became clear that the problem of synthetic chemical disruption of biological processes is a much wider issue. In humans, a wide range of adult health issues (e.g.obesity, type 2 diabetes, thyroid disorders, neuro developmental disease, hormone-dependent cancers, and reproductive disorders) have been linked with early life exposure to a range of exogenous chemicals (e.g. BPA, phthalates, polybrominated fire retardants, per fluoroalkyl substances, organophosphate pesticides). But the fog of chemicals swirling throughout the environment affects similar critical, long-evolved biological signalling systems in all life forms. Determining the biological effects and dose-response relationships of single chemicals in a single test speciesis relatively easy in controlled laboratory conditions. Extrapolating this knowledge to predict their real-life effects in complex ecosystems is complicated by the huge variety of chemicals, present in varying amounts and combinations, for variable lengths of time and with simultaneous exposure to other environmental variables (e.g. nutrition, stress, weather etc).

The immense practical benefit of many of the chemicals inevitably means that humans will continue to produce and use them in increasing quantities. Limiting human exposure to potentially harmful chemicals in the workplace and through the food or skin is often possible, but it is much more difficult to limit the

release of the chemicals into the general exposure environment. Much greater thought and emphasis needs to be given to limiting their disposal onto land, into air and water systems and understanding the fate of the chemicals once in the environment.

The problem of environmental synthetic chemicals should not be viewed in isolation but is part of the wider issue of human pressures on the planet. The disruptive effects of the increasingly dense and complex fog of synthetic chemicals impacts individual and species survival and ecosystem function. At a time when other environmental pressures (habitat loss and disturbance, climate change etc etc) are also increasing due to the growth of the human population and continued industrialization, urgent political and public action to control all these issues needs to be taken to prevent reaching irreversible tipping points.

Environmental Endocrine Disrupting Chemicals: Why should we be concerned?

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The natural environment includes the physical, chemical and biological materials that occur naturally in our surroundings (air, water, soil and food). The Man-made Environment, includes physical structures where people live, work and play and the consequences of human degradation to the natural environment (e.g. pollution). The Social Environment encompasses life style factors such as diet and exercise, and other societal influences that may affect health of animals, humans and wildlife.

The issue of Endocrine Disruption and the harmful effects of pollutants on human health have been considered as global environmental problems. The environmental pollutants are chemicals that result from human activities, which end up in the environment and subsequently pose risks to human and animal health. Several of these chemicals are collectively known as endocrine-disrupting chemicals (EDCs), which are presently gaining more importance in terms of public health issue due to their widespread deleterious effects on human health and potential cause of morbidity in animals and wildlife too. The Endocrine Society defines EDCs as "an exogenous chemical, or a mixture of chemicals, that interferes with any aspect of hormone action." These chemicals alter the hormonal balance of the body through several mechanisms; they can mimic hormones, disrupt their synthesis or breakdown, change the development of hormone receptors, act as hormone antagonists or alter hormone receptor binding.

Humans, animals and wildlife are continuously exposed to some chemicals in the environment that produce numerous deleterious effects in animals, wildlife and humans. Body's natural hormones play important role in development and growth of developing foetus and EDCs are reported to interfere with the developmental processes. Our natural hormones are of greatest importance for a healthy development during the entire life span from the moment of conception until death.

The environment has been a complex entity and all living organisms communicate with their external environment mainly through two important systems: the nervous system and the endocrine system. Endocrine system is a set of glands and the hormones they produce that help guide and regulate the development, growth, reproduction and behavior of most living things. Endocrine Disrupting Chemicals are substances that interfere with an animal's endocrine system and disrupt the physiologic function of hormones. The EDCs are synthetic as well as naturally occurring chemical substances in the environment are disrupting the normal functions of the endocrine system and its hormones in humans and wildlife.

The concept that man-made chemicals may cause serious adverse effects on health of humans and animals is not entirely new. In her book "Silent Spring" eminent environmentalist, Rachal Carson pointed out that synthetic chemicals coming out of the industries were polluting the three main life supporting systems on earth, soil, water, and air and they may bio-accumulate in tissues of animals, wildlife and humans. Her work warned the entire world about the severe health issues and fortunately, her warning resulted in researches in that particular direction in identifying, characterising and restrict use of harmful chemicals. In 1996, another book "Our Stolen Future" published by -T. Colborn *et al.* strongly reiterated the issue of Endocrine disruption and threats to our environment. Numerous scientific studies have linked endocrine disrupting chemicals to adverse biological effects in animals, giving rise to concerns that even low-level exposure may cause similar effects in human beings as well. Here are a few reported examples of how exposure to EDCs can impact animals, wildlife and humans include:

- The impaired reproduction and immune system in seals,
- Reproductive and developmental abnormalities in alligators,
- Bird egg-shell thinning resulting in reduced number of offspring,
- Masculinisation of female freshwater and marine snails,
- Feminization of male fish that produce a female egg yolk protein,
- Skeletal deformities in frogs and fish.
- Premature breast bud development in Puerto Rican girls exposed to phthalate esters
- Phthalates linked to obesity (waist circumference). Ubiquitous in US population.
- Premature puberty in Michigan girls exposed to PBDEs

- Significant exposure to bisphenol A (estrogenic) from food plastics and baby bottles.
- Vinclozolin is a fungicide used in viticulture (wine making) and on fruits (e.g. strawberries) since 1975.
- Vinclozolin exposure in rodents during development leads to epigenetic changes maintained over 3 generations affecting sperm count and fertility i.e. a single exposure affects all offspring of subsequent generations.
- Dramatic decline in sperm count and sperm quality (data from EU and US) in the last few decades.
- Increase incidence of breast cancer, cervical cancer and testicular cancer
- Reproductive abnormalities etc.
- Some wildlife species like birds considered as **"**wildlife sentinels" for EDCs, as they react to environmental contaminants before humans do.

It has been observed that currently, every natural system is in decline. The problems are incredibly varied in both cause and effect. These are global warming, average temperature rising, toxic pollutants in air, soil, water, plants and animals. The ocean systems are also changing or declining day by day. Moreover, the large scale and global environmental hazards to human health include: climate change, stratospheric ozone depletion, loss of biodiversity, changes in hydrological systems and the supply of freshwater, land degradation and all these create stresses on food-producing systems. If these, the world's life support systems, are damaged irreparably, there will be no viable economy for the entire population of the world in near future. Therefore, the environmental concerns have to be understood, as the basis upon which all economic - and even human - activities rest. The environmental problem is not only an important social or scientific issue, but one that influences political, economic, developmental and humanitarian issues at regional, national and global levels.

As far as EDCs Issue has been concerned and in view of the reported undesirable health problems cause by EDCs on animals, humans and wildlife, there has been the urgent need for bio-monitoring of EDCs for developing preventive measures as well as effective management strategies. The environmental quality has been considered as the one of the key factors in determining whether a child will survive the first year of life. A healthy future for our children will be ensured only through safe guarding our environment.

Historical analysis of taxonomical studies in the 20th century with special reference to genus *Syzygium* Gaertner. (Myrtaceae)

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Abstract

Present review highlights historical aspect of a large genera Syzygium Gaertner (Myrtaceae) and elaborates a gradual chronology of the research and exploratory works performed by botanists throughout the world starting from preliminary provincial revisions to regional and state floras eventually leading to advanced and modern phylogenetic and numerical studies. A special case study of this genus and the family on a global scale.

Introduction:

Syzygium Gaertner belongs to the family Myrtaceae A. L de Juss., which is a dicotyledonous family under the order Myrtales (Soltis *et al.*, 2005). It is one of the largest amongst Myrtaceae with an estimated occurrence of *c*1200 species (Govaerts *et al*., 2008). It is geographically distributed from Africa to the far Pacific Islands up to Japan through Southern Asia, Malesia and Australia (Soh & Parnell, 2015). The genesis of the word *Suzygium* traces back to the Latin word "*syzygia*" and Greek word "*syzygos*" both of which means being yoked together (Soh, 2017). Historical literatures suggests that, the name *Syzygium* was coined by Joseph Gaertner (1788) in his *De fructibus et seminibus plantarum* based on P. Browne's name "*Suzygium*".

In India, this genus holds a great diversity and species richness in the forests of the Western Ghats and the North East India. In the second volume of the "*Flora of British India*", Duthie (1879) placed *c* 131 species under the genus *Eugenia* (*Eugenia sensu lato)* of Myrteae tribe (Duthie**,** 1879). A total revision of the *Syzygium* species from the Western Ghats has been conducted, where *c* 48 taxa with 27 endemic species have been recorded and described (Sujanapal & Kunhikannan, 2017).

The genus *Syzygium*as well the family Myrtaceae with its huge number and diversity can be regarded as a taxonomical giant but unfortunately very little review data is available on the historical evidence of its study. The present review elaborates a gradual chronology of the research and exploratory works performed by botanists throughout the world starting from preliminary provincial revisions to regional and state floras eventually leading to advanced and modern phylogenetic and numerical studies. A special case study of this genus and the family on a global scale.

Materials and methods:

The present review articleis based on a rigorous collection and thorough analysis of original research papers published by different experts and authorities on the genus *Syzygium* and/or the family Myrtaceae from various parts of the world. It also includes data from different global, regional and state floras of various parts of the world. The collected items were segregated broadly into 2 sections, those published in the early 20thcentury (1900 to 1950) and others published in the later 20thcentury (from 1950-2000). The transition in the research topics, research methodologies and research outputs between both the centuries have also been analyzed and placed here in a comparative form.

Historical analysis of the taxonomic studies published during the 20th century with special reference to the genus *Syzygium*:

From 1900 to 1950:

CB Robinson (1909**:** 331–407) conducted a preliminary revision of the family Myrtaceae in the Philippines. H.C. Skeels (1912: 248) renamed Linnaeus *Myrtus cumini* L. (1753: 471) to *Syzygium cumini* (L.) Skeels, the most common and widespread species of the genus. A. D.E.Elmer (1914: 2343–2358) revised the family Myrtaceae in Mount Urdaneta (now Mount Masay), Philippines. J.S. Gamble (1919: 788 – 864) enumerated the family Myrtaceae in the *Flora of the Presidency of Madras*. F. Gagnepain (1920) studied the genus Myrtaceae of Indochina in details. E.D Merrill (1921**:** 289–308) studied and documented the new species of the family Myrtaceae in Philippines. L. Diels (1922: 356–426) studied the species belonging to the family Myrtaceae of Papua. He (1924: 85–96) also studied the members of the same family from New Guinea. W.G. Craib (1929: 105-119) described a number of new species of *Syzygium* as contributions to the Flora of Siam. A.H.G. Alston (1931: 350) enumerated the *Syzygium* species and other Myrtaceae species occurring in the province of Ceylon and published the same in *A Handbook to the Flora of Ceylon*. E. D. Merrill & L. M. Perry (1937**:** 322–343) conducted reinstatement and revised the genus *Cleistocalyx* Blume (including *Acicalyptus* A. Gray) and published it as a valid genus of Myrtaceae. P.C. Kanjilal & A. Das (1937: 12) described a new species from Assam under the name *Eugenia cyanophylla.* E. D. Merrill & L. M. Perry (1938: 1-20) wrote a detailed synopsis of the genus *Acmena* DC. and validly published it as a genus of the Myrtaceae. Kanjilal U.N., Kanjilal P.C. & Das A.(1938**:** 257-287) enumerated the family Myrtaceae occurring in Assam in the 2nd volume of the *Flora of Assam*. E. D. Merrill & L. M. Perry (1938a**:** 99–116) documented the Indo-Chinese species of *Syzygium*, They (1938b**:** 191–247) also enumerated the species belonging to Myrtaceae in China. They (1939:135-202) also studied and documented the *Syzygium* species of Borneo. M.R Henderson (1949: 1-293) documented the genus *Eugenia* (Myrtaceae) in Malaya.

From 1950 to 2000:

E.D. Merrill (1951: 351-430) made readjustments in the nomenclature of the Philippine based *Eugenia* species. H.D. Ingle & H.E. Dadswell (1953: 353-401) performed and published the anatomy of the Myrtaceous timber trees of the south-west Pacific area. K. A. Wilson (1957: 161-180) conducted a taxonomic study of the genus *Eugenia* (Myrtaceae) in Hawaii. G.J.H. Amshof (1963: 333–351) studied the family Myrtaceae in the *Flora of Java*. R. Schmid (1972a: 423-436). Published one of the most significant publication of the family Myrtaceae entitled "A resolution of the *Eugenia - Syzygium* controversy (Myrtaceae)". He (1972b: 433–489) also studied the floral anatomy of the genus *Syzygium* (Myrtaceae). T. G. Hartley & L. M. Perry LM (1973: 160–227) provided a provisional key and detailed enumeration of the species of *Syzygium* (Myrtaceae) from the island nation of Papuasia. B. G. Briggs & L.A.S Johnson (1979: 157–256) studied the evolution in the Myrtaceae based on the evidences from inflorescence structure. N.P. Balakrishnan (1981: 198-201) documented the family Myrtaceae occurring in Jowai, Meghalaya in *Flora of Jowai*.Deb, D.B. (1981: 366–373) similarly described the species occurring to the family Myrtaceae in *The Flora of Tripura State.* A.J.G.H. Kostermans (1981: 117-188) enlisted and analysed the species belonging to the genera *Eugenia, Syzygium* and *Cleistocalyx* (Myrtaceae) in Ceylon. Hyland, B.P.M. (1983: 1-164) conducted a revision of *Syzygium* and allied genera (Myrtaceae) in Australia. V. Chithra, (1983: 150–158) conducted a rigorous treatment of the family *Myrtaceae* in N.C. Nair & A.N. Henry's *Flora of Tamil Nadu, India.* S. A. Mori et al., (1983: 68–70) mentioned the ecological importance of Myrtaceae in an Eastern Brazilian Wet Forest. L.A.S. Johnson & B.G. Briggs (1984: 700-756) conducted the first ever phylogenetic studies of the order Myrtales and family Myrtaceae. K. Haridasan, & R.R. Rao (1985: 386–403) enumerated the genus *Syzygium* and other Myrtaceae species occurring in Meghalaya in their *Forest Fora of Meghalaya.* H.H. Katijah, et al., (1992: 137-156) performed leaf anatomical studies of the genus *Eugenia* L. (Myrtaceae) from the Malay Peninsula. P. Chantaranothai & J. Parnell (1993: 589-610) provided new taxa and nomenclature combinations in the genera *Cleistocalyx* and *Syzygium* of Thailand. P. Chantaranothai & J. Parnell (1994: 1-123) conducted a revision of the genera *Acmena, Cleistocalyx, Eugenia s.s.* and *Syzygium* (Myrtaceae) of Thailand. J. Chen & L.A. Craven (1994: 321) documented the species belonging to the family Myrtaceae in W. Zhengyi, P. H. Raven and H. Deyuan's *Flora of China*. K.M. Kochummen (1995: 172-247) documented the genus *Eugenia* in F.S.P.Ng's *Tree Flora of Malaya*. W.H. Noorma & D.M. Moore (1996: 265-277) studied and elaborated the taxonomic significance of leaf micromorphology in the genus *Eugenia* L. (Myrtaceae). C. J. Saldanha (1996: 23–32) documented the species of Myrtaceae occurring in Karnataka, India in his *Flora of Karnataka.* P.K. Hajra et al., (1996: 470–479) studied and documented the genus *Syzygium* under Myrtaceae in the *Materials for the Flora of Arunachal Pradesh*. A.S. Chauhan et al., (1996: 167) enlisted the *Syzygium* species occurring in the Namdapha National Park and vicinity in their book "A Contribution

to the Flora of Namdapha, Arunachal Pradesh". J.A.N Parnell (1999: 351-379) studied the first ever numerical analys is of the Thai members of the *Eugenia-Syzygium* group (Myrtaceae).

Conclusion:

The present review study clearly depicts the first half of the 20th century conducting various revisionary works on regional and province basis. Rarely, establishments of new species took place. Most of the revisionary works and family enumerations were performed on regional and state basis, mainly from the Asian Pacific areas like India, China, Siam, Indochina, Thailand, Papua, New Guinea, Malyasia, Philippine, Hawaii, Ceylon (Sri Lanka), Borneo, Java etc. where the diversity and species richness is the highest in the world apart from Australia.

Whereas on the second half of the 20th century, the onset of phylogenetic and numerical studies gets introduced for the first time. The anatomical studies of leaf micromorphology, inflorescence and other parts also took a new pace with various workers taking the aid of such organs in the classification of the genus *Syzygium* and the family Myrtaceae. Various nomenclature combinations and reinstatements of subgenera as a valid genus also started to emerge rapidly. Intrageneric studies also started to come up. Other ecological studies of the genus *Syzygium* also came into focus for the time ever. On a national level, with the publication of the various state floras, the genus *Syzygium* and family Myrtaceae came out into a more prominent and well-studied manner, preparing the future taxonomists to conduct for further revisions at more deeper level, establishments of novel taxa, nomenclature combinations and changes, ecological, anatomical and phylogenetic studies.

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Potential application of housefly maggot cultivation in organic waste management

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Abstract

The enormous increase in the global population has led to the production of massive quantity of waste. So there is an urgent requirement for more efficient and sustainable waste management. In the current study, Musca domestica maggots were utilized as the carrier for bioconversion of organic waste to obtain value-added products like maggot protein, organic fertilizers and compost. The larva or maggots of Musca domestica feeds on a wide variety of decomposing organic waste, such as rotting flesh or tissue debris of animals and plants, poultry manure, or even municipal waste. The aim of this study was to evaluate the prospective of housefly maggot cultivation in reducing organic waste materials and to determine the feasibility of using it as a method for sustainable organic waste management which encompasses both waste reduction and waste transformation. Comparative assessment of maggot cultivation in the plant-based substrate and animal-based waste substrates and utility of the products obtained at the end of the harvest has been explored. The study has been carried out in Sonali Swanirbhar Gosthi Farm located in Chumpuli village, West Bengal, India. It was observed that 5 kg plant-based waste on average yielded 0.7 kg maggots and produced approximately 2.8 kg compost and 351 ml liquid fertilizer as byproducts. On the other hand, the same weight of animal-based waste produced approximately 1.2 kg live maggots, 2 kg compost, and 211 ml liquid fertilizer on average. The material reduction rate in the case of plant-based waste was observed to be 45% and in the case of animal-based waste, it was 58.5%. Thus,we observed a higher consumption capacity and lower residual waste in the case of animal-based waste. The total weight of maggots produced from the animal-based substrate was found to be 40% more compared to that of the plant-based substrate. Hence,we conclude that animal-based waste provides a better substrate for maggot cultivation compared to the plant-based waste substrate. To evaluate the potential of maggot meal as an alternative for commercial feed, a diet comprising commercial feed and live maggot in the ratio of 3:1 respectively was introduced to 200 chickens, 100 ducks, and 2000 monosex Tilapia on the farm. As a result, the previous requirement of 730 kg commercial feed per month was reduced to 438 kg; the rest of the protein requirement was fulfilled by 146 kg live maggots. It was observed that maggot meal is a viable alternative source for high-quality protein feed of poultry birds and fishes and its utilization reduced the feed cost drastically, leading to sustainable aquaculture and poultry industry. The incentive in the form of organic fertilizer and compost is worth selling or using on the farm. Overall absolute biotransformation of low-value organic waste into high-value products like animal feed, compost and plant fertilizer was observed.Thus, housefly maggot cultivation can be utilized as a low-cost technique for complete organic waste reduction.

Keywords : Musca domestica, maggot cultivation, organic waste management

Introduction:

In recent years, waste management has emerged as a fundamental challenge. Countries are producing an enormous quantity of waste with fewer alternatives for its disposal. This global crisis of waste management is becoming more and more significant in both developed and developing countries. Consequently, it has become the need of the hour to find more proficient, sustainable, and economically

viable methods for waste recycling. Contemporary waste management schemes and infrastructures in most developing countries, including India is unable to cope with the massive volumes of waste generated by an increasing urban population, and this has an impact on the environment, human health, and prosperity. Wastes can be broadly classified into organic waste and inorganic waste. Organic waste is the largest constituent of the waste stream globally; it includes biodegradable materials that come from either a plant source or an animal source. However, if properly managed, organic waste can be of economic value and help to boost household income. One of the key advantages of organic waste is its high nutrient content. Due to this, many insects naturally feed on organic wastes, incorporating the nutrients into their bodies and reducing the amount of waste material in the process. This property can be exploited to combat the ever-increasing amounts of waste. Maggot cultivation is a suitable method of bioconversion (Čičková et al., 2015). A variety of fly species can be used for this purpose, including the black soldier fly, *Hermetia illucens* (Nguyen et al, 2015; Lalander et al., 2019; Gold et al., 2020). But, due to convenience, indigenous species such as houseflies, *Musca domestica* are often utilized (Larraín and Salas, 2008; Niu et al., 2017). Maggot bioconversion technology can also help us deal with the increasing demand for animal feed. In recent years, fly larvae are promoted as a new, sustainable and safe source of protein for animal feed worldwide (Makkar et al., 2014).

The aim of this study was to evaluate the prospective of housefly maggot cultivation in reducing organic waste materials and to determine the feasibility of using it as a method for sustainable organic waste management which encompasses both waste reduction and waste transformation. Comparative assessment of maggot cultivation in the plant-based substrate and animal-based waste substrates and utility of the products obtained at the end of the harvest has been explored in this study.

Materials and methods:

The study was carried out in Sonali Swanirbhar Gosthi Farm (Figure 1) located in Chumpuli village, West Bengal, India. The study was carried out in the month of May. The average minimum temperature during the study was noted to be 26°C. The average maximum temperature was around 35°C. The average precipitation was 5.6 inches.

The maggots feed and develop on a variety of organic waste substances, such as rotting flesh or tissue debris of animals and plants, poultry manure, or even municipal waste (Amano, 1985; Barnard et al., 2019). In the current study, plant-based wastes and animal-based wastes are separately utilized for maggot cultivation. The plant-based waste contained rotten fruits and vegetables (Figure 2a), whereas the animal based-waste contained discarded parts of fish and chicken collected from the fish market and poultry slaughterhouse respectively (Figure 2b).

Fig. 1. Sonali Swanirbhar Gosthi Farm, West Bengal, India

Fig. 2. (a) Rotten fruit and vegetable wastes at the local market

Fig. 2. (b) Poultry slaughterhouse waste containing discarded parts of chicken

The local market was visited every alternate day to collect the rotten fruits and vegetables, as well as fish waste. Abattoir waste was also collected from butchers shop and a local poultry slaughterhouse. 25 kg each of plant-based and animal-based wastes were collected in a single day from the market and these were handled separately. After the collection, these wastes were weighed and dumped into plastic crates or drums. In each crate, 5 kg of either rotten fruits and vegetables or a similar quantity of slaughterhouse waste were used. The crates were covered with a lid to protect them from large animals. A small hole was drilled onto the side of each crate for the entry of the housefly (Figure 3). 5 crates containing plant-based substrate and 5 crates containing animal-based substrate were set up in each batch.

3 (a)

3 (b)

Fig. 3 (a, b): Arrangement of crates for maggot cultivation

The houseflies deposit their eggs on the moist surface of the decaying organic waste present in the crates. The eggs require 8 to 12 hours to hatch into larvae under ordinary conditions. The maggots were pale-whitish in color, 3 to 10 mm long, and limbless. The larval stage lasted for approximately 5 days; throughout this period the maggots consumed a massive volume of organic wastes to sustain their development. After 5 days the maggots were harvested. It was observed that the quantity of waste had significantly reduced. A huge number of maggots appeared to be crawling in residual waste (Figure 4a). Apart from that, a dark brownish liquid residue was found to accumulate in the crates, which was produced by the breakdown of the organic wastes; it was drained through small filtering holes drilled at the bottom of the crate. The liquid was collected in a separate container for using it as a liquid plant fertilizer. The larvae were then manually separated from the residue using a wire-mesh sieve. Then the maggots were cleaned with tap water, dried with paper towels, and weighed (Figure 4b). The remaining

Fig.4 (a) Development of maggots in the crate after 5 days

Fig.4 (b) Harvested maggots after washing with water and drying

residue in each crate was also weighed. This residual waste acts as effective compost. The same protocol was followed for both plant-based and animal-based wastes. The whole process was conducted every alternate day to ensure a steady production of live maggot feed. Subsequently, 15 batches of maggot cultivation were completed in one month.

After harvesting, the live maggots were fed to the poultry birds and fishes. A special feed formulation was calculated by consulting the local veterinary doctor; which included commercial feed and live maggot in the ratio of 3:1 respectively. This diet was prescribed to 200 chickens, 100 ducks and 2000 monosex Tilapia (*Oreochromis niloticus*) on the farm. Details regarding the quantity of feed requirement of each animal, before and after introducing live maggots in the diet are provided in Table 4.

Results and discussions:

The small-scale larva production unit at Sonali Swanirbhar Gosthi farm deals with approximately 50 kg of organic waste every single day, which comprises 25 kg each of plant-based and animal-based waste. Table 1 and 2 represents the values of the initial weight of the plant-based and animal-based waste substrate, and the weights of the products and by-products obtained from them respectively. The cycle is repeated every alternate day, leading to the utilization of approximately 750 kg of waste in a month (Table 3). The biodegradable wastes are mostly collected from the local market, thereby introducing a local waste management system. At the end of each harvest, it was observed that 50 kg organic waste was reduced to approximately 24 kg high-quality compost and yielded 9.7 kg larva. From this data, we can infer that *Musca domestica* larva has a substrate consumption capacity of more than 50% approximately. However, maggots exhibit dissimilar feeding capacities in different substrates. In this study, the maggot production, compost yield, and substrate consumption potential of plant-based and animal-based waste were compared to provide a deeper insight.

Table 1. Comparison between the values of the initial weight of plant-based waste and the weight of the products and by-products obtained at the end of 5 days (Substrate 1- Plant based waste)

Crate	Initial weight of waste (gm)	Residual liquid/ Fertilizer (ml)	Residual waste/ Compost (gm)	Weight of maggots produced (gm)
1	5000	365	2900	750
2	5000	320	3150	650
3	5000	420	2600	770
4	5000	270	2450	705
5	5000	380	2700	790
Average	5000	351	2760	733

Table 2. Comparison between the values of the initial weight of animal-based waste and the weight of the products and by-products obtained at the end of 5 days. (Substrate 2- Animal based waste)

Crate	Initial weight of waste (gm)	Residual liquid/ Fertilizer (ml)	Residual waste/ Compost (gm)	Weight of maggots produced (gm)
1	5000	225	2250	1105
2	5000	225	2005	1300
3	5000	180	1950	1305
4	5000	205	2320	950
5	5000	190	1850	1430
Average	5000	211	2075	1218

Table 3. Total requirement of plant-based and animal-based waste substrate compared to the total weight of products obtained in 1 batch (daily) and 15 batches (monthly)

Substrate	Total weight of initial waste (gm)	Total liquid residue fertilizer (ml)	Total residual / waste/Compost (gm)	Total maggots produced (gm)
Plant-based waste (in 1 batch)	25000	1755	13800	3665
Animal-based waste (in 1 batch)	25000	1055	10375	6090
Total (in 1 batch)	50000	2810	24175	9755
Total (in 15 batches/1 month)	750000	42150	362625	146325

Table 4. Feed requirement of the poultry birds and fishes before and after introducing live maggots in the diet

Feeding Species	Total count	Feed requirement before introducing maggots in diet	Feed requirement after introducing maggots in diet	
		Commercial feed	Live maggots	Commercial feed
	(kg/month)	(kg/month)	(kg/month)	
Chicken200	300	60	180	
Duck	100	250	50	150
Monosex Tilapia	2000	180	36	108
Total		730	146	438

It was observed from Table 1 and 2 that on average 5 kg plant-based waste yielded 0.7 kg maggots and produced approximately 2.8 kg compost and 351 ml liquid fertilizer as byproducts. On the other hand, the same weight of animal-based waste yielded approximately 1.2 kg live maggots, 2 kg compost, and 211 ml liquid fertilizer on average (Figure 5). The material reduction rate in the case of plant-based waste was found to be 45% and in the case of animal-based waste, it was 58.5%. Thus, we observe a higher consumption capacity and lower residual waste in the case of animal-based waste. Furthermore, the total weight of maggots produced from the animal-based substrate was found to be 40% than that of the plant-based substrate. Hence, we conclude that animal-based waste provides a

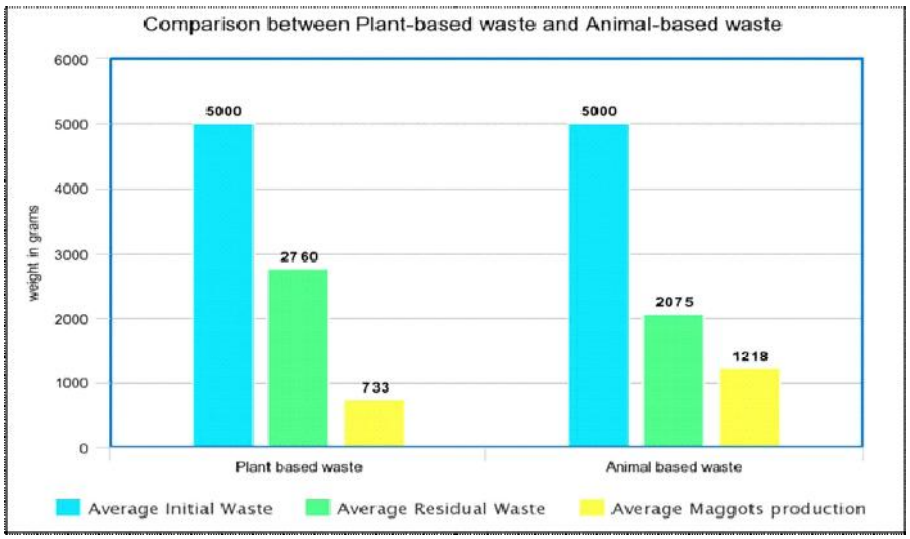

Fig. 5. Comparison of the weights of initial waste substrate, residual substrate and maggot production between plant-based and animal-based wastes

better substrate for maggot cultivation than rotten fruits and vegetables. One of the reasons behind this might be that slaughterhouse waste and fish residues are extremely suitable in attracting adult houseflies to lay eggs and subsequently produce larvae. Moreover, both substrates supported the development of housefly larva to a varying degree.

The maggots are used as a high protein feed for poultry birds (Hwangbo et al., 2015). It also acts as an excellent alternative for commercial fish feeds available in the market (Ogunji et al, 2008; Henry et al., 2015). However, live maggot meal can only be introduced into the diet of carnivorous animals. A diet comprising commercial feed and live maggot in the ratio of 3:1 respectively was introduced to 200 chickens, 100 ducks, and 2000 Monosex Tilapia on the farm. Earlier, these animals were solely fed on commercial feed, whose protein percentage ranges between 22-30%. While the crude protein percentage in housefly maggot ranges between 45 to 60%. As a result, the previous requirement of 730 kg commercial feed per month was reduced to 438 kg; the rest of the protein requirement was fulfilled by 146 kg live maggots (Table 4). It was found that the introduction of live maggots in the diet of poultry birds (Figure 6), caused a slight increase in body weight and average daily egg production compared to just commercial feed diet. Hence, it was observed that maggot meal is a viable protein source for poultry birds and animals, and its utilization reduced the feed cost drastically.

Fig. 6. Poultry chicken fed with live maggot meal

The remaining organic waste left after the consumption by maggots was finally turned into high-quality organic manure that could be used to fertilize plants and crops. In a span of 30 days, 750 kg organic waste was reduced to approximately 362 kg compost and 42-liter liquid residue which acts as a potent plant fertilizer. The compost was kept undisturbed for 30 days to reduce the excess moisture content; then it was applied to the plants by superficially mixing it with the upper surface of the soil,

known as a top dressing. The compost processed by fly larvae has a blackish color, loose granular structure, and is suitable for use as an organic fertilizer (Figure 7a). This fertilizer enhances soil structure, adds beneficial microbes to the soil, and provides nourishment to the plants. On the other hand, the extracted liquid residue was dark brown in color. It was extremely rich and concentrated, so to avoid plant damage it was diluted in a ratio of 20:1, and then either sprayed onto plant leaves or the soil around the root zone was drenched with this (Figure 7b). This liquid fertilizer makes it easy for the plants to absorb nutrients quickly and also reduces the possibility of harm from synthetic fertilizers available in the market. Thus it provides a low-cost method for the production of organic crops. Overall we can notice absolute biotransformation of low-value organic waste into high-value products like animal feed and fertilizer.

Fig.7(a) By products of maggot cultivation (a) cultivation Organic compost obtained from the waste residue

Fig.7(b) Diluted liquid residue from maggot applied to plants as an alternative for liquid fertilizer

Conclusions:

Bioconversion of organic waste using maggot cultivation is a novel concept for waste disposal that has recently drawn immense attention in the field of environmental safety and protection. In our present study, maggots of *Musca domestica* have been chosen as the carrier for bioconversion. Apart from its outstanding capacity for food waste consumption, the products and by-products were also estimable. A wide variety of organic substrates can be utilized for housefly larva production. From the experimental results, it can be concluded that animal-based wastes provide a better substrate for housefly maggot cultivation compared to plant-based wastes. Moreover, eco-friendly waste management from maggot cultivation brings a sustainable environment and enhances the economic value of organic waste by turning it into valuable resources like animal feed, plant fertilizer, and compost, which the community can trade or use. In our system, 750 kg of organic waste could be disposed of in a month. This whole bioconversion produced approximately 146 kg of fresh maggots along with, 42 liters of liquid fertilizer and 383 kg compost. The housefly larvae produced by this process act as a viable alternative protein source for poultry birds and fishes. Its utilization decreases the feed cost substantially, thus leading to

viable and feasible aquaculture and poultry industry. The incentive in the form of organic fertilizer and compost are also worth selling or using on the farm. Thus it provides additional income and thereby encourages the community to continue maggot cultivation. Under suitable conditions, the efficiency of organic waste consumption and yield of products via the bioconversion by the housefly was encouraging. Although, more studies on the safety of the maggot protein need to be explored. All the materials required for maggot cultivation are readily accessible and inexpensive. Therefore, it can be suggested that housefly maggot cultivation is an economic, environment-friendly, and high-value-added process. Thus it can be established as an innovative and low-cost system of organic waste disposal.

Acknowledgement:

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Landscape: a determinant in occurrence of three Critically Endangered *Gyps* vultures in Daying Ering Memorial Wildlife Sanctuary, East Siang, Arunachal Pradesh

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Abstract

The survey for vulture's distribution between 2016 and 2018 in Arunachal Pradesh resultin regular record of vultures from Daying Ering Memorial Wildlife Sanctuary (DEMWLS). Three critically endangered species of vulture namely Long-billed vulture Gyps indicus, Slender-billed vulture Gyps tenuirostris and White rumped vulture Gyps bengalensis have been recorded along with Gypshimalayensis from DEMWLS. Distribution of vulture is affectedby a wide range of environmental factors, each with different extent. The present study has been carried out to understand the role of landscape in distribution of vultures. A landscape consist the physical characteristics of a particular area including vegetation cover, terrain, slope and water bodies. It covers the habitats of particular species. The landscape of DEMWLS is composed of grassland, riverine island forest of tall trees and scattered bushes. The sanctuary is completely a flood plain region which stretches over an area of 190 km^2 with a maiximum altitude of 150 msl. Such landscape provides better area for searching carcasses and roosting site for vulture. In our study, a total of 10 individuals in 2016, 8 individuals in 2017 and 31 individuals in 2018 of three critically endangered Gyps vultures are recorded. DEMWLS had been recorded as preferred habitat for Gyps vulture due to its favorable landscape. Thus, we conclude that the vultures prefer tall trees for roosting and open field for searching food which is a prominent characteristic of DEMWLS landscape. Also, DEMWLS being a well-protected area with less human intervention provides a suitable habitat for Gyps vultures.The finding of this research work will help in conservation and monitoring of Gyps vultures as well as management of the sanctuary.

Keywords: Gyps vultures, landscape, Arunachal Pradesh, vegetation, conservation,

Introduction:

Vultures are nature's most successful scavengers and thus play a crucial role in maintaining ecological, economic and cultural services (Moleon et al., 2014). Due to a lot of variations in geographical and environmental gradient, nine species of vulture are found in the Indian sub-continent (Ali & Ripley, 1987), of these, six are found in Daying Ering Memorial Wildlife Sanctuary (DEMWLS) namely Slender-billed Vulture *Gyps tenuirostris*, Himalayan Griffon *Gyps himalayensis*, White-rumped Vulture *Gyps bengalensis*, Long-billed Vulture *Gyps indicus*, Eurasian Griffon *Gyps fulvus* and Cinereous Vulture *Aegypiusmonachus* (Biswas et al., 2005, Mize et al., 2016,). Vultures are known to inhabit tall trees in forests, smaller trees in open areas, rocky cliffs, old monuments and the countryside (Thompson et al., 1990; Liberatori & Penteriani, 2001). Three species of resident *Gyps*vulture namely Long-billed Vulture (LBV) *Gyps indicus*, Slender-billed Vulture (SBV) *Gyps tenuirostris*, and White-rumped Vulture (WRV)*Gyps bengalensis*) are threatened with extinction in South Asia due to the contamination

of domestic ungulate carcasses with the drug diclofenac and have declined by more than 90 per cent since the early 1990s (Chaudhary et al., 2012) thus the three vultures have been are listed as critically endangered species (Birdlife International 2001). From the ecological perspectives the landscape can be defined as an area of land containing a mosaic of habitat patches, often within which a particular "focal" or "target" habitat patch is embedded (Dunning et al., 1992). Changes in landscape composition alter the food availability, thus act as one of the determining factors in occurrence of vultures (Carretea et al., 2007).

Daying Ering Memorial Wildlife Sanctuary (DEMWLS) lies on the border area of Assam and Arunachal Pradesh in the flood plain between the Rivers Siang and Sibya. Regarding the landscape, the sanctuary area mainly comprised of two types of habitats namely alluvial grasslands and semi evergreen forest patches (Mangement Plan, 2000). The soil of DEMWLS is of new alluvial type and It is harbor of many islands, varying in shape and size, which remains flooded during the rainy season and provide a good habitat to various plant taxa, birds (resident as well as migratory) and animals (Jeyaprakash and Rathinavel, 2016). Divided into three administrative ranges, Anchalghat, Sibiamukh and Borguli, the vegetation of Sanctuary is Semi-evergreen forests, river islands, marshes and extensive grasslands (Barman, 1996).The purpose of this research work is to show that the landscape pattern of DEMWLS is a determinant for occurrence of the three CR Gyps vultures. It will also help in understanding the role of landscape pattern in occurrence of vultures which is an important aspect for taking any conservation steps for the three *Gyps* CR vultures in near future.

Materials and Method:

Study site

Daying Ering Memorial Wildlife Sanctuary (DEMWLS) is located in Arunachal Pradesh which is one of the northeastern states of India.The DEMWLS lies in between 95° 15'to 95°30' east longitude and 27°50'to 28°50'to north latitude and is situated in East Siang District, Arunachal Pradesh, at a distance of 13 – 15 km from Pasighat. It covers a total area of 190 sq km lies in the low-altitude floodplains on the border of Arunachal Pradesh and Assam. In Arunachal Pradesh Siang River (Brahmaputra in Assam) surrounds the northern, eastern and western parts of the sanctuary, however, its southern part extends into the adjoining state of Assam where it is called Kobo Chapori. DEMWLS falls under the Indo-Malayan Bio-geographic Zone along with rest of North Eastern Region. The area of DEMWLS is divided into three ranges – Anchalghat, Sibiamukh and Borguli, and is administered by the divisional Forest officer based at Pasighat.

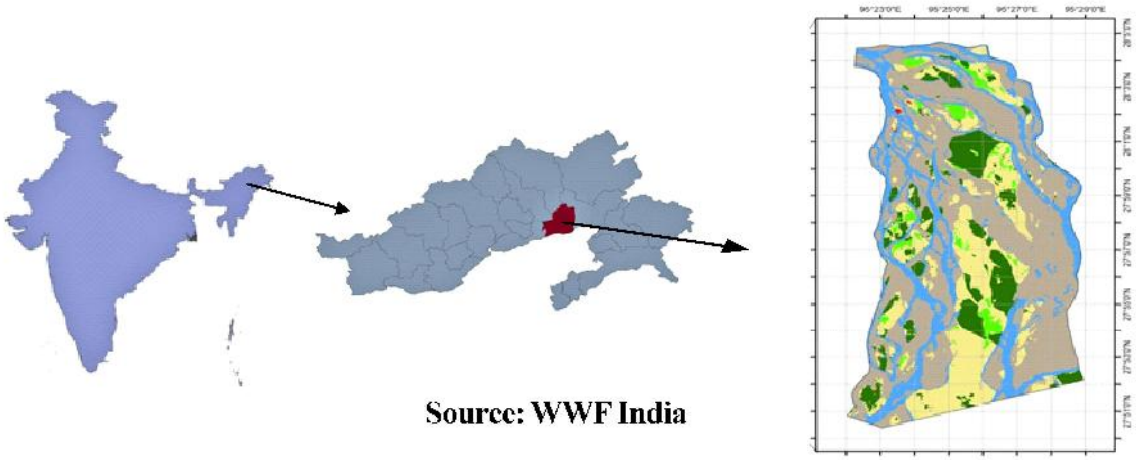


Fig: - Study area - DEMWLS

Methods:

To study population vultures

The survey was conducted across the DEMWLS of district East Siang during from January 2016 to December 2018 using the road-transect survey method (Fuller and Musher, 1981). Direct observations were made at feeding and roosting sites to assess the population size and different vulture activities. For more accurate data, each year three vulture counts were undertaken in three different seasons: summer (May), rainy season (August), and winter (December) for three consecutive years 2016-2018. The population estimation protocol was revised and improved after every count. All the vultures seen were counted during the first estimation in different part of the sanctuary in the span of one week for summer season (month of May), assuming that vultures would not have changed their roosting or nesting sites during such a short period. In the second estimation a particular day was fixed (month of August) for rainy season population estimation of vultures to avoid double counting in case of movement of vultures to another territory. Pre-estimation exercises were conducted to locate the roosting and nesting sites in advance. This time the coordinates of vulture sites were recorded and an attempt was made to identify the vulture species. Month of December was fixed for the third or winter population estimation keeping in view the chances of fluctuation of vulture's population during this period. In addition to running transects, we also visited dumpyards, looking for carcasses and vultures in and around the surrounding villages. The survey was conducted between 0700 hrs to 1800 hrs and 8 x 40x binoculars were used for sighting vultures. The sighted species were confirmed by consulting Collin's Bird field guide for Indian sub-continent and Birdlife International website. The photographs of the vultures were captured by using Cannon 1200 D camera with 55-250 mm lenses and cannon EF 800 mm super telephoto lenses. For GPS coordinates of sighted vultures, Garmin Montana GPS device was used. A questionnaire survey was conducted among the forest guards and the people from of the nearby villages/towns of DEMWLS about vulture ecology like, habitat use, availability of trophic resources, other competitors for carrion, conservation issues etc.

Image 1. Vultures photography during field survey

Image 2. Carcass feeding site of vulture

To study landscape pattern:

During the field survey the types of landscape pattern of DEMWLS were thoroughly recorded. The identification trees and plant species were done to record the types of vegetation. The photographic evidences of different types of landscape pattern were also collected for future records. The classification of types of vegetation was done on the base of 'The Champion and Seth 1968 classification of forest'. For other required information, the forest officials and villagers of the adjacent villages were consulted. The landscape maps were taken fromspatial database including land use /land cover (LULC) map and vegetation map by Areendran, G. et al., 2019.

Questionnaire for vulture survey :

This questionnaire is produced only to know and evaluate the anthropogenic effect on the population of vultures and the information gathered will be used only for research purpose. The information provide

by any participants will be kept confidential. Further, you will neither get monetary benefits nor be penalized for participating in the survey.

Your participation and cooperation is highly appreciable and the information collected from you will be helpful in the conservation of vulture in near future.

Name of participant:
Age/ Sex:
Address/ Place:

1. Have you observed any vulture in your locality? Yes / No
Local name, if any?

2. If Yes,
a) When?
b) Where?
c) How many?
d) encountered alive or dead?

3. Is there any hunting of vulture in your area? Yes / No
If Yes, why?
4. Is there any use of vulture in local tradition and custom? Yes / No
If yes, How?

5. What do you do with your livestock's carcases? Burn / Bury / Sell / Throw / Others
If others, please specify

6. Are agriculture/ cultivation done in your locality? Yes / No
If yes, what types of agriculture?

7. Do you use any pesticides? Yes / No
If yes, name those pesticides?

8.Do you agree that the use of pesticides have been increased in your area? Yes / No

Signature of participant Information collected by

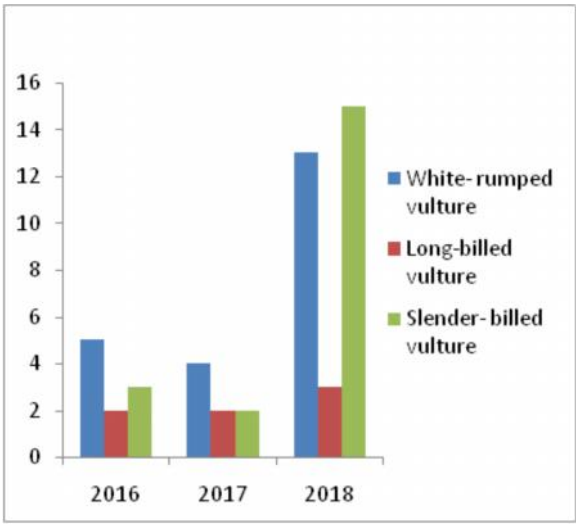
Results:

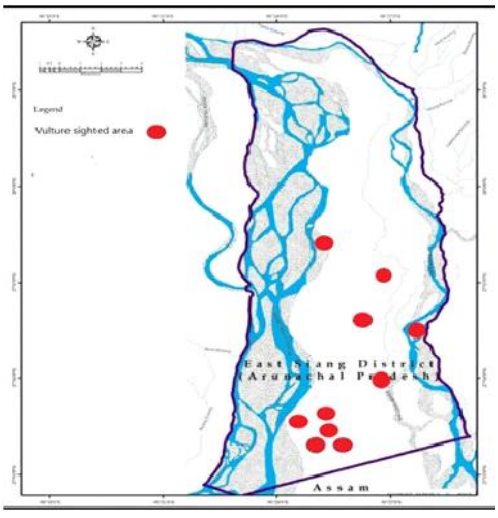
Vultures recorded in DEMWLS

During the continuous three years (2016 to 2018) regular survey for three CR *Gyps* vultures; we have recorded total 48 individuals viz. 10 in 2016, 8 in 2017 and 31 in 2018 from D'Ering Memorial Wildlife sanctuary. *Gyps bengalensis* was in the highest no. followed by *Gyps tenuirostris* and *Gyps indicus*. Along with the above three CR *Gyps* vultures Himalayan Griffon *Gyps himalayensis* are also recorded.

Name of the species	Individual numbers in 2016	Individual numbers in 2017	Individual numbers in 2018	Total
WRV	5	4	13	22
LBV	2	2	3	7
SBV	3	2	15	20
Total	10	8	31	

Table: - Record of number of individuals of vultures in year 2016-2018.





Source:-WWF India

Fig 1. Graphical representationof CRGyps vultures in DEMWLS

Fig 2. Distribution map of CR Gyps vultures in DEMWLS

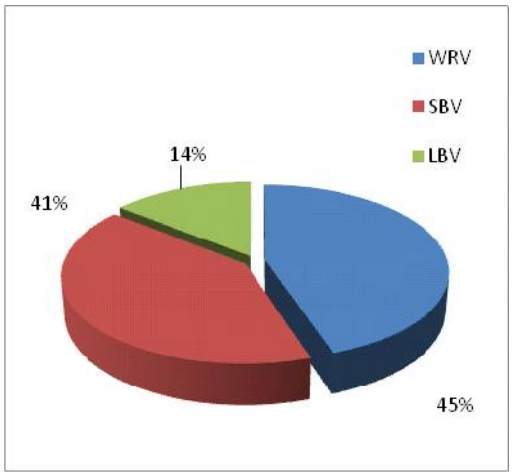


Fig 3. Composition of CR Gyps vultures in DEMWLS

Images 1. Vultures roosting in *Bombyx ceiba*
Images 3. LBV (J)

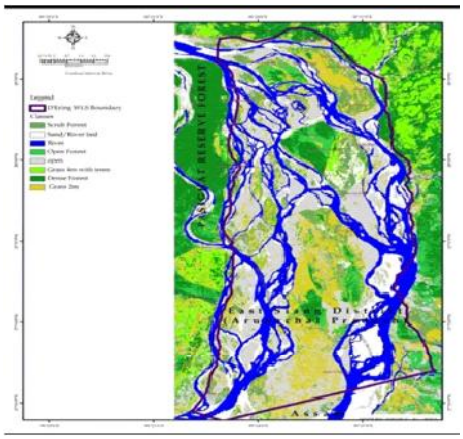
Images 2. Vultures soaring in the sky
Images 4. WRV (A) and SBV (A) near feeding Site

Images: - Photographs of CR Gyps Vultures in DEMWLS

Landscape pattern of DEMWLS:

During the study of landscape pattern of DEMWLS, It has been recorded that the entire sanctuary area is riverine plain criss-crossed by Siangriver and Sibia river forming numerous river islands. The vegetative covers of the sanctuary are in early stages of succession, about 75% of the areas have extensive Alluvial Grasslands and the remaining 15 % of the area is covered by patches of Woodlands Forest and Water Courses. The Woodlands Forest falls under the category Assam Alluvial plain

Semievergreen forest of Champion & Seth's Classification with tree species such as *Bombax ceiba, Sterculia villosa, Terminalia myriocarpa, Dillenia indica, Aesculus assamica, Moringa oleifera, Dalbergia sissoo, Cinnamomum bejolghota, Ficus spp., Duabanga grandiflora* etc. The main grass species of Alluvial Grasslands in the sanctuary are *Saccharum spontaneum, Saccharum arundinaceum, Saccharum procerum, Solanum nigrum, Neyraudiar eynaudina, Chrysopogon, Imperata cylindrica, Phragmatis karka, Vetiver iazizanioides* with *lantana camara* and other shrubs.



Sources: - WWF India

Fig1. Vegetation mapping of DEMWLS

Sources: - WWF India

Fig2. Vegetation mapping of DEMWLS

Landscape as determinant for the occurrence of vultures:

The landscape of DEMWLS provides a perfect habitat for survival of grazing animals where the vulture in this area feed on the carcasses of these grazing animals. During the survey it has been observed that the vultures built their nest in tall tree like *Bombax ceiba* which is abundantly available in DEMWLS. The altitude of the DEMWLS ranges from 53 m to 187 m above mean sea level gradually decreasing from north to south. Such type of low altitude area with almost uniform altitude ranges is a favorable landform for soaring raptors to find their foods. The three CR vultures viz., LBV, WRV and SBV belongs to the group of old world vultures and depends on sighting for searching their food. Thus the plain and open landscape of DEMWLS offer a favorable landscape for the survival of the vultures. They can have a wide range of visibility for foods during their flight.

Sl no:-	Components of landscape	Role in occurrence of vultures	Remark
1	River	Availability of water leads to richness in the population of the animals on which vulture feeds on.	Vultures are often found on the bank of the river feeding on the carcasses of animals trap in muds and ponds for Also vultures are found to be taking sun bath in the river bank
2	Dry riverbed	Open areas for searching carcasses	Most of the time vultures appears to be soaring in the sky above the dry riverbed
3	Dense Mixed Jungle	Provides the habitat for the animals on which vulture feeds. Also provide the habitat for vultures for roosting and nesting.	*Bombaxceiba*is one of the most common and preferable Roosting and nesting site for the vultures.
4	Open Mixed Jungle	It mainly provides the vegetation for grazing animals like cattles from nearby cow and buffaloes sheds.	Most of the feeding sites of vultures were recorded from these areas
5	Grassland	The tall and short grasslands allows the vulture to get clear and broad view during their flight. It also helps them to track the cattle and other wild animals.	Approximately 75% of the total landcovers are alluvial grassland.
6.	Nearby villages/town	The cattle and other domesticated animals from nearby villages/towns penetrate inside the periphery of the sanctuary which becomes one of the largest sources of food for the vultures.	There are large numbers of cow and buffaloes shed (Khutis) near the boundary of DEMWLS.

Table: -Different components of landscape that determining the occurrence of vulturesin DEMWLS.

Image 1. Open Mixed forest Image

Inage2. Grassland plain

Image 3. Dense Mixed forest Image

Image 4. Dry Riverbed

Images: Different components of landscape of DEMWLS

There are conclusive evidences that the landscape play a significant role in determining the survival of vultures in DEMWLS. Also DEMWLS is the only place in Arunachal Pradesh where regular sighting of vultures are recorded in recent years. Hence, landscape can be considered as a determinant for the occurrence of vultures in DEMWLS.

Discussion:

The landscape pattern plays a crucial role in distribution of vultures in an area. Vultures are high altitude soaring birds so they need an open field for the searching of carcasses and tall trees for roosting. DEMWLS provides a favorable condition for the survival of the vultures in its periphery where the landscape pattern plays an important role, which can be considered as one of the determinant in the occurrence of three CR *Gyps*vultures' i.e. Long-billed vulture, White-rumped vulture and Slender-billed vulture. DEMWLS being a well-protected area with less human intervention provides a suitable habitat for *Gyps* vultures.The potential threats that may cause landscape degradation in DEMWLS are the breaking out of forest fire during dry season, devastating floods during monsoon season, deforestation, overgrazing by the cattle of many Khuties (cattle camps) etc. The degradation of landscape in DEMWLS will cause reduction in vegetation cover, changing of water course and habitat loss for all the native species including vultures.The base line conclusion generated in this study can be used for future monitoring and further detailed study. Better supported findings can define better management action in the direction of the conservation of this highly endangered group of species.

Acknowledgement:

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Status of Threatened Biodiversity in Behali Reserve Forest, Assam, India

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Abstract

Biodiversity all over the world are facing some serious and immediate threats to their survival in the form of destruction of forests, hunting, developmental activities in the cost of forest degradation etc. Growth of anthropogenic activities in and around the forest areas since a long time has caused great harm to the environment by disrupting the biodiversity of the wild. The balance of an ecosystem is maintained only when the biodiversity of the habitat or ecosystem as a whole is left undisturbed. However, this balance is being highly challenged mainly by the human activities and this has led to extinction of many species from the earth already. Therefore threatened species are identified and accordingly strategies are prepared towards their conservation. The Behali Reserve Forest in Assam, India, is a very rich centre to biodiversity of the region which harbors a very good number of wildlife species of flora as well as fauna. In this work, the wide range of important biodiversity found in the Behali Reserve Forest with special reference to the threatened species of the forest has been aimed to be found out. From the study, a total of 1047 species of plants and animals were recorded. Out of these, 3 threatened species were flowering plants and 40 threatened species were animals.

Keywords : Biodiversity; Threatened species; Behali RF; Anthropogenic activities

Introduction:

Human activities are causing loss of biological diversity among animals and plants globally which would have been less by many folds in the absence of human activities. One of the major activities of humans that are directly destroying the biodiversity in all the aspects is deforestation. It is a major concern for the planet. It has impact on almost every life form on land, including the human race. Besides the natural causes of deforestation, anthropogenic activities have accelerated the destruction of forests by many folds. This, in turn is causing a chain of consequences which are very much harmful in long term, compared to the handful of immediate benefits resulting through it. The destruction of forest areas has helped to create space for human settlements and use but the cost it carries in the form of loss of resources and harm to the natural balance weighs far more in value. It is a matter of serious concern for the mankind which needs immediate attention and better understanding, practices and policies to be implemented to address the issues associated with deforestation and its control. Hunting is another such concern which is causing multiple threats to biodiversity of any region. Behali Reserve Forest is located at the foothills of the Eastern Himalaya, in Biswanath district of Assam, on the Assam-Arunachal Pradesh border. It was declared as a Reserve Forest on 31st of August 1917 via notification No. 4031R, Dated. 13th of August, 1917. It is also been declared as an "Important Bird Area" by the Bombay Natural

History Society. Falling under the East Himalayan Biodiversity hotspot region declared by IUCN, it forms a part of Sonitpur-Kameng Elephant Reserve that was notified in 2003. The area is flat with gentle slopes, whereas some hilly areas present lie in the extreme north.

Materials and methods:

Study area:

Behali Reserve Forest has a total area of 14,000 hectares, but according to newer statistics of 2021, the area has been reduced to 8000 hectares (Choudhury, 2000). It is situated in Behali Mouza in the Biswanath district of Assam. The main route of communication to the area is via the NH 15. There are many tributaries viz. Bihmari, Deojan, Naharjan, Bedeti, Dikal, Dihiri, Thandapani, and many others which drain the water to the Buroi and the Borgang River and finally Brahmaputra. In the east there flows the Buroi River which is connected to the Singlijan reserve forest. To the west the boundary is marked by the Borgang River. The northern boundary is shared by the Papung Reserve Forest of Arunachal Pradesh. It is located between 26° 52' and 26° 57' North longitudes and 93° 15' and 93° 24' East latitudes with $26^{0}54'33.17"$ N, $93^{0}18'18.$ 79" E central co-ordinates. The elevation is approximately 128 ma

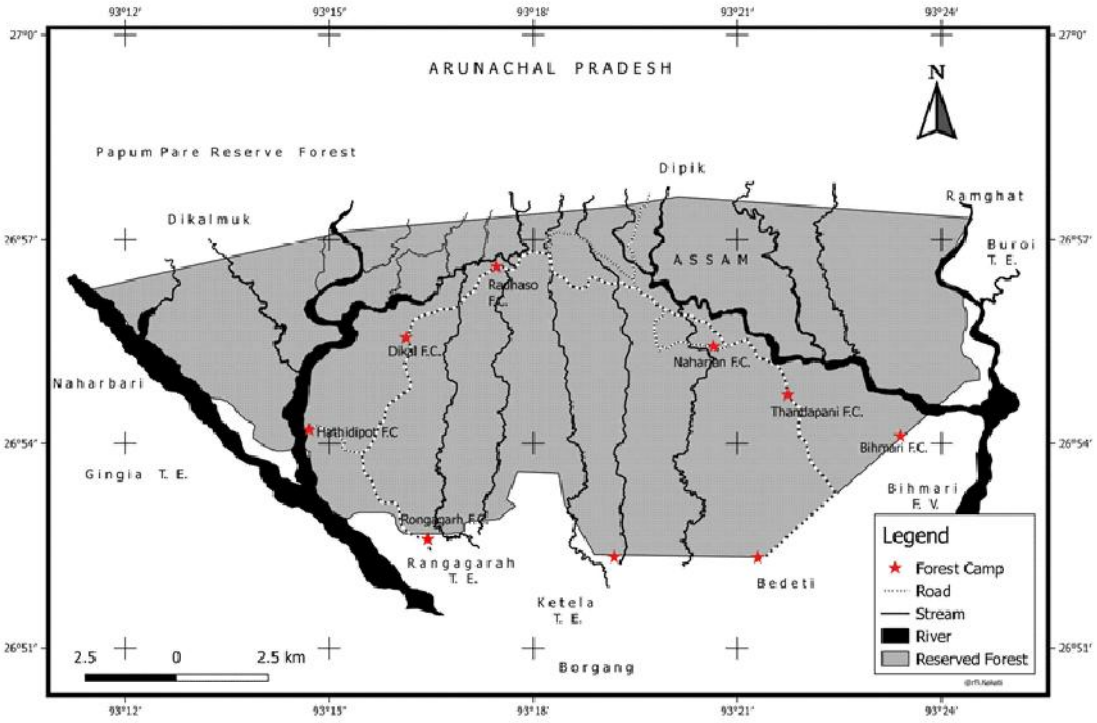

Fig 1: Map of Behali Reserve Forest

Southern boundary has many tea plantations and human habitation areas which includes Rangagorha Tea Estate, Khorang Line, Serelia pathar, Hatimara pathar, Sialmari, Bihmari area, Serelia Bongaon, Bihmari Bongaon etc. The elevation of the Behali Reserve Forest ranges from 80 metres to 275 metres above sea level. The soil type found in Behali is cambisoil. The habitat is made up of tropical evergreen, semi evergreen, and moist deciduous forests with cane bamboo brakes and narrow strips of open grassland along the Borgang River. Grassland comprises of less than 7% of the total area of the reserve forest while the semi-evergreen and moist deciduous species dominate the area. The climate is humid subtropical type with three distinct seasons namely, the summer from March to May, rainy season from June to august and winter season from October to February. The main characteristics of humid subtropical climates are long and very hot summers that start from mid April and peaks in May. Winters are relatively short, dry, mild and often foggy. Within a year, usually most of the rainfall is received during the summer months and winters remain dry due to land derived winter winds. During rainy season, heavy rains are received almost in daily basis. Although the temperature declines during the monsoon season, the humidity increases leading to hot and humid conditions. Temperature records a maximum of 35 ^{o}C during July, August months and the minimum temperature falls to 10 degree Celsius in January. The area is influenced by the tropical monsoons, which cause rainfall to be seasonal and heavy. The study started at the winter season and continued up to early monsoon. The soil is mostly composed of new and old alluvium (Saikia and Saikia, 2012). The mean annual rainfall varies from 1500 mm to 4000 mm and the temperature ranges from 35^{o}C to 5^{o}C (Islam and Rahmani, 2004). The Reserve Forest is an important area for mammals like Indian Elephant (*Elephas maximus*), Slow Loris (*Nycticebus coucang*), Capped Langur (*Trachypithecus pileata*), Malayan Giant Squirrel (*Ratufa bicolor*), etc. (Islam and Rahmani, 2004; Kakati et al., 2021).

Data Collection:

The study was carried out from September 2016 to October 2020 covering all seasons' i.e. summer (March–June), monsoon (July–October), and winter (November–February) (Devi and Saikia, 2012). Short duration field visits were made with fixed intervals within a month and all data were collected between 5.30 am to 5.30 pm. Data were collected through literature, direct observation and indirect evidences which are left by animals. The fix line transect method of Bibby et al.,(2000) was used. The whole study area was carried out in three zones i.e., intact forest (densely forested area covered by primary and secondary forest with high canopy coverage), moderately intact forest (forested are a with some extent of degradation due to firewood collection and timber exploitation) and transitional zones of forest (edges of the forest area, agricultural lands, and human settlements). A total of 12 transects were randomly laid (T1 to T12), which approximately covers 1 km long and 10 m wide.

The plant species records were collected from the literature (Borah et al., 2018, 2019a, 2019b, 2020a, 2020b, 2020c, 2020d, 2021). Fishes were collected with the help of the local fisherman who used different kinds of fishing nets, traps, and local fishing techniques (Vishwanath, 2017). The specimen were identified based on morphometric and anatomical studies, using Talwar and Jhingran (1991) and Vishwanath (2017). The bird species were identified by their primary calls, sight, photographs and relevant literature (Grimmett et al., 2011). Reptiles and amphibians were observed by visual encounter survey (Crump and Scott, 1994), randomized walk (Lambert 1984), active searching (Rolfe and McKenzie, 2000). The specimen were later identified through the methods of Ahmed et al., (2009), Mathew and Sen, (2010), Purkayastha (2013), and Saikia and Kharkongor (2017). Turtle species data were observed by direct sighting, visual encounter survey (VES), and active searching method (Qaiser and Sharma, 2016, Basumatary and Sharma, 2013). Specimens were identified based on morphometric study and with the help of Ahmed et al., (2009) and Daniel (2016). Mammal sightings were counted by direct observation and track count techniques (Khan et al., 2007, Lin et al., 1988). Some earlier records of animals were recorded from some literatures (Upadhyaya 2016-17). The threat statuses of all the taxa are as per IUCN Red List (2020). Some data were collected from the earlier records.

Results and Discussion:

From the study, a total of 1047 species of plants and animals were recorded. Out of these, 310 species were flowering plants and 38 species of Orchid. During the recent study, various new species were discovered and recorded from the forest. *Chlorophytum assamicum* was a critically endangered species, *Peliosanthes macrophylla* var. *assamensis* and endangered *Aristolochia assamica* have been described as new to science from this forest. Among these rare species, two of the plants have been assessed as threatened and are found only in this forest. Other species of plants like *Tupistra stoliczkana*, the endangered *Citrusv indica*, *Galeola nudifolia* and *Pandanus unguifer* were recent rediscoveries and new records for the state. (Borah et al., 2018, 2019a, 2019b, 2020a, 2020b, 2020c, 2020d, 2021)

A total of 699 animal species were found during the study. Out of them, 52 species were of mammals, 282 species of birds, 275 species of butterflies, 23 species of snakes, 11 species of turtles, 13 species of amphibians, 11 species of lizards and 32 species of fishes were identified. Out of these 699 animal species, 22 species of mammals, 14 species of birds, 2 species of snakes and 6 species of turtles were threatened as per IUCN.

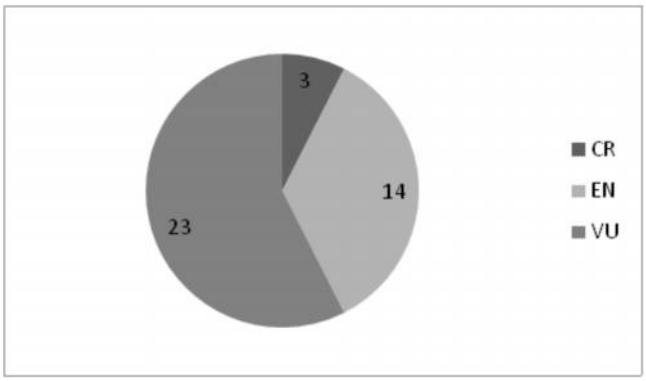

Fig 2**:** Pie diagram showing the threatened categories found in Behali Reserve Forest.

Chinese Pangolin, Black Softshell Turtle and Red Necked Vulture, these three species are critically endangered animals found in the Behali Reserve Forest. Fourteen numbers of animal species which are endangered as per IUCN namely Bengal Slow Loris, Asian Elephant, Hog Deer, Pigmy Hog, Tiger, Wild Dog, Hispid Hare, White-Winged Duck, Steppe Eagle, Indian softshell Turtle, Black Pond Turtle, Tricarinate Hill Turtle; Twenty three numbers of animal species are under vulnerable categories namely Capped Langur, Sambar, Wild Gaur, Common Leopard, Indo-Chinese Clouded Leopard, Fishing Cat, Binturong, Himalayan Black Bear, Sloth Bear, Smooth-coated Otter, Wreathed Hornbill, Rufous-necked Hornbill, Great Hornbill, Woolly-necked Stork, Lesser Adjutant Stork, River Tern, Greater Spotted Eagle, Steppe Eagle, Eastern Imperial Eagle, Common Pochard, Burmese Python and King Cobra.

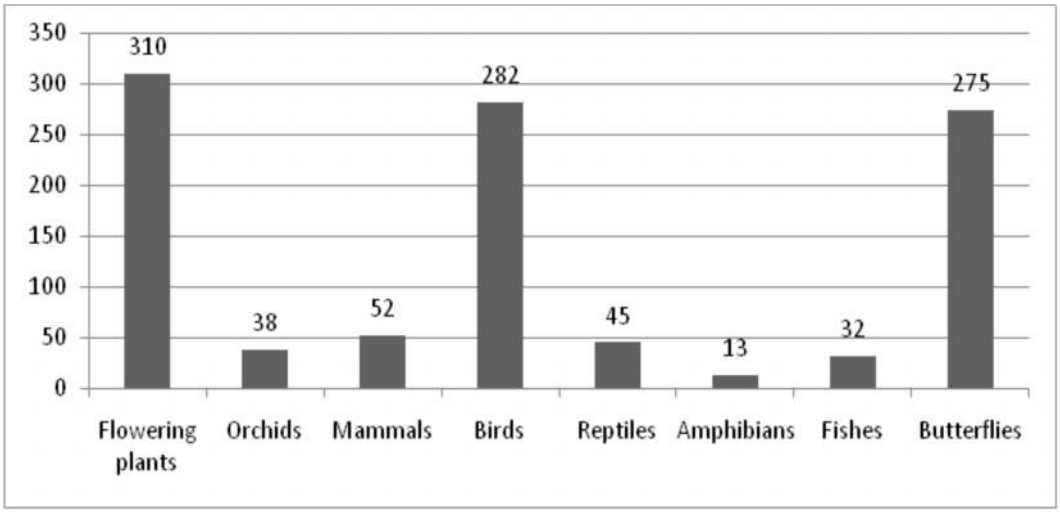

Fig 3: Bar diagram shows the species diversity in Behali Reserve Forest

Out of these some are now found in Behali Reserve Forest but were earlier considered to be locally extinct from the forest namely: Pygmy Hog, Hispid Hare.

Sl. No.	Common Name	Scientific Name	IUCN Status
1.	Bengal Slow Loris	*Nycticebus bengalensis*	EN
2.	Capped Langur	*Trachypithecus pileatus*	VU
3.	Asian Elephant	*Elephas maximus*	EN
4.	Sambar	*Rusa unicolor*	VU
5.	Hog Deer	*Axis porcinus*	EN
6.	Gaur	*Bos gaurus*	VU *
7.	Pigmy Hog	*Porcula salvania*	EN*
8.	Tiger	*Penthera tigris*	EN
9.	Common Leopard	*Penthera pardus*	VU
10.	Indo-Chinese Clouded Leopard	*Neofelis nebulosa*	VU*
11.	Fishing cat	*Prionailurus viverrinus*	VU
12.	Binturong	*Arctictis binturong*	VU*
13.	Wild Dog	*Cuon alpines*	EN*
14.	Himalayan Black Bear	*Ursus thibetanus*	VU*
15.	Sloth Bear	*Melursus ursinus*	VU*
16.	Hog Badger	*Arctonyx collaris*	VU*
17.	Smooth-coated Otter	*Lutrogale perspicillata*	VU
18.	Hispid Hare	*Caprolagus hispidus*	EN*
19.	Indian Pangolin	*Manis crassicaudata*	EN*
20.	Chinese Pangolin	*Manis pentadactyla*	CR
21.	Red-necked vulture	*Sarcogyps calvus*	CR*
22.	White-winged duck	*Asarcornis scutulata*	EN
23.	Wreathed Hornbill	*Aceros undulates*	VU
24.	Rufous-necked hornbill	*Aceros nipalensis*	VU
25.	Great hornbill	*Buceros bicornis*	VU
26.	Woolly-necked Stork	*Ciconia episcopus*	VU
27.	Lesser Adjutant Stork	*Leptoptilos javanicus*	VU
28.	River tern	*Sterna aurantia*	VU
29.	Greater Spotted Eagle	*Clanga clanga*	VU
30.	Steppe Eagle	*Aquila nipalensis*	EN
31.	Eastern Imperial Eagle	*Aquila heliacal*	VU
32.	Common pochard	*Aythya ferina*	VU
33.	Indian peacock softshell turtle	*Nilssonia hurum*	VU
34.	Indian softshell turtle	*Nilssonia gangeticus*	EN
35.	Tricarinate hill turtle	*Melanochelys tricarinata*	EN*
36.	Black pond turtle	*Geoclemys hamiltonii*	EN
37.	Black softshell turtle	*Nilssonia nigricans*	CR
38.	Burmese python	*Python bivittatus*	VU

Abbreviations : CR-Critically endangered , EN-Endangered , VU-Vulnerable.

At present, the Behali Reserve Forest, which is very rich in terms of biodiversity, is facing serious threats due to deforestation over the years and it requires attention and strict steps immediately to protect the biodiversity it harbors. Considering its richness and the number of important species facing threat in the forest, the forest needs to be declared as a wildlife sanctuary for better protection and management of such an important natural resource. In case of mammals, the Behali Reserve Forest has almost equal number of the mammalian diversity compared to the Nameri National Park (Saikia & Saikia, 2012) and Kaziranga National Park (Sharma, 2018). The main threats to the Behali Reserve forest in general are deforestation and hunting which is continuously disrupting the natural habitat and exploiting the biodiversity of the forest.

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Indigenous Technological Knowledge (ITK) of Pest Management for Rice Cultivation in Bongaigaon District, Assam

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Abstract

Majority of the people of Bongaigaon district, Assam depends mainly on agriculture. The main agricultural crop of in the district is rice. The aim of the study is to know the indigenous knowledge of pest management and documentation in paddy applied by different communities of Bongaigaon district, Assam. Farmers are using ITK for insect pest management since time immemorial. The present study was conducted among four communities on the basis of personal interview to each of the farmer through a questionnaire. The farmers were selected randomly according to age group in 20 different villages. A total number of 21indigenous practices were identified and these practices were mostly used by old farmers. The young generation of farmers are not interested in the indigenous knowledge of pest management, they prefer chemical pesticides for high production of crop. This indigenous knowledge should be studied properly and insist the younger farmers to apply these practices to protect the environment from chemical hazardous.

Keywords: Indigenous Technological Knowledge, Pest management, rice cultivation

Introduction:

In agricultural practices, farmers have evolved their own ways for growing a variety of crops. Indigenous technological knowledge (ITK) is the term used to describe these techniques (Deka et al., 2006). ITKs are practical in nature and optimise local thinking in the agricultural sectors. ITKs, according to agricultural specialists, can play a vital role in resolving difficulties connected to modern agriculture and the environment (*Berkes* et al., *2000*). The scientific community agreed that evaluating ITKs is an essential component of introducing new agricultural technology. Before any new technology is developed and spread, it is widely acknowledged that farmers' expertise must be considered.

Since the dawn of time, farmers have used biorationals like as ITKs to control insect pests. This understanding is the result of many generations of close engagement with natural and physical microenvironments (Rajasekaran et al., 1991; Kolawole, 2001). Except for a handful, ITKs are passed down from generation to generation verbally, with no validated written documents. Many definitions for ITK systems have been proposed, however they are all incomplete because the notion is still developing. The ITKs are environmentally benign and work well with pest management techniques (Deka et al., 2006). ITKs are mostly based on the community's cultural values. As a result, it is made up of technologies that farmers have created through decades of modifying farming systems to local agroclimatic and

socio-economic conditions (Venkata Ramaiah and Rama Raju, 2004). Because farming did not entail the use of artificial pesticides or fertilizers, the methods for managing pests were natural. ITK collection, compilation, and scientific evaluation are critical in this setting.

Assam's economy is primarily based on agriculture. Rice is Assam's principal crop, accounting for more than 80 per cent of the region's total agricultural acreage (Islam et al., 2004). Traditional knowledge is put to use in the field by a specific community using local resources that they inherited from their forefathers. This particular knowledge is based on long term observations, personal experiences or trial and error methods, which are eco-friendly, low cost, socially accepted, ecologically sound passed from one generation to another generation without any written documents. Traditional knowledge growth has been a matter of survival for people, since it aids in the management of the natural environment and human health (Baruah et al., 2020). Indigenous Technical Knowledge (ITK) was defined as the actual knowledge of a certain group that reflects traditional experiences as well as more recent encounters with current technologies (Harverkort, 1995). These approaches are utilized by rice and vegetable growers to successfully cultivate rice and vegetables while managing various pests and diseases. Due to the increased demand for output to meet the congested population, farmers are now using chemical pesticides. Pesticides used indiscriminately have an impact on beneficial soil microorganisms, rivers, lakes, ponds, the environment, and human health.

Materials and Methods:

The current work was carried out in Bongaigaon district, Assam, which is geographically located between 26.75^{o}N and 96.22^{o}E. The district is administratively divided into five development blocks viz. Srijangram, Tapattary, Boitamari, Manikpur and Dangtol. All the block of this district are inhabited by several ethnic communities of which Koch-Rajbongshi, Rabha, Garo and Bodo are the major ones. Inhabitants of all these communities are thought to have a rich culture that adheres to the ITKs in relation to rice cultivation.

The present survey-based study was conducted in five development blocks of the study district covering farmers of 20 different villages (four villages from each development block). For the purpose, four villages were selected randomly from each development block and the information from the farmers were collected through a questionnaire that was distributed among them. Farmers of four different communities viz. Koch-Rajbongshi, Rabha, Garo and Bodo community were interacted and interviewed for gathering information on ITKs used traditionally by the farmers of these communities. A total of 188 farmers (Table-1) from all the four communities were purposefully chosen for this study. In addition to formatted questionnaire, certain information on the use of ITKs in rice cultivation was obtained by personal interview and/or group discussion using a semi organized interview plan. These 20 villages were surveyed at different times of the year. Following the knowledge of indigenous practices, a list of

those practices was compiled. During the years 2019 and 2020, ITK was collected, compiled, and scientifically evaluated in the four indigenous groups of farmers in Bongaigaon district, Assam.

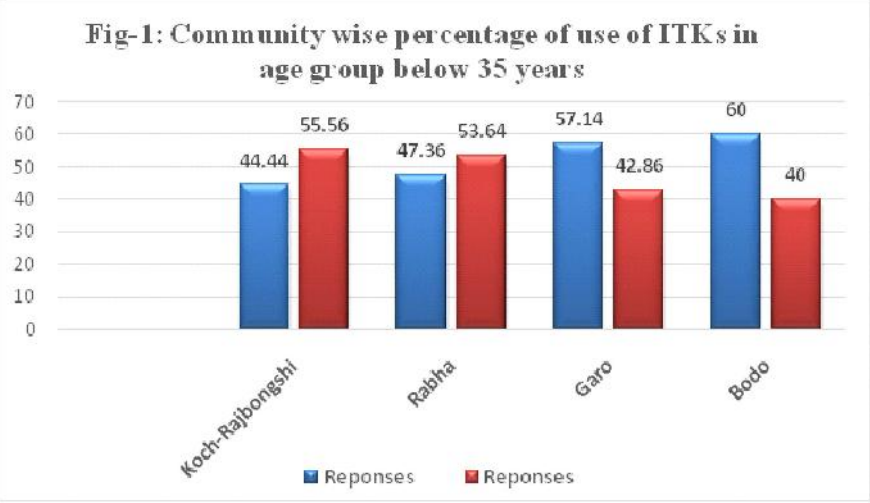
Model Questionnaires

1. Are you familiar with ITKs?
2. How did you learn about ITKs?
3. What kind of pests are being targeted?
4. Do you use any medication?
5. What are the reasons you don't use them despite knowing all of the ITKs?
6. Do you think they'll work on any type of crop pest?

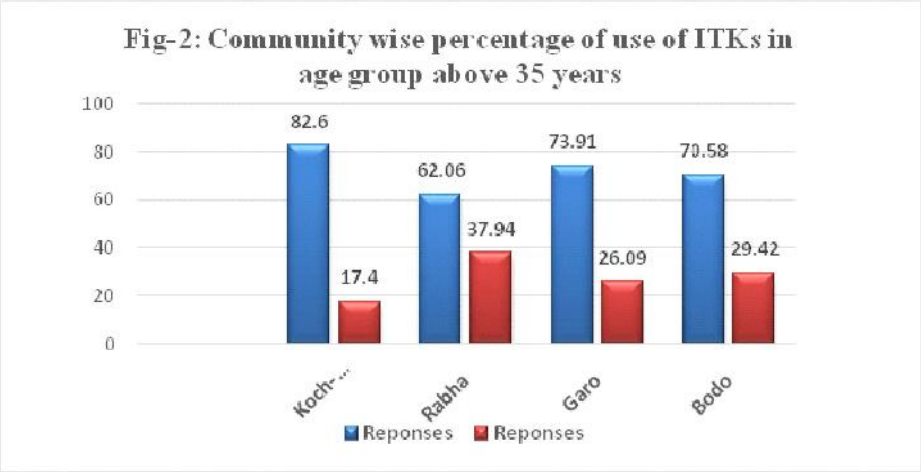
Results and Discussion:

After completion of survey, we found that majority of the farmers (more than 60 per cent) use ITKs to control the rice pest in the present study area (Table-2). From the investigation, it was observed that a total number of 21 ITKs (Table-3) are being practiced by the farmers of the four study communities (ie. Koch-Rajbongshi, Rabha, Garo and Bodo communities) in the present area of the study for the pest management of rice crop. All these ITKs were found to be used, more or less, by all the four communities in their practices of pest management during rice cultivation.

It has been found from the present investigation that young farmers (age group below 35 years) are less interested in using ITKs and prefer modern technologies for more produce of rice among the study communities. In the age group of below 35 years community wise interests for ITK are different (Figure-1). Among the farmers of Koch-Rajbongshi community 55.56 percent of young farmers do not prefer ITKs over modern technology while 44.44 percent were interested in using ITKs in their rice cultivation practices. Similarly, 53.64 per cent of farmers of Rabha community, 42.86 per cent of farmers of Garo community and 40 per cent farmers of Bodo community do not prefer ITK in their rice fields.



On the contrary, older farmers from age group above 35 years are very familiar with ITK and they prefer this over modern technologies (Figure-2). Among the older farmers of Koch-Rajbongshi community, 82.60 per cent farmers practice and prefer ITKs in their rice field. Similarly, 62.06 per cent of Rabha farmers, 73.91 per cent of Garo farmers and 70.58 per cent of Bodo farmers practice and prefer ITKs for pest management in their rice fields during its cultivation.



Conclusion:

The current research was carried out for the benefit of farmers. The discovery of indigenous knowledge and documentation of scientifically sound indigenous practises will aid in the technological blending programme as well as the development of low-cost, location-specific, and appropriate pesticide-reduction technology.

ITK was employed to control the pest by mostly small-scale farmers on a regular basis. Chemicals, on the other hand, are frequently used in the pest management of medium and large farm holdings. They've learned these approaches from their elders. Farmers are intelligently using locally accessible natural resources for the management of harmful pests, according to the findings of the investigation.

Table-1: Block wise and village wise numbers of farmers interviewed

Blocks	Villages	Farmers Interviewed (Community wise)				Total
		Koch-Rajbongshi	Rabha	Garo	Bodo	
1	Borghola	9	5	0	2	16
	Deohati	13	0	0	0	13
	Kakoijana	2	6	2	3	13
	Uttar Salmara	1	4	10	5	20
2	Bamungaon	0	10	0	5	15
	Khuragaon	7	1	3	0	11
	Lalmati	3	0	1	0	4
	Malegahr	1	2	3	2	8
3	Sankarghola	2	8	7	3	20
	Khagarpur	1	3	12	5	21
	Bishnupur	3	1	0	0	4
	BhairabPahar	0	2	6	1	9
4	Hapachara	4	0	0	1	5
	Jamdoha	2	0	0	7	9
	Chowraguri	1	2	0	2	5
	Dankinamari	2	3	0	0	5
5	Chaprakata	1	1	0	1	3
	Chokapara	2	0	0	0	2
	Kandulimari	3	0	0	0	3
	Siponsila	2	0	0	0	2
Total	**20**	**59**	**48**	**44**	**37**	**188**

1. Srijangram Development Block; 2. Tapattary Development Block; 3. Boitamari Development Block; 4. Manikpur Development Block; 5. Dangtol Development Block

Table-2: Responses of farmers on use of ITKs according to age group and community

Communities	Age group	Reponses		Age group	Reponses	
	Below 35 Years	Yes	No	Above 35 years	Yes	No
Koch-Rajbongshi	36	16 (44.44%)	20 (55.56%)	23	19 (82.60%)	4 (17.40%)
Rabha	19	9 (47.36%)	10 (53.64%)	29	18 (62.06%)	11 (37.94%)
Garo	21	12 (57.14%)	9 (42.86%)	23	17 (73.91%)	5 (26.09%)
Bodo	20	12 (60.00%)	8 (40.00%)	17	12 (70.58%)	5 (29.42%)

Table-3: ITKs used by the farmers of four different communities in the study area

Sl. No.	ITK Used	Targeted Pest and Diseases	Remarks
1	Uses of twigs of bitter bush (*Chromolaena odorata*)	Rice stem borer (*Scipophaga incertulas* and *S. innota*),	Insect repellent properties
2	Uses of twigs of ***Pochotia*** (Chinese chaste tree: *Vitex negundo*)	Rice stem borer (*Scipophaga incertulas* and *S. innota*)	Insect repellent properties
3	Peels of bortenga (Pomelo: *Citrus grandis*)	Rice stem borer (*Scipophaga incertulas* and *S. innota*)	Insect repellent properties
4	Crushed rhizome of Keturi halodhi (wild turmeric: *Curcuma aromatica*)	Rice stem borer (*Scipophaga incertulas* and *S. innota*)	Insect repellent properties
5	Use of jute or coconut fibre rope, dipped in kerosene oil	Rice case worm (*Nymphulade punctalis*)	Insect repellent properties
6	Use of mustard oil cake	Control Red ant	Insect repellent properties
7	Hanging of dead frogs and toads in the field	Gundhi bug (*Leptocorisa varicornis* Fabricius, *L. acuta* Thunberg)	Rotten smell acts as repellent
8	Application of neem leaf extract (Neem leaves are boiled, and the water is sprayed).	Rice leaf folder (*Cnaphalocro cismedinalis*)	Act as insect repellent
9	Use of fire (light trap).	Rice Gandhi bug (*Leptocorisa acuta*)	Insect move towards light and immolate themselves.
10	Using inner portion of Jack fruit (*Artocarpus heterocephyllus*)	Rice Gandhi bug (*Leptocorisa acuta*)	Act as insect repellent.

Sl. No.	ITK Used	Targeted Pest and Diseases	Remarks
11	Highly Branched top bamboo sticks are erected in the field for bird sitting	Foliage feeding insects	Birds act as predator of insects
12	Using the spray of cow dung	Rice hispa (*Dicladispaarmigera*)	Insect repellent properties
13	Wrapping gourd with a polythene	Fruit flies	Fruit flies are deterred by polythene
14	Placing of grounded bark of Drumstick (*Moringa oleifera* Lam.) in the rice field	yellow stem borer of rice (*Scirpophagaincertulus*)	Insecticidal qualities of bark powder of drumstick
15	Thorny branches of Bogori (*Zizpus jujube*Lamk) swept over the growing crop field	Rice hispa (*Dicladispaarmigera*); Rice case worm (*Nymphuladepunctalis*)	Insects become harmed and die as a result of their injuries
16	Biting empty drum in the field	Control birds	Birds are frightened and driven away from the field
17	Placing few branches of fern(*Diplazium esculentum*)	Control of *Scirpophagaincertulus*	It acts as insecticide
18	Sprinkling of domestic ash	Soft bodied insects	Assist in the formation of corrosive materials
19	Burning of crop residue after harvesting of paddy	Stem borer (*Scipophagaincertulas*and *S. innota*)	Burning destroys the resting stages of insects
20	Hanging a plastic bag and birds wing tighten on long stick	Control the birds	Birds are scared and fleeing from the field
21	Cow urine mixed with water and applied in the field	Rice hispa (*Dicladispaarmigera*)	Act as an insect repellent

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Diversity, Habitat Preferences, Distribution and Conservation of Geckos at Eastern Karbi Anglong, Assam, India: An Extensive Survey

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Abstract

The central part of Assam in India is a part of Indo-Burma Biodiversity hotspot which harbors in it a large number of plants and animal species. The place contains one of the oldest wildlife sanctuaries namely Garampani Wildlife Sanctuary, the only wildlife sanctuary in Assam with hotspring, and also contains the second largest reserve forest of Assam, the Dhansiri. The place is an abode to one of the highly endangered species, the Geckos. Geckhos are small night lizards belonging to the family Gekkonidae. Though they were once one of the Least concerned species, but due to habitat destruction and excessive poaching, they are added into Schedule III of the Indian Wildlife Protection Act as a 'highly endangered animal'. The present article provides an extensive survey on the availability of Geckos in Assam with reference to their distribution, habitat preferences, threats and conservation. In addition to this, data from the field observations of the author provides information on the declining rate of Geckos in the eastern Karbi Anglong , Assam.

Keywords : Geckos, distribution, habitat destruction, threats, conservation.

Introduction:

Assam, a state located in northeast India, falls under two global biodiversity hotspots: the Indo-Burma and the Himalayan[1] Karbi Anglong district is one of the 34 administrative districts of Assam in India. The district is administrated by Karbi Anglong Autonomous Council according to the Sixth Schedule of the Constitution of India. The districts plateau are an extension of the Indian Plate (The Peninsular Block) in the Northeast India. Numerous rivers and tributaries flow through these districts namely Dhansiri river, Longnit River, Jamuna, kolioni, Nambor,etc.[2,3] The district is bounded by Golaghat district on the east, Meghalaya state and Morigaon district on the west, Nagaon and Golaghat districts on the north and Dima Hasao district and Nagaland state on the south. The district is located between 25º 332 and 26º 352 North latitude and from 92º 102 to 93º 502 East longitude. About 41.12% of geographical area of Karbi Anglong is under forest cover[4,5]. According to MSME-Development Institute, Diphu, the important forest types found in Karbi Anglong District are: Moist semi-evergreen forests, Moist Mixed Deciduous forests, Riverain Type and Miscellaneous type with scattered pure or mixed patches of bamboos.[6] These forest areas are natural museums of living giant trees, having a rich collection of rare, endemic and endangered species, the forests consists of various medicinal plants and economically important organisms, a treasure for nature lovers and a laboratory

for environmentalists.[7] The region experiences monsoon from March up to September with an average rainfall of about 2416 mm. The Karbi Anglong district is rich in wildlife, it harbors in it a large amount of plant and animal species. One-horned rhinoceros, wild buffaloes and Bisons are very common in the adjoining areas of Kaziranga National park. In every part of the district we can get Tigers, Leopard, Wolf and Bears. Elephant, monitor lizard and Pythons are also common. The avifauna includes a large collection of colourful birds such as Great Himalayan Hornbill, Imperial Pigeon, Green Pigeon , Emerald dove, Hill partridges, Jungle fowl, Pheasant, Hoopoe, Koel, Kingfisher, Storks, Herons, Pelicans, Wood Pecker, Mynas, Yellow bittern, Egrets etc.[7]

The district includes five wildlife sanctuaries, namely- Garampani Wildlife sanctuary, East Karbi-Anglong Wildlife Sanctuary, Marat Longri Wildlife Sanctuary, Nambor Wildlife Sanctuary and North Karbi-Anglong Wildlife Sanctuary, it also contains two elephant reserves (Dhansiri – Lumding and Kaziranga – Karbi Anglong) and 17 District Council Reserve Forests (DCRFs)[6,7,9,10]. The Garampani wildlife sanctuary has an area of 6 Sq.km and Marat Longri Wildlife Sanctuary with an proposed area of 451.87 sq. km, is quite rich in floral and faunal composition, and comprises of four important Reserve Forests namely Miyungdisa, Disama, Kaki and Englongkiri . The important wildlife species found inside this proposed sanctuary includes Asiatic Elephant, Royal Bengal Tiger, Binturong, Himalayan Black Bear, Barking Deer, Hoollock gibbon, etc. and a variety of avifauna[7]. However, the forests and wildlife of these districts continue to face threats from deforestation, habitat destruction due to overpopulation, poaching and other human activities [5] Illegal minings in these places is also a matter of immense concern as it very much contributes to ecological disturbance[8]

Geckos are one of the three diverse groups of squamate reptiles (lizards, snakes, amphisbaenians) that have risen since the major squamate radiations began diversifying about 200 million years ago. 1921 species of Geckos were known in Nov 2019 belonging to seven families and 124 genera and these approximately 2000 species were described by about 950 individuals, among them 100 described more than 10 gecko species each. Most of the species of Geckos were discovered during the last 40 years. The type specimens of all geckos are distributed over 161 collections worldwide, with 20 collections having two thirds of all the types. With the help of DNA sequencing the phylogeny of Geckos is understood and morphological characters of about 76 % of Geckos is now being collected in databases. Geographically, Geckos occur on five continents and many islands but are most species-rich in Australia, Southeast Asia, Madagascar, Africa and West Indies. About 240 species of Geckos were discovered in Australia along with the 100 described species each from India, Madagascar and Malaysia[11]

Geckos are small lizards belonging to the family Gekkonidae, order Squamata and infraorder Gekkota found in warm climate throughout the world. They range in size from 1.6 to 60 cm (0.64 to

24 inches). They are unique among lizards due to their vocalizations, which differ from species to species. Most of the geckos in the family Gekkonidae use chirping or clicking sounds in their social interaction. Tokay Gecko (*Gekko gecko*) are also known for their loud mating calls, and some other species are capable of making hissing noises when alarmed or threatened. They are the most species-rich group of lizards, with about 1,500 different species worldwide. All geckos lack eyelids except in the family Eublepharidae; instead of this the outer surface of the eyeball has a transmembrane membrane, the cornea. They have a fixed lens within each iris that enlarges in darkness to let more light inside. The Geckos don't blink, they generally lick their own corneas to get rid of dust and dirt, and also keep it moist and clean [12]. Geckos, when under defence lose their tails by the process of autotomy [13].

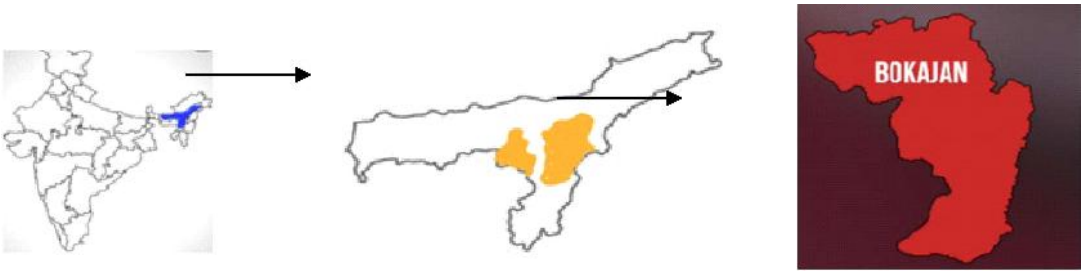
Northeast India is home to various geckos, among them Tokay Geckos, Common House Geckos, *Cnemaspis assamensis*, or the Assam. Day Gecko are some of the common geckos found in Assam. *Cnemaspis assamensis* or the Assam Day Gecko was discovered from the Mayeng forest in the Kamrup district of Assam *Cassamensis* was also reported from the Garbhanga Reserve forest and the Nilachal Hills respectively, both from the Kamrup district of Assam. *Cnemaspis jerdonii* was discovered from the Dainadubi forest in the Garo Hills of Meghalaya [30]. It has been recently found out that Northeast India is an abode to six new Geckos. The Guwahati bent-toed gecko is currently found near a small hillock in the urban sprawl of the city and hence named as *Cyrtodactylus guwahatiensis*, the Jaintia bent toed gecko, the Kaziranga bent-toed gecko and the Nagaland bent-toed gecko have been discovered from the Jaintia Hills of Meghalaya, the Kaziranga National Park of Assam and Khonoma village in Nagaland, respectively. Another Gecko found in the vicinity of Abhayapuri town in the Bongaigaon district of Assam is named as Abhayapuri bent-toed gecko, the Jampui bent toed gecko is found only in the Jampui Hills of Tripura. All the new lizards belong to the genus *Cyrtodactylus* and are called bent-toed or bow-fingered geckos, named after their bent toesv [14]

The Geckos can be found in a wide range of habitats, such as rain forests, savannas and deserts. Though it was originally a terrestrial tree living species,but in more populated areas they are found in buildings, especially near artificial lightings. Geckos tend to feed on Insects, mosquitoes, moths etc. The common house gecko is found in tropical, subtropical and warm temperate regions as they prefer warm and humid areas. As they are nocturnal, they prefer to hide during the daytime**.** In more natural environments, *H.frenatus* can be found in forested areas, open fields and rocky areas. They tend to dwell under large rocks, rotting logs, tree trunks and areas with low ground coverage. They also prefer to stay near the areas which have concentrated population of insects so that they can hunt easily. *H. frenatus* are less abundant in forests and prefer to stay in human populated areas where flat walls and ceilings provides them easy hunting [15].

Materials and Methods:

The Study area:

Bokajan is a town in the Karbianglong district of Assam and is best known for its cement factory (Fig1). Bokajan is located at 26°012′N 93°47′E / 26.02°N 93.78°E and has an average elevation of 138 metres (452 feet**)** [15]. The Bokajan subdivision harbors in it 3 wildlife sanctuaries, These are:- Nambor wildlife sanctuary having an area of 37 Sq. km and is situated with its Northern boundary along the western and southern boundary of Garampani Wildlife Santuary upto Dhansiri River, East Karbi Anglong wildlife sanctuary having an area of 221.81 sq.km, the boundary of this Sanctuary is the external boundary of Mikir Hills Reserve Forests and Karbi Anglong Wildlife sanctuary which has an area of 96 sq.km[7].



a) b) c)

(https://www.sentinelassam.com/assam-election-2021/constituencies/phase2/bokajan-530240)

Fig 1:a**)** Sketch map of India highlighting Assam. b) Sketch map of Assam highlighting Karbi Anglong district.c) Map showing Bokajan subdivision**.**

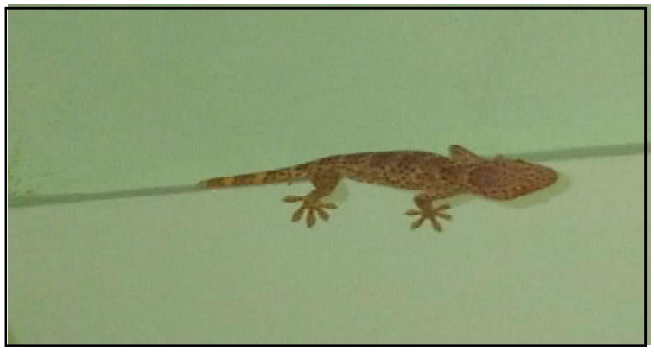
Data collection

I conducted visual encounter surveys in accessible forested and human-modified areas, both during daylight and after sunset from January 2018 to February 2019 to know about the status of Geckos in Bokajan subdivision of Karbi Anglong district. The survey was conducted to know about the population of Geckos present in that area along with the number of geckos present per kilometer. A binocular along with camera were used to spot and take the photographs. Local elderly people were interacted about the availability of geckos in that area. In this survey, I identified and recorded the presence of Tokay Geckos *(Gecko gecko)*, belonging to the order Squamata, Family Gekkonidae in this area. The identification of species was based on diagnostic characters extracted from the original species descriptions and from the study of my secondary sources.

Tokay Gecko (*Gecko gecko*):

It is a large nocturnal gecko, and can reach a total length of upto 30 cm [17]. It is believed to be the third largest species of Gecko, after the Giant leaf tail gecko (*Uroplatus giganteus*) and New Caledonian gecko (*Rhacodactylus leachianus*). Its body is cylindrical in shape and some what flattened

in appearance (Fig:2). Its skin is generally gray with black speckles, it can also change its skin colour to blend with the environment. It is a sexually dimorphic species ,where the males are more brightly colored and slightly larger [18]. They are generally aggressive and territorial, and can inflict a strong bite. The females lay one or two clutches of hard shelled eggs (Fig:3). The females guard the eggs until they are hatched. They feed on insects, fruits, vegetation, and small vertebrates [18,19]. It is a strong climber with foot pads that can support the entire weight of the body on vertical surfaces for long period of time. The tokay Geckos has a robust built in structure,with a large head, muscular jaws and a semi prehensile tail. They are common in pet trade, but due their strong bite, inexperienced keepers finds it difficult to handle them [20]. The strength of the bite is enough for piercing the skin and cause immediate bleeding.The male's mating call, a loud croak is often preceded by a quick "cackling". When threatened or alarmed, Tokay Geckos usually starts barking while opening their mouth in a defensive posture. The native habitat of Tokay geckos is rainforest, where it lives on trees and cliffs, besides this , Tokay geckos also frequently adapts to rural human habitations, roaming on the walls and ceilings at night in search of insect prey [33].



Fg 2: An adult Tokay Gecko (*Gecko gecko*).

Fig 3: Eggs of Tokay Gecko attached to the wall.

Fig 4: A baby Tokay Gecko.

Results:

It is found out that the population of Tokay Geckos is declining at an alarming rate. Earlier the presence of Tokay geckos was approximately 14-15 geckos per kilometer, but now it is hardly 4-5 Geckos per kilometer.

Conservation issues:

The major threats to the Species include habitat loss and fragmentation, jhum cultivation, poaching, timbering etc.

Habitat loss and fragmentation:

Habitat loss and fragmentation are one of the biggest threats to wildlife of northeast India [21]. Due to continuous deforestation, the Geckos are seeking refuge in the human habitations owing to which they are sometimes even killed and their eggs are also destroyed . Though their native habitat is rainforest, where it lives on trees and cliffs, but due to habitat destruction and poaching ,they are now mostly found in the houses. They hide behind large furniture and lay eggs on the walls which are also sometimes destroyed by the house owner.

Poaching :

The main threat to the geckos is their unrestricted poaching for multiple reasons. The geckos are smuggled from northeast India to various parts of the world. The illegal trade of Tokay Geckos is running unrestricted in the North East and adjoining Indo-Bhutan border areas due to its multi million dollar price tag in the international market, the price tag of over $2 million for each live Tokay gecko weighing over 300 gram makes is making it vulnerable. The regions stretching from deep North East to the Indo-Nepal border in northern West Bengal witnesses seizures and apprehensions of people trading the animal [22]. The craze for gecko smuggling has reached to such an extent that illegal breeding centres are opened in various parts of Assam, as said by an official of Wildlife Control Bureau. [23] Even the low weight geckos are injected with mercury to make them heavier though it kills the animal within a few days [24]. This species is poached for the medicinal trades in parts of Asia [25]. The tokay gecko is an ingredient in Traditional Chinese medicine known as *Ge Jie*. It is believed to nourish the kidneys and lungs, beliefs that are not at all substantiated by medical science [26]. The species is highly sought after various countries such as China, Hong Kong, Taiwan, Vietnam, Malaysia, Singapore and other parts of Asia with Chinese communities, to the point where some merchants have taken to modifying the bodies of monitor lizards with prosthetics to pass them off as colossal tokay gecko specimens [26]. From 2009 to 2011 the poaching of Tokay geckos intensified due to a short lived belief that it was an effective HIV cure, though it has no scientific evidence. Even the body fluids of Tokay geckos is sucked out with a syringe by the experts which is supposedly used in the treatment of cancer in China and thus buyers are willing to pay any price for this fluid though there is not any scientific proof about these supposedly curative property [23].

Jhum cultivation:

Jhum cultivation or shifting cultivation. Jhum cultivation (a slash-and-burn type of shifting cultivation), is one of the biggest threats to wildlife [27]. Jhum cultivation is done mainly by tribal communities for planting various trees, fruits and vegetables. Jhum cultivation has destroyed large forest covers by creating canopy gaps and depletion of food. In addition to this, Jhum cultivation also leads to soil erosion and landslides [21]. The Geckos have also lost their native habitat due to this type of cultivation.

Timbering:

Timbering and collection of fuel wood is done for a large number of uses, such as construction of houses, bridges, commonly used implements, and agricultural tools. Large Trees having good market value are cut down and thus habitats of various species along with the Geckos are destroyed [28].

Discussion:

Due to high demand and unrestricted smuggling of Tokay Geckos, the species is declining at an alarming rate. It has been added into Schedule III of the Indian Wildlife Protection Act as a 'highly endangered animal' which means that there could be a three year jail term for anyone who is convicted of hunting and smuggling geckos. The Assam State Biodiversity Board included the Tokay Gecko and the Assamese Day gecko in a new list of threatened species in the year 2018. DFO (wildlife) S.Ghatak said that as the species is not yet included into the International Union for Conservation of Nature Red list, hence it is not protected by strong norms globally. S. Ghatak also said that closely related species of Tokay gecko , Golden Gecko (*Gecko badenii*) and Assamese Day gecko (*Cnemaspis assamensis*) are also being smuggled [23]. Jayanta Kumar Das, honorary Wildlife Warden of Udalguri district ,who rescued a number of geckos from would be smugglers said that the state forest department as well as the Wildlife Crime Control Bureau have miserably failed to check the trade as most of the violators of the act go unpunished as a result of which trafficking of geckos has increased in the recent years. Besides this, he said that the forest staffs are also unfamiliar with the creature they have to protect, the staffs have to be trained to identify the species first and rescue it later [23].

The Geckos are now becoming an important subject of study in space research as studies are conducted to replicate the unique adhesive ability of its feet which can also help in capturing free floating uncontrollable space debris which causes damage to the expensive spacecraft and satellites. Besides this, to ensure better appearance and health of the skin with less perceivable scar, there is ongoing research to use the gecko's adhesive characteristic to develop medical tape to substitute the post operative suturing, stapling or even pasting for wound closures. All these things are increasing the demand for the Tokay Gecko and other geckos and thus they are being caught in large numbers than before[29].

Conclusion:

The present article demonstrates that northeast India harbors in it various species of Geckos. The article focuses on the declining rate of Tokay Geckos (*Gecko gecko*) in the Bokajan subdivision. It also tells us about the various conservation measures taken by the government to check the trading of geckos**.** Therefore it is strongly recommended that if the smuggling of this species is not stopped, then the decreasing quantity of this species will ultimately lead to its local extinction.

Conflict of Interest :

None declared.

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Municipal Solid Waste Management, Challenges and Opportunities in India

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Abstract

Municipal solid waste (MSW) is one of the major areas of concern all over the world. In developing country like India, there is rapid increase in municipal solid waste due to urbanization and population growth. Composition of waste varies with different factors like living standard, climatic condition, socio-economic factor etc. This paper gives current scenario of India with respect to municipal solid waste quantity, quality and its management. Solid waste is the useless, unwanted and discarded material resulting from day to day activities in the community. Solid waste management may be defined as the discipline associated with the control of generation, storage, collection, transfer, processing and disposal of solid waste. Biodegradable waste (organics and papers) and non-biodegradable or recyclables (metals, glass, textiles, leather and rubbers). However, organics and plastics, the two major fractions of the household waste varied considerably across the geographical areas. India faces major environmental challenges associated with waste generation and inadequate waste collection, transport, treatment and disposal. Waste segregation at source and use of specialized waste processing facilities to separate recyclable materials has a key role. Disposal of residual waste after extraction of material resources needs engineered landfill sites and/or investment in waste-to-energy facilities. The potential for energy generation from landfill via methane extraction or thermal treatment is a major opportunity, but a key barrier is the shortage of qualified engineers and environmental professionals with the experience to deliver improved waste management systems in India.

Keywords: Solid waste, Household waste, Municipal solid waste, management, composition.

Introduction:

Municipal or household wastes are often generated from several sources where variable human activities are encountered. Several studies indicate that much of the municipal solid waste from developing countries are generated from households (55–80%), followed by commercial or market areas (10–30%) with varying quantities from streets, industries, institutions among others, (Nagabooshnam, 2011, Okot-Okumu, J., 2012). Waste from these sources are highly heterogeneous in nature and have variable compositions are food and yard waste, wood, plastics, papers, metals, leather, rubbers, inert materials, batteries, paint and oil containers, textiles, construction and demolishing materials and many others which would be difficult to classify.

Solid waste management (SWM) is a major problem for many urban local bodies (ULBs) in India, where urbanization, industrialization and economic growth have resulted in increased municipal solid waste (MSW) generation per person, PPCB (Punjab Pollution Control Board) 2010. Effective

SWM is a major challenge in cities with high population density. Achieving sustainable development within a country experiencing rapid population growth and improvements in living standards is made more difficult in India. There is an urgent need to move to more sustainable SWM, and this requires new management systems and waste management facilities. Current SWM systems are inefficient, with waste having a negative impact on public health, the environment and the economy, (Biswas AK et al., 2010). The waste Management and Handling Rules in India were introduced by the Ministry of Environment and Forests (MoEF, 2015) Rapid population growth in India has led to depletion of natural resources. Wastes are potential resources and effective waste management with resource extraction is fundamental to effective SWM. MSW may also contain hazardous wastes such as pesticides, paints, used medicine and batteries. Compostable organics include fruits, vegetables and food waste. Healthcare waste contains disposable syringes, sanitary materials and blood containing textiles and is governed by the Biomedical Waste (Management and Handling) Rules 1998 and the Amended Rules, 2003.

Waste collection, storage and transport are essential elements of any SWM system and can be major challenges in cities. Waste collection is the responsibility of the municipal corporations in India, and bins are normally provided for biodegradable and inert waste, (Guria N, Tiwari VK, 2010, Das S, Bhattarcharys BK, 2014) Mixed biodegradable and inert waste is often dumped with open burning a common practice. Improvements to waste collection and transport infrastructure in India will create jobs, improve public health.Waste dumps have adverse impacts on the environment and public health, (Rathi S, 2006). Open dumps release methane from decomposition of biodegradable waste under anaerobic conditions. Methane causes fires and explosions and is a major contributor to global warming, (Srivastava R. et al., 2014). Odour is a serious problem, particularly during the summer when average temperatures in India, (Dasgupta B, et al.,2013). Discarded tyres collect water, allowing mosquitoes to breed, increasing the risk of diseases such as malaria, dengue and West Nile fever. Uncontrolled burning of waste at dump sites releases fine particles which are a major cause of respiratory disease and cause smog, (Sridevi P. et al., 2012) Open burning of MSW and tyres emits 22,000 tonnes of pollutants into the atmosphere around Mumbai every year, (Annepu RK. 2012). The impacts of poor waste management increased incidences of nose and throat infections, breathing difficulties, inflammation, bacterial infections, anemia, reduced immunity, allergies.

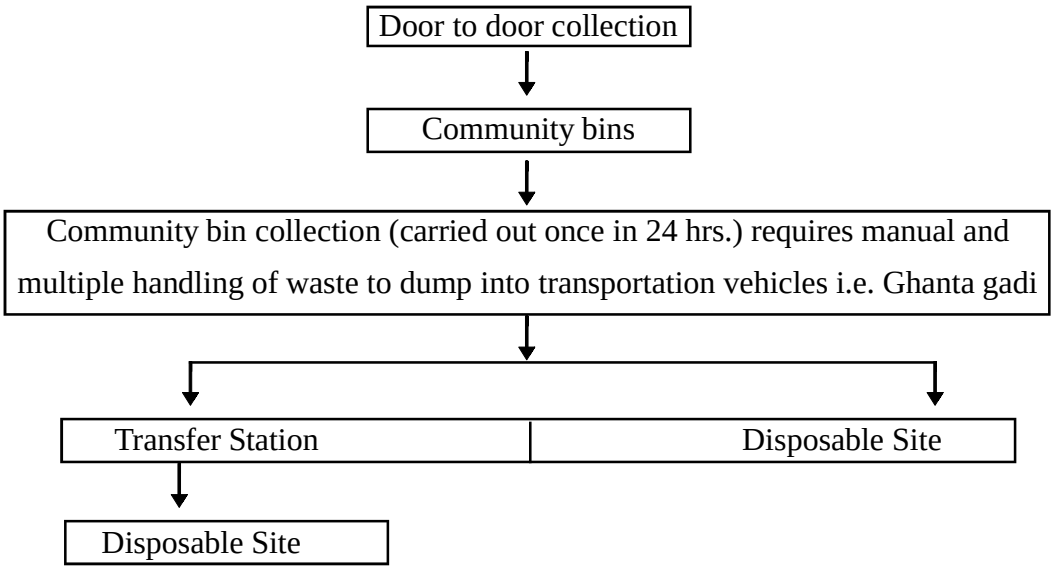
Nandurbar district in the NorthWest corner (Khandesh Region) of Maharashtra state surrounded by Madhya Pradesh State on the North, Dhule District on the East, Gujarat State in the West and Nasik district on the south. The northern boundary of the district is defined by the great Narmada River. The district occupies an area of 5035 km² and headquarters are located at Nan durbar city. Location & Geographical Area Nan durbar situated between 73.31 and 74.32 East longitude and 21.03 and

22.00 North latitude. The district has a total area of 5034.23 sq. kms. Total solid waste generation is 21 tones/day in Nan durbar city and 34 to 38 metric tonnes of waste generates per year. From that solid waste generation per person is approximately 200 gm/capita/day. The activities associated with the management of municipal solid waste from the point of generation to final disposal can be grouped into the six functional elements**.**

- Waste generation
- Storage
- Collection
- Transportation
- Segregation & Processing
- Disposal

In Nandurbar regularly Ghanta Gadi collects waste materials from different parts, Slogan is ***Gadiwala aayahai tu kachara nikal***,and also give social information.

Collection of Solid Waste:



As a part of decentralization entire city is divided into six zones for the collection of solid waste as follows:

- =Weekly Market
- =Railway station
- =Bus stop
- =Colony areas
- =Old city
- =School and Colleges

Challenges and opportunities associated with waste management:

India faces major environmental challenges associated with waste generation and inadequate waste collection, transport, treatment and disposal. Current systems in India cannot cope with the volumes of waste generated by an increasing urban population, and these impacts on the environment and public health. The challenges and barriers are significant, but so are the opportunities.

Key waste management:

The MoEF Ministry of Environment and Forests (MoEF) issued MSW **(**Municipal waste management), Management and Handling Rules 2000 to ensure proper waste management in India and new updated draft rules have recently been published. Municipal authorities are responsible for implementing these rules and developing infrastructure for collection, storage, segregation, transportation, processing and disposal of MSW. Chandigarh is the first city to develop SWM **(**Solid waste management) in a planned way and has improved waste management compared with other Indian cities, (Rana R, et al., 2015).

Solid waste management:

In India can claim 100% segregation of waste at dwelling unit and on an average only 70% waste collection is observed, while the remaining 30% is again mixed up and lost in the urban environment. Out of total waste collected, only 12.45% waste is scientifically processed and rest is disposed in open dumps, CPCB, report 2014.

Segregation:

There is no organized and scientifically planned segregation of MSW either at household level or at community bin. Sorting of waste, is mostly accomplished by un organized sector and seldom practiced by waste producers. Segregation and sorting takes places under very unsafe and hazardous conditions and the effectiveness of segregation is reasonably low as unorganized sector segregates only valuable discarded constituents from waste comparatively higher economic return in the recycling market, (Singhal & Pandey, (2013).

Collection:

Waste produced by houses and street sweepings are usually transferred into communal bins that are fabricated from metal. These community waste bins are used by other commercial sectors.

Reuse/recycle:

This entails activities like collecting those materials from the waste, which could be gainfully retrieved and utilized for making new products. Recyclable material like plastics, glass, papers.

Transportation:

Modes of transportation for MSWM practiced are bullock carts, hand rickshaws, compactors, trucks, tractor, trailers, and dumpers are used without adequate cover system.

Disposal:

In city adopted unscientific disposal of MSW. The existing practice and technology availability for MSWM is traditional. Waste collection, storage and transport are essential elements of any SWM system and can be major challenges in city. Uncontrolled open dumping is a common feature in city. Morethan 90% of waste to be dumped in an unsatisfactory manner.

The following disposal practices are in use in hierarchy:

Open dumping:

MSW generated is usually directly disposed on low lying area in routine way violating the practices of sanitary land filling. Almost no ULBs (urban local bodies) have adequate sanitary land filling facility and MSW is dumped in the outskirts of town along the roads. Unscientific dumping is prone to flooding and major source of surface water contamination during monsoon and ground water contamination due to percolation of leachate.

Land filling:

Land filling would continue to be extensively accepted practices have limited availability of land for waste disposal and designated landfill sites are running beyond their capacity. The development of new sanitary landfills/expansion of existing landfill are reported in the city.

Biological treatment of organic waste:

The waste generated has produced more organic content nearly 50% as compared to 30% generated by developed countries, Following composting methods are commonly adopted in India. Aerobic composting, Vermi-composting, Anaerobic digestion, Thermal treatment.

Challenges:

Awareness to enhance segregation:

Ecological awareness and citizen participation to segregate waste at source, door-to-door collection, and disposal in appropriate collecting bin is imperative. The awareness plays an important role in MSWM and augments the efficiency of waste management stream. It is themost critical phase in the whole process of MSWM, which helps in handling solid waste leadingto ultimate success. However, in India, the present scenario reveals that there is almost no segregation of garbage at source which leads to various environmental problems and it becomes very difficult to segregate waste at transfer station or in landfill or treatment site. Also, due to lack of coordination among the residents and lack of planned cities, the residents throw garbage improperly. Apart from this, the community bins are not located in the close vicinity and the number of ULBs employees is not adequate as per population residing in that area.

Characterization of municipal solid waste:

India is a vast country divided into different climatic zone different food habits, and different living standard thereby producing waste of different types. Until date, no comprehensive studies have been conducted to cover almost all cities and towns of India to characterize the waste generated and disposed on landfill. The policy-makers rely on the limited source of information available from few places thereby are unable to provide appropriate solutions for the kind of waste produced for a particular region.

Urbanization and lack of appropriate level funding:

With the population growth, challenge to provide adequate infrastructure in urban area and new landfill site selection is important. Most of the landfill sites are running beyond their capacity in metropolitan cities. Inadequate financial support to cater to waste management problem aggravates it. Due to financial crunch ULBs do not have adequate infrastructure to provide suitable solutions.

Implementation of rules at ground level:

ULBs are not implementing MSWR adequately as revealed by various government reports; thus it is difficult to manage the MSW properly. There is a need to create dedicated group of officers and skilled staff for ULBs with specialization in MSWM.

Involvement of organized sector:

For improving MSW collection efficiency and source segregations, rag-pickers can be engaged through organized sector. However, due to lack of recycling industries and acceptance of society this vast potential has been ignored.

Results and discussion:

There are many varieties of municipal solid waste such as food waste, rubbish, commercial waste, institutional waste, street sweeping waste, industrial waste, construction waste and sanitation waste. It contains recyclable (paper, plastic, glass and metal etc.), toxic substances (paints, pesticides, used batteries, medicines etc.) Compostable organic matter (fruit and vegetable peels, food waste), soiled waste (sanitary napkins, etc.) As manual separation plate form of solid waste is there at the disposal site in village Tokartale, it is the most positive way to achieve the recovery and reuse of material such as metal, plastic, glass and rubber etc. It should be done through out the year. System should be based on Environmental protection rules (reduce, recycle, reuse and recover).

Disposal of solid waste:

There is a site for the municipal solid waste management at Village Tokartale area situated at 4 km. from the Nan durbar city. Disposal of solid waste is done by the following two methods.

Composting:

It is done by vermin composting of any type of biodegradable wastes such as hotel refuge, biodegradable portion from residence and commercial market, vegetable waste, leaf litter etc. Size of each vermin composting rack is 7m X 2 m X 1m made up of steel. It requires two month.

Land filling:

Waste is stored on the top of the hill in 4 acres area. All inorganic material is used for the land filling and dumping.

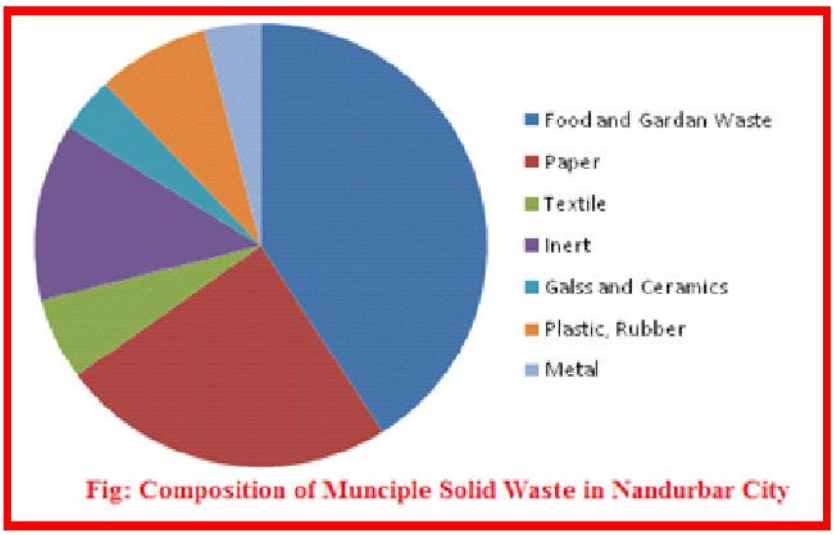


Fig: 1 Composition of Munciple Solid Waste in Nandurbar City

Conclusion:

- The collected data shows that the maximum proportion of refuse caused by food and garden wastes, proportion of the reuse caused by food and garden wastes, second highest was paper and the third highest was inert material. Percentage of Plastic carry bags was higher, where glass, ceramic and metals were nearly equal with each other.
- Provision of litter bins at public places shall be made and compulsory segregation all the sources.
- As the disposal site is at 4 km away and smaller vehicles are used for the transportation of solid waste, it would be desirable to set up transfer station to economize the expenditure on the transportation.
- As manual separation plate form of solid waste is there at the disposal site in village Tokartale, it is the most positive way to achieve the recovery and reuse of material such as metal, plastic, glass, papers, and rubber etc. System should be based on Environmental protection rules (reduce, recycle, reuse and recover).
- Public awareness, political will and public participation as essential for the successful implementation towards sustainable management of municipal solid wastes.
- There should be sufficient health and safety provisions for workers at all stages of waste handling.

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Sampling and forecasting of vegetable pests in an agricultural land of Barkhetri Circle under Nalbari district, Assam

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Abstract

Sampling and knowledge of insect-pest population dynamics is a basic requirement in order to develop an effective control strategy in an economically and ecologically sound way for integrated pest management program in agriculture and forestry. Regular or periodic sampling of insect pests is essential for ensuring their short term and long term viability and effectiveness. A field survey was conducted at Mukalmua irrigation site (approx 13 acres) near the bank of the river Brahmaputra with a view of investigating the occurrence of insect pests attacking some vegetables cultivated in the farm land. Morphological identification of insect pests was done using handlens. Quadrate sampling was used to determine the frequency of occurrence of pests on leaves, twig and bark in different vegetable plants which was used in computing insect pest density Nine vegetable types were found to be predominantly cultivated in that farmland namely, Brinjal, Okra, Cucumber, Papaya, Pumpkin, Bittergourd, Ridge gourd, Bottle gourd, and Ivy gourd.The major insect pests dominated were found as Aphids (Hemiptera) , Shoot and fruitborer (Lepidoptera), Fruitfly (Diptera), Beetles (Coloeoptera). It has been recorded from these studies that brinjal has the highest pest prevalence (15.75) with a mean density value 1.33m^{-2}while the ivygourd had the least pest prevalence(6.51) with a mean density value 0.55m^{-2}..The result shows that the pest prevalence was significantly different between the vegetable types in the study area. Both the larval and the adult stages of the pests were found attacking different parts of the vegetables. Vegetable damage ranges from reduced plant vigor to plant death and ultimately heavy crop losses occur. Pest problem is one of the major constraints for achieving higher production in agricultural crops. Most vegetable crops are subjected to remarkable damage by the pests namely seeds, roots, leaves, stems, fruits. With changesin the cropping pattern, ecosystems and habitat, climate and introduction of input intensive high yielding varieties or hybrids, a shift in pest status has been realized in time and space.Many pests have expanded their host horizon, developed resistance to pesticides and of then there are secondary outbreaks.This paper envisages these emerging insect pests in vegetable ecosystem. In the present studies, pest image data were collected and information about vegetable pests were extracted. The results synthesized from the present study on the insect population dynamics may be helpful to determine and to assess the economic injury level of the crop land by the pests.

Keywords : Sampling, Vegetable pests,Quadrate sampling, Population density, Pest prevalence,Economic Injury Level.

Introduction:

Vegetables are important part of the world agriculture which constitutes a major part of the diet contributing nutrients and vitamins.Vegetables are eaten in a variety of ways as a part of main meals and as snacks as they are relatively cheaper and rich source of nutrition (Vainio, 2003). The nutritional content of vegetables varies considerably, though generally they contain little protein or fats and varying proportions of vitamin A, K, and B_6, dietary minerals and carbohydrates (Woodruff, 1995). Their consumption can also play a key task in neutralizing the acids created during digestion of fatty and

proteinous foods, and moreover offer important roughages that assist in forwarding of food in intestine. (Sarwar, 2012). Vegetables contain agreat variety of other phyto-chemicals, some of which have been claimed to have antioxidant, antibacterial, antifungal, antiviral and anti-carcinogenic properties. Vegetables contain important nutrients necessary for healthy hair and skin (Gruda, 2005). A plenty of thoughts and research exists to determine and recommend the uses of vegetables to eat and protect against diseases, Thus, vegetable crops possess high medical value and play a vital role for curing of certain diseases (Steinmetz and Potter, 1996). Vegetables production is increasing day by day and these can be grown in different seasons of the year in certain regions. It is necessary to maintain improved vegetables production for addition to nutritional values of the community. But the yield per unit area of vegetables is quite low since the insect pestscause 30-40% losses in general and even 100% losses in case of menace if no control measured is applied. A conservative estimate puts about annual yield losses in vegetables at 25% due to insect pests alone (Rahman, 2006)

Besides the importance of these crops, there are various constraints to their production which include high cost of inputs, transportation accessibility to market, insect infestation and disease problems. Pests cause severe damages to these vegetable crops which reduce the quality or quantity of yield. Crop damage by insect pests could be due to biting and chewing of plant materials like in Orthoptera. Another type of damage is due to sucking of the plant sap from the phloem of xylem system or from general tissues of leaves, roots and fruits like in bugs and thrips. Insect pest that is able to multiply on different variety of plants is said to have a wide host range and termed as polyphagous. Polyphagous insects attack both leafy and succulent types of plants like spinach and tomato. Some insects are restricted to a limited number of host plants especially the leafy types, these are known as monophagous.

Farmers generally rated insect pests as the most serious problem because of the pest's significant effect to their crops by reducing the vegetable harvest. A good integrated pest management strategy employs correct identification of insect pests and good understanding of their biology as a key pillar to their control (Okunlola and Ofuya, 2010). This involves monitoring the pest population as well as noticing the stage of the insect development and only mobilizing control measures when the pest numbers reach the economic injury level. The moist climatic and soil conditions of the irrigation site are highly favourable for fruits and broad- leaves juicy vegetables production, but is equally favorable for the insect pests. Often the first manifestation of the presence of a pest or disease is in the appearance of the crop which may exhibit particular types of pest damage or disease symptoms (Hein,2003)

In view of the above interest, the present study was aimed to carry out an investigation on the identification, occurrence and damage of insect pests that attack vegetables grown in the agricultural land and to assess the abundance of pests and to follow the progress of insect pest population through time by regular sampling.

Materials and Methods :

Study area:

The present study was carried out at Mukalmua of Barkhetri Circle under District Nalbari near the Brahmaputra bank. (approx.13 acres). The site is approximately located at 26' N and 27' N latitude and 91'E and 97'E longitude at the height of 89.00 m above sea level. The study was conducted between June to August and sampling was done across the study period. Regular or periodic sampling of insect pests is essential for ensuring their short and long term viability and effectiveness.

Sample collection:

Methods of Legg, D.E and Yeargon (1985)was followed for sample collection. The sampling site was divided into four quadrates and nine plants were selected within the square meter area randomly.

Identification of insect pest:

Morphological identification of pests were done consulting journals, atlas and other website sources. Pest identification of the vegetables is the most important step and the correct identification of pest is the beginning of a successful management program.

Data analysis:

Raw data on the population density and prevalence were calculated out to find out the economic injury of the cropland. The surface area of the infested leaf were measured and percent damage in terms of square area were recorded. Data collected were summarized into frequencies and percentages.

Results and Discussion :

The results of the pest study revealed cultivation of vegetables which varies differently in the Barkhetri Circle by the farmers. Different plants were selected randomly and from there mean number of pests were recorded and total number of insect pests were identified. The population density was calculated by finding the total number of pests per square area of the quadrate. In this study, the prevalence of the insect pests were recorded to find out the highest prevalence and lowest prevalence among the different insects. From table1, it has been found that the brinjal has the highest pest prevalence (15.75) and ivy gourd has the lowest pest prevalence (6.51). The result shows that the pest prevalence was significantly different between the vegetable types cultivated. The major pests found are aphid (homoptera), shoot and fruit borer (lepidoptera), fruit fly (diptera), beetles (coleoptera), hadda (coleoptera).The percent damage area of leaves were calculated by measuring the surface area of the

infested leaves. Table 2 shows Okra has the highest infestation (3.56) while pumpkin has the lowest infestation (0.40) of leaves respectively. Both the larval and adult stages of pests were found attacking different parts of the vegetable plants. The pie diagram shows the infested surface area of the vegetable leaves.

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Vegetables	Mean number of pests	Density	Prevalence
Brinjal	5.33	1.33	15.75
Okra	3	0.75	8.88
Cucumber	5.2	1.3	15.40
Papaya	4.69	1.17	13.86
Pumpkin	3.33	0.83	9.83
Bittergourd	3	0.75	8.88
Ridgegourd	3.8	0.95	11.25
Bottle gourd	3.25	0.81	9.59
Ivygourd	2.2	0.55	6.51

Table1: Prevalence of insect pests of some cultivated vegetables.

Vegetable	Percentage of infested area by the pest
Brinjal	2.85
Okra	3.56
Cucumber	0.65
Papaya	3.60
Pumpkin	0.40
Bittergourd	1.32
Ridgegourd	0.51
Bottle gourd	1.38
Ivygourd	2.52

Table 2: Percentage of in fested surface area of vegetable leaves.

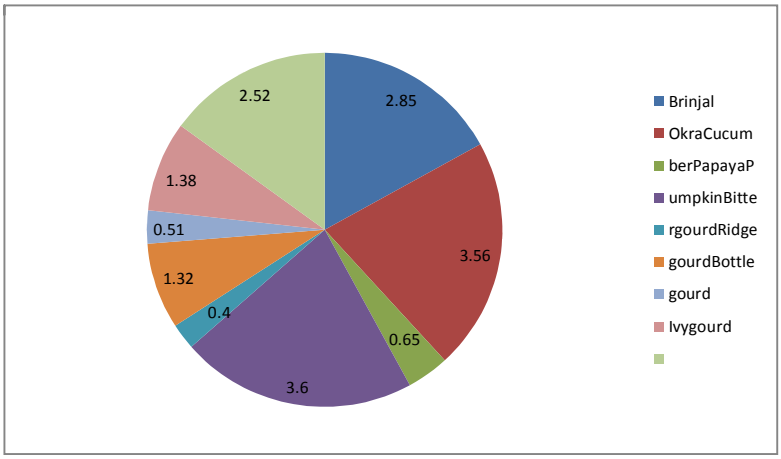

Fig: Pie diagram shows the infested area of the leaves (%).

Fig:1 Fruit fly in bittergourd

Fig.2 Hadda in brinjal

Fig.3 Ticks in ivygourd

Fig. 4 Shoot and fruit borer

Fig.5 Aphids in okra

Fig.6 Thrips in papaya

Fig.7 Larvae of aphid in okra

Fig.8 Aphid in bitter gourd

Fig.1-8 shows some infested vegetable in the study area.

Fig.9 Infested leaf of Bottlegourd

Fig.10 Infested leaf of Brinjal

Fig.11 Infested leaf of Cucumber

Fig.12 Infested leaf of Ivygourd

Fig.9-12 shows infested surface area of vegetable leaves in the study area.

Insect pest surveillance and forecasting is an important aspect in Integrated Pest Management to protect the crop damage and food production. It refers to the constant watch on the population dynamics of pests, its incidence and damage in each crop. There is an urgent need to develop precise estimation procedure and forecasting models for estimating functional relationships as well as the ratios of pests to natural enemies to understand the pest population dynamics.

Findings of the present survey also indicates that the aphids are reported as the most occurred insect pests attacking the vegetables. Foster and Obermeyer (2001) explained that aphids cause severe damage to vegetables by sucking juice of plant. From the figures 8-11, it can be concluded that various pests cause damages to the leaves as well as fruits of the plants. The infestation of ridgegourd and okra is higher in comparison to the other leaves. However, thrips were also found attacking leaves of Okra. This findings is inconformity with that of Alston and Drost (2001) who reported thrips is the key insect in such vegetables (Oparaocha and Okigibo, 2003). The shoot and fruit borer is the major pests of brinjal (Latif et al., 2009). The occurrence of leaf eating caterpillar attacking the leaves of ridge gourd, bitter gourd has been noticed (Ridge, 2007). The aphids, thrips population increases rapidly under hot, arid condition and can lead to economic damage. The findings of this survey also revealed that most of the farmers engaged in using chemical methods of control, while some of the farmers applied some other methods like cultural methods which include crop rotation, inter cropping and manipulation of planting times. (Umehand Manga, 2002)

Conclusion:

This study has revealed that different insects attacked variety of vegetable under the cropland in the study area. These pests chiefly belongs to Hemiptera, Lepidoptera, Diptera, Thysanoptera. Information obtained from this study will further provide a record of these insect pests which will further help the farmers to prevent from damaging the vegetable crops. In insect pest management, Substantial knowledge is required on the dynamics of pest population in order to determine the density of the injury level of the plants. It has been observed that the farmers practices different type of control methods, though concentrated more on chemical method. Information obtained from this study provides a record of insect pests found in this study for the first time and would definitely assist in promoting pests control through Integrated Pest Management. It helps to calculate the correlation between crop yield and degree of damage of infestation loss in the yield. This study will help guided to form the basis for prioritizing plant species for evaluation of their efficacy against the pests. The farmers may have a wide choice to select suitable crop protection measures to adjust in their cropping system in agiven situation. A combination of pest control strategies is of paramount importance and usually works well to reduce damage and keep the insect population below economic injury level for minimizing the yield loss. Development of a large number of improved varieties, their wider adaptability and standardization of

production technologies for various agro-climatic conditions, seed treatment, regular pest scouting can make it possible to produce vegetables in a wider areasand improve the prospects of their supply tremendously. Vegetables insect pests can be effectively managed by incorporating the subsequent practices such as proper field selection, growing insect free transplants, planting early, controlling weeds and diseases, operating insect traps, examining fields periodically, and immediate destruction of crop on completion of harvest to ensure success in pest management. Implementation of Integrated Pest Management practices can enhance the crop production, environmental benefits, and improve the health of vegetables and the farm system.

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Toxicity by Cadmium and Mercury

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Abstract

Heavy metal pollution is an inorganic chemical hazard, mainly caused by lead, chromium, arsenic, cadmium, mercury, zinc, copper, cobalt and nickel which are classified as strong carcinogens by the International Agency for Research on Cancer. There are hundreds of sources of these metals in air, water and soil including both natural and man-made activities. High level of heavy metal exposure can cause permanent intellectual and developmental disabilities, including reading and learning disabilities, behavioural problems, hearing loss, attention problems and disruption in the development of visual and motor functions. Their toxicity depends on several factors including the dose and route of exposure as well as the age, gender, genetics and nutritional status of exposed individuals. Among these heavy metals, group 12 elements of the periodic table such as Cadmium and Mercury are considered systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure. The present review paper discusses broadly about their environmental occurrence, production and use, potential for human exposure, toxicity and the recent techniques that have been developed for the removal of these harmful pollutants from the surrounding environment

Introduction:

Though heavy metals are natural components of the earth's crust, most environmental contamination and human exposure result from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metal-containing compounds. Environmental contamination can also occur through metal corrosion, atmospheric deposition, soil erosion of metal ions and leaching of heavy metals, sediment re-suspension and metal evaporation from water resources to soil and ground water. Natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution. Industrial sources include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations and high tension lines, plastics, textiles, microelectronics, wood preservation and paper processing plants[1].

To a small extent they enter our bodies via food, drinking water and air. As trace elements, some metals such as copper, magnesium, zinc, cobalt, chromium, nickel, iron, molybdenum, manganese and selenium are essential nutrients that are required for various biochemical and physiological functions. The essential heavy metals exert biochemical and physiological functions in plants and animals. They are important constituents of several key enzymes and play important roles in biologic functioning such as in various oxidation-reduction reactions. However, at higher concentrations they can lead to

poisoning including cellular and tissue damage leading to a variety of adverse effects and human diseases. In biological systems, heavy metals have been reported to affect cellular organelles and cell components. Several studies found that the reactive oxygen species production and oxidative stress play a key role in toxicity and carcinogenicity of the metals[2].

Cadmium:

Cadmium is a soft bluish white metal[3], discovered in 1817 simultaneously by Stromeyer and Hermann. It makes up about 0.1 ppm of earth's crust. Greenockite (CdS) is the only cadmium ore of significant abundance which is nearly always associated with sphalerite (ZnS)[4]. The use of cadmium is generally decreasing now-a-days due to its toxicity and the replacement of nickel-cadmium batteries has been done with nickel metal hydride and lithium-ion batteries.

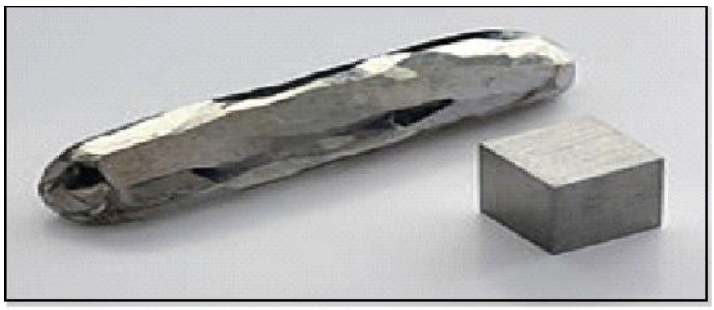

Figure 1: A view of cadmium crystals.

Sources:

Cadmium can be released to the environment in a number of ways including natural activities such as volcanic activity, erosion and river transport. Human activities such as tobacco smoking, mining, smelting and refining of non-ferrous metals, fossil fuel combustion, incineration of municipal waste (especially cadmium-containing batteries and plastics), manufacture of phosphate fertilizers and recycling of cadmium-plated steel scrap and electronic waste also contributes to the overall release of cadmium into the environment.

Human exposure to cadmium occurs mainly through inhalation or ingestion. It is observed that about ten to fifty percent of inhaled cadmium is in the form of dust. About five to ten percent of ingested cadmium is absorbed depending on the particle size. However, intestinal absorption is greater in persons with iron, calcium or zinc deficiency[5].

Applications:

Cadmium has many common industrial uses as it is a key component in a number of processes:

(i) Batteries: Until 2009, 86% of cadmium was used in batteries, predominantly in rechargeable nickel-cadmium batteries which have a nominal cell potential of 1.2 V. The cell consists of a positive nickel hydroxide electrode and a negative cadmium electrode plate separated by an alkaline electrolyte (potassium hydroxide)[6].

Figure 2: Ni-Cd battery.

(ii) Electroplating: Cadmium electroplating is used widely in the aircraft industry due to its ability to resist corrosion when applied to steel components. This coating is passivated by the usage of chromate salts[7]. However hydrogen embrittlement of high strength steels is one of the main limitations of this process.

(iii) Nuclear fission: An alloy of cadmium is used as a barrier to control neutrons in nuclear fission in high pressure water reactors. The alloy consists of 80% silver, 15% indium and 5% cadmium.

(iv) Paints: Cadmium is commonly used as pigments in strong oranges, reds and yellows. These can be used in dry form, as with chalk pastels or in mixing with other paints.

Effects of cadmium poisoning:

Cadmium can be transported over great distances when it is absorbed by sludge which can pollute surface waters as well as soils. Cadmium strongly adsorbs to organic matter in soils, particularly soils that are acidified enhance the cadmium uptake by plants. As a result the uptake through food will increase which can be extremely dangerous. This is a potential danger to the animals that are dependent upon the plants for survival. Cadmium can accumulate in their bodies, especially when they eat multiple plants. In aquatic ecosystems also, cadmium can bioaccumulate in mussels, oysters, shrimps, lobsters and fish.

Cadmium exerts toxic effects on the kidney, the skeletal system and the respiratory system and is classified as a human carcinogen by the International Agency for Research on Cancer (IARC)[8]. In very high levels it poses serious health problems related to bones, liver and kidneys and can eventually cause death. Long-term and high-level occupational exposure is associated with lung changes, primarily characterized by chronic obstructive airway disease. There is sufficient evidence that long-term occupational exposure to cadmium (e.g. through cadmium fume) contributes to the development of lung cancer. There is limited evidence that cadmium may also cause cancers of the kidney and prostate.

Figure 3: A villager suffering from swelling and abnormality due to cadmium poisoning.

Removal techniques:

A cadmium removal technique which has recently received a sharp increase in research activities for in simulated wastewater is "ion floatation"[9]. This technique has four important advantages for treating wastewaters - low energy consumption, small space requirements, small volume of sludge and acting selectively. The process involves a reaction between cadmium and sodium dodecylesulfate (SDS) collector followed by floatation with ethanol as froather. The experiments are carried out in a floatation column at laboratory temperature (27°C) and adjusted p^H of 4[9]. The obtained results are found to be very promising, as both cadmium and collector were effectively removed from waste water. Hence, the ion floatation method for cadmium removal from effluents seems to be very efficient.

Mercury:

Mercury is the only metallic element that is liquid at standard temperature and pressure. It rarely occurs free in nature and is found mainly as cinnabar ore (HgS) in Spain and Italy. Mercury is silvery-white colour and it is a poor conductor of heat, but a fair conductor of electricity as compared to other metals[10]. It alloys easily with many metals, such as gold, silver and tin which are popularly known as amalgams.

Figure 4: A view of elemental mercury.

Sources

Natural sources of mercury include volcanoes, forest fires, cinnabar and fossil fuels such as coal and petroleum. Anthropogenic sources include discharge from hydroelectric, mining and paper industries, municipal and medical waste and emissions from coal-using power plants. Mishandled or spilled mercury from devices used in the home or workplace is often the source of unintentional exposures. Power plants are now considered as the largest of mercury.

Mercury is deposited from atmosphere into the water where some bacteria convert elemental mercury into organic mercury compounds such as methyl mercury. The main human exposure to mercury is through ingestion of fish that contain methyl mercury. The recycling of anthropogenic mercury that involves volatalization of mercury containing water also raises levels of mercury in the environment.

Applications:

Mercury is used primarily for the manufacture of industrial chemicals or for electronic applications. It is used in high temperature thermometers and in fluorescent lamps, while most of the other applications are slowly phased out due to health and safety regulations[11].

(i) Medicine: Mercury and its compounds have been used in medicine, although they are much less common today than they once were as the toxic effects of mercury and its compounds are more widely understood. The elemental mercury is an ingredient in dental amalgams whereas mercury compounds are found in some drugs, including antiseptics, stimulant laxatives, diaper-rash ointment, eye drops and nasal sprays.

Figure 5: Teeth Amalgam filling.

(ii) Laboratory: Mercury is used in transit telescopes as a basin to form a flat and absolutely horizontal mirror, useful in determining an absolute vertical or perpendicular reference. Liquid mercury is a part of popular calomel electrode, the secondary reference electrode in electro chemistry as an alternative to the standard hydrogen electrode[12]. In polarography also, both the dropping and the hanging electrode are made of elemental mercury[13]. Calibration lamps used in optical spectroscopy also made of gaseous mercury[14].

Figure 6: Bulb of mercury in glass thermometer.

(iii)Daily uses: Gaseous mercury is used in mercury-vapour lamps and some advertising signs and fluorescent lamps[14]. In cosmetics industry, mercury as thiomersal is widely used in the manufacture of mascara[15].

Effects of mercury poisoning:

Adverse effects from mercury differ depending on the form and the route of exposure. Inhalation is the primary route of exposure to elemental mercury vapour, which is readily absorbed by the lungs and blood stream about up to 80%. A portion is converted to divalent form(Hg^{2+}) in the red blood cells, while the remaining portion is directly transported to the brain unchanged. The symptoms of acute exposure via inhalation of Hg vapour are often cough, chest pain, chest tightness and difficulties in breathing. The existence of mercury in the brain results in the symptoms like enlarged thyroid, increased radio-iodine uptake by the thyroid, increased mercury excretion in urine, memory loss, depression etc. Elemental mercury vapour is slowly absorbed also through the skin and causes irritation of both skin and eyes and may produce contact dermatitis.

The presence of mercury in the body results anatomic gastrointestinal abnormalities, kidney damage, stomach disruption, damage to intestine, reproductive failure and DNA alteration[13]. Hg poisoning also can result in birth defects, damage to the unborn child who may develop problems in vision, hearing, memory and mental ability.

Removal techniques:

There are four processes for removal of mercury from the contaminated water: coagulation/filtration, lime softening, granular activated carbon process and reverse osmosis. Coagulation/filtration is a common treatment for the removal of Hg forming a solid which can precipitate out of the water. Lime softening process uses excess of calcium hydroxide to raise the p^H level and then the heavy metal precipitates out as mercurous hydroxide. An advantage of both these methods is low cost and proven reliability[15]. Granular activated carbon method uses porous carbon media. As the water passes through the media,

the dissolved contaminants are absorbed and held on the solid surface. This process has a limitation that the effectiveness depends on the concentration of mercury in the water. In reverse osmosis, water is pushed through a semi permeable membrane such as polyamide film. This method produces water with high quality, but is fairly expensive[15].

Preventive measures:

It is important to mention here that one of the most used methods to reduce any heavy metal pollution now-a-days is the use of growing plants. This is often called phyto-remediation and is of wide public acceptance. Phyto-remediation has the disadvantage of taking longer time to accomplish than other treatment.

Plants can be used in different ways. Sometimes a contaminated site is simply revegetated in a process called phyto-stabilization. The plants are used to reduce wind and water erosion that spread materials containing heavy metals. However, it would be necessary to find plants that could tolerate high levels of heavy metals. The applications of genetic engineering in the modification of the microorganisms for increasing the efficiency of the bio filtration process for heavy metals removal have been critically analyzed. The results show that the efficiency of the process can be increased three to six fold with the application of recombinant microbial treatment[16,17].

It is always said that prevention is better than cure. Group 12 elements cadmium, mercury and most of their compounds are extremely toxic and must be handled with care; in cases of spills, specific cleaning procedures should be used to avoid exposure. There is a huge need to develop techniques for their safe disposal. For example, heating of mercury or compounds of mercury that may decompose when heated, is always carried out with adequate ventilation in order to avoid exposure to mercury vapours**.**

In addition, it is important to promote effective measures to increase recycling of these metals as well as their compounds and to restrict non recyclable uses. On a final note, to decrease global environmental releases and reduce occupational and environmental exposure to these metals and associated health effects, a global awareness is required on the importance of minimizing waste discharges.

Conclusion:

Among all the heavy metals, the toxicity of Cadmium and Mercury are found to be very prominent. There are several natural and man-made sources of these two metals which on exposure may disrupt the functions of the digestive system, respiratory system, reproductive system etc. However, their toxicity can be treated with the help of a number of techniques. It is definitely better to prevent direct exposure to such toxic metals by creating awareness among the people about the adverse effects of them.

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A Short-Term Analysis of the Waste Disposal Mechanism of Local Shops of Garia, West Bengal

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Abstract

The waste management of the local shops of Ramkrishna Nagar area, Garia, West Bengal was reported. Until last 20-25 years this area was fairly moderately populated with an uneven distribution of population. Very old settlements centering the Garia Bazaar and Garia crematorium were pretty densely populated but the rest of the areas like Ramkrishna Nagar, Laskarpur, Aatabagan and adjoining areas had a lot of open spaces reclaimed by wild vegetation. However, construction of the Garia metro brought in a huge influx of population (mainly cosmopolitan) into a relatively homogeneous area. As a result large housing complexes, various institutes and innumerable shops were set up. Soon this place turned into an urban hotspot teaming with life and chaos. However, due to its rapid development in order to race with time, a lot of these developments were often unplanned and not environment friendly. One of the major nuances of current times globally is inappropriate waste disposal mechanism. Often this is a result of lack of awareness and rapid, unplanned growth. And since our locality in particular had an exponential development in a short period of time, we simply decided to look into the waste disposal mechanism of the shops lining our street and thus draw a conclusion about the hygienic condition of our area. We observed all the four shops in my locality they are: a grocery shop, a sweet shop, a printing and binding shop and a beauty parlor. These shops line the street of the locality. We prepared a questionnaire to conduct a survey on these shops; two sets of data were generated. One consists of basic information of each shops and the other was data generated in real time through observation. Finally, we discussed about the hygienic condition of our area, suggested some improvements that the Kolkata Municipal Corporation in our area could implement and lastly focused on the overall problematic condition of the biggest landfill of our city.

Keywords: waste disposal mechanism; hygienic condition; waste management

Introduction:

This is a report on the waste management of the shops located at Ramkrishna Nagar area, Garia, West Bengal, India. Garia area itself is an extremely old area in Kolkata. Its biggest landmark is Garia Adi Mahashoshoshan with its twin temples of approximately 350 years ago. This crematorium is located is at the north terminal of our locality that is Ramkrishna Nagar.

Until last 20-25 years this area was fairly moderately populated with an uneven distribution of population. Very old settlements surrounding the Garia Bazaar and Garia crematorium were pretty densely populated but the rest of the areas like Ramkrishna Nagar, Laskarpur, Aatabagan and adjoining areas had a lot of open spaces reclaimed by wild vegetation. However construction of the Garia metro brought in a huge influx of population (mainly cosmopolitan) into a relatively homogeneous area. As a

result large housing complexes, various institutes and innumerable shops were set up. Ref: https://en.wikipedia.org/wiki/Garia#History). Soon this place turned into an urban hotspot teaming with life and chaos. However due to its rapid development in order to race with time a lot of these developments were often unplanned and not environment friendly. One of the major nuances of current times globally is inappropriate waste disposal mechanism. Often this is a result of lack of awareness and rapid, unplanned growth. And since our locality in particular had an exponential development in a short period of time, We simply decided to look into the waste disposal mechanism of the shops lining our street and thus draw a conclusion about the hygienic condition of our area.

Our locality, Ramkrishna Nagar with a latitude and longitude of 22.4561° N and 88.3816° E consists of two housing complexes "Victoria Greens" and "Mainaak Gardens." Surrounding these two highly cosmopolitan complexes a string of shops has been set up whose main source of income is from these two complexes coupled with other houses in our locality and the neighbouring localities. We have decided to study the waste disposal mechanism and efficiency of these particular shops lining our street.

Fig. 1. Map of Kolkata showcasing our location Garia (here spelt as Gariya)

(Source:https://www.worldmap1.com/map/india/calcutta-map.asp)

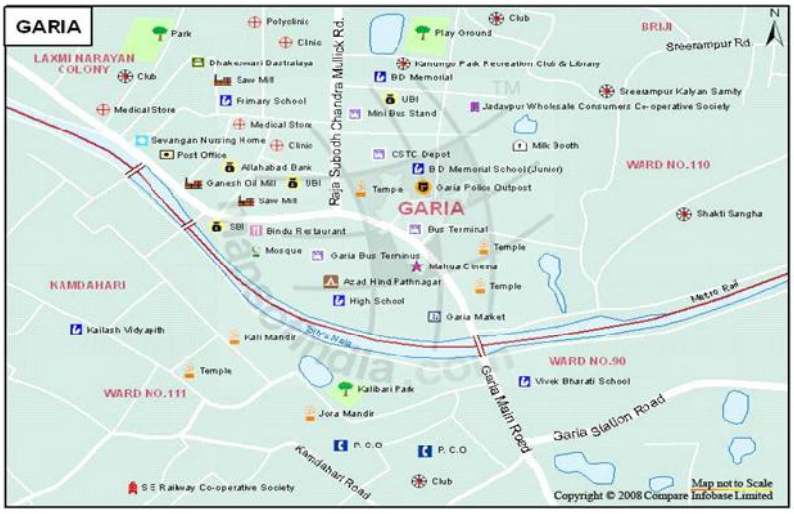

Fig. 2. A map of Garia (Source:https://www.maps of india.com/kolkata/garia.html

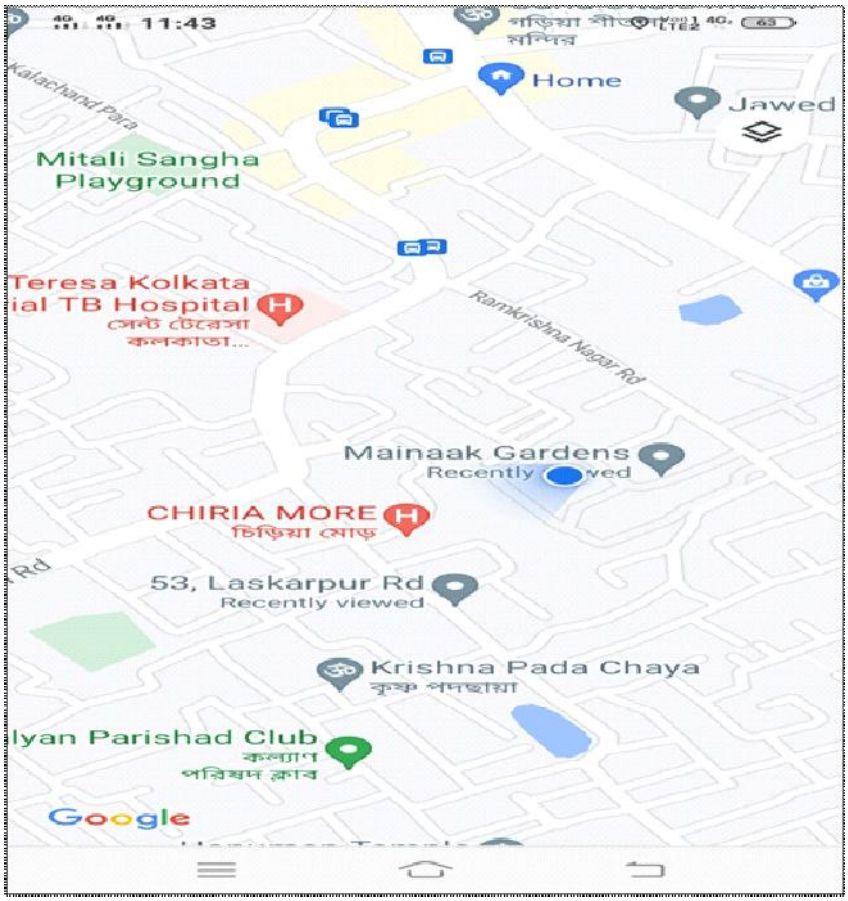

Fig. 3. A map showing the location of our complex “Mainaak Gardens” and the locality of Ramkrishna Nagar. Map not up to scale. (Source: Google map)

Methodology:

We observed all the four shops in my locality. They are: a grocery shop (Shop A), a sweet shop (Shop B), a printingand binding shop (Shop C) and a beauty parlour (Shop D). These shops line the street of the locality.

We prepared a questionnaire to conduct a survey on these shops; two sets of data were generated. One consists of basic information of each shop and the other was data generated in real time through observation. This style of survey was inspired from the works of Babaei et al., 2015 and Delgermaa and Matsumoto, 2016.

Results:

Questions	Shop A	Shop B	Shop C	Shop D
1. Age of shop?	7 years	4 months	35 years	4.5 Years
2. Opening and closing time?	7am- 1pm then 6pm-10pm	7am- 10:30 pm	10am-8pm	10am-8pm
3. How many times do you clear the garbage in a day?	Once in the morning	Once in the morning	Garbage is stored and is cleared off weekly	once
4. What type of container do you use to keep garbage?	Polybag in basket	green plastic dustbin	Jute bag	black polythene bags
5. Do you separate biodegradable and non biodegradable waste?	No	No	Yes	no
6. Are you aware of the concept of biodegradable and non-biodegradable waste?	Yes	not really	Yes	no
7. Do you clearthe garbage yourself?	No, it is collected by the Kolkata Municipal Corporation	No, it is collected by the Kolkata Municipal Corporation	yes	yes
8. When do you clear your garbage?	around 10am	around 10:30am	around 10-11am	in the evening around 7pm before closing the shop

Questions	Shop A	Shop B	Shop C	Shop D
9. Where do you dump your garbage?	we don't dump ourselves the KMC collects it	we don't dump ourselves the KMC collects it	We sell the papers and cloth to scrap dealers but the rest of the waste is collected by the KMC.	KMC truck standing infront of Garia crematorium
10. Is your garbage cleaning service regular?	yes	yes	yes	not applicable,as we clear it ourselves
11. Do you know where they take your garbage?	Not sure, probably Dhapa	no	Yes, Dhapa	no
12. Do you recycle any products?	no	no	Yes we sell the papers and cloth pieces for reuse to local scrap dealers	no
13. Are you aware of the concept of reuse and recycling?	yes	yes	yes	yes
14. Are you aware of plastic pollution?	yes	yes	yes	yes
15. Have you taken any measures to reduce plastic pollutions in your area?	No	No	we don't use plastic in our shop	no
16. why not?	Because I don't think it is a major problem in our area. The KMC collects everything	It's not our job	----	It's not our job
17. Does plastic form a major part of your waste?	yes	no	no	yes

Questions	Shop A	Shop B	Shop C	Shop D
18. Are you satisfied with the hygienic condition of your area?	yes	yes	yes	yes
19. Has the pandemic in any way affected your waste disposal mechanism?	Yes use of hand sanitizers and gloves has increased, finished bottles of hand sanitizers, tissues and gloves have become a part of our generated waste.	no, it's pretty much the same.	The pandemic has impacted us economically as we get much fewer customers than usual. Hence overall garbage build up is much less. Instead of weekly clearance we can store upto 1 month without any problem.	yes, a lot more waste is generated due to more usage of hand sanitizers, disposable towels, tissues, face napkins, gloves etc.

3.1 Some pictures taken during our survey

Fig. 4. a) Grocery shop

Fig. 4. b) Generated waste

Fig . 5 a) Sweet shop

Fig . 5 b) wooden spoons, papers andc) daily waste thermocol plates inside the shop

Fig. 6. a) Printing and Binding Shop

Fig. 6 b) wastes kept in paper bags

Fig. 7 Beauty parlour along with its daily generated waste which is kept outside.(We can clearly see a tuft of hair which forms a major part of their waste

Fig. 8 The drain which runs along our street and it is this common drain where most of the shops and also the households dump their liquid wastes.

Observed Data:

These data were collected over a span of 3 weeks by observation. 10 sets of data are as follows:

Day 1

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Dust, rotten potatoes, rotten eggs, rotten onions, polythene bags, cigerrete cartons	Thermocolplates,use and throw spoons, paper packets, sweet boxes, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Face mask,waxstrip,discarded wax gel,facenapkin,cuttingsheet,color tubes, hand gloves, shower caps, water generated from spa
Did you separate the wastes by any criteria?	no	Oil(liquid waste) was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradablewaste kept in separate jute bag	Water generated from shampoo, pedicure and spa was discarded into the drain. Solid wastes kept in bin

Questions	Shop A	Shop B	Shop C	Shop D
Daily average customer	25	50	2	7
Daily average income	4000	2500	250	2000

Day 2

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Egg trays, rotten potatoes, rotten eggs, , polythene bags, cigarette cartons, rice bags	Rotten sweets, rotten cheese curd, thermocol plates,use and throw spoons, sweet boxes, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Hair,waxstrip,discarded wax gel,face napkin , cutting sheet, color tubes, hand gloves, shower caps
Did you separate the wastes by any criteria?	no	Frying oil, rotten cheese curd and water formed over the milk was discarded separately in the drain	Paper kept in separate jute bag while rest of non biode-gradable waste kept in separate jute bag	no
Daily average customer	30	53	0	10
Daily average income	5500	3000	0	2600

Day 3

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	polythene bags, cigarette cartons ,dust, rotten potatoes, rotten eggs, rotten onions	use and throw spoons, thermocol plates, sweet packets, sweet boxes, discarded frying oil and watery fluid formed over diary product	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	hand gloves, shower caps, facemask, waxstrip, discarded wax gel, face napkin, cutting sheet, color tubes, water generated from spa, hair
Did you separate the wastes by any criteria?	no	Oil and water was discarded separately in the drain	Paper was kept in jute bag while rest of non biode-gradable waste was kept in separate jute bag	Water generated from shampoo, pedicure and spa discarded into the drain. Solid wastes kept in bin
Daily average customer	27	46	1	11
Daily average income	4500	1700	200	3000

Day 4

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Polythene bags, rice bags, egg trays, rotten potatoes, rotten eggs, cigerrete cartons	sweet boxes, thermocol plates, rotten sweets, rotten cheese curd, use and throw spoons, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Nails, handgloves, showercaps, hair, waxstrip, discarded waxgel, face napkin, cutting sheet, color tubes, used containers
Did you separate the wastes by any criteria?	no	Frying oil, rotten cheese curd and water formed over the milk was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradable waste kept in separate jute bag	no
Daily average customer	50	76	3	26
Daily average income	7500	5000	750	6600

Day 5

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Egg trays, rotten potatoes, rotten eggs, , polythene bags, cigarette cartons, rice bags	Rotten sweets, rotten cheese curd, thermocol plates,use and throw spoons, sweet boxes, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Hair,waxstrip, discarded wax gel, face napkin,cutting sheet, color tubes, hand gloves, shower caps
Did you separate the wastes by any criteria?	no	Frying oil, rotten cheese curd and water formed over the milk was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradable waste kept in separate jute bag	no
Daily average customer	27	60	1	6
Daily average income	4000	3500	100	1000

Day 6

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Dust, rotten potatoes, rotten eggs, rotten onions, polythene bags, cigarette cartons	Thermocol plates, use and throw spoons, paper packets, sweet boxes, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Face mask, waxstrip, discarded wax gel, face napkin,cutting sheet, color tubes, hand gloves, shower caps, water generated from spa
Did you separate the wastes by any criteria?	no	Oil(liquid waste) was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradable waste kept in separate jute bag	Water generated from shampoo, pedicure, spa discarded into drain. Solid wastes kept in bin
Daily average customer	23	41	0	12
Daily average income	3200	1500	0	3000

Day 7

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Polythene bags, rice bags, egg trays, rotten potatoes, rotten eggs, , cigarette cartons	sweet boxes, thermocol plates, rotten sweets, rotten cheese curd, use and throw spoons, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Nails, hand gloves, shower caps hair, waxstrip, discarded wax gel, face napkin, cutting sheet,color tubes, used containers
Did you separate the wastes by any criteria?	no	Frying oil,rotten cheese curd, water formed over the milk was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradable waste kept in separate jute bag	no
Daily average customer	48	70	2	23
Daily average income	6800	4500	500	5000

Day 8

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Dust, rotten potatoes, rotten eggs, rotten onions, polythene bags, cigarette cartons	Thermocol plates,use and throw spoons, paper packets, sweet boxes, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Face mask, waxs trip, discarded wax gel, face napkin,cutting sheet, color tubes, hand gloves, shower caps, water generated from spa
Did you separate the wastes by any criteria?	no	Oil(liquid waste) was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradable waste kept in separate jute bag	Water generated from shampoo, pedicure and spa was discarded into the drain. Solid wastes kept in bin
Daily average customer	25	50	2	7
Daily average income	4000	2500	250	2000

Day 9

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Polythene bags, rice bags, egg trays, rotten potatoes, rotten eggs, , cigarette cartons	sweet boxes, thermocol plates, rotten sweets, rotten cheese curd, use and throw spoons, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Nails, hand gloves, shower caps hair, waxs trip, discarded wax gel, face napkin, cutting sheet, color tubes, used containers
Did you separate the wastes by any criteria?	no	Frying Oil, rotten cheese curd and water formed over the milk was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradable waste kept in separate jute bag	no
Daily average customer	79	35	10	24
Daily average income	9000	3000	1500	6000

Day 10

Questions	Shop A	Shop B	Shop C	Shop D
Types of waste generated	Polythene bags, rice bags, egg trays, rotten potatoes, rotten eggs, , cigarette cartons	sweet boxes, thermocol plates, rotten sweets, rotten cheese curd, use and throw spoons, discarded frying oil	Paper pieces, threads, pins, gum bottles, ink bottles, pieces of cloths	Nails, hand gloves, shower caps hair, waxstrip, discarded wax gel, face napkin, cutting sheet, color tubes, used containers
Did you separate the wastes by any criteria?	no	Frying oil, rotten cheese curd and water formed over the milk was discarded separately in the drain	Paper kept in separate jute bag while rest of non biodegradable waste kept in separate jute bag	no
Daily average customer	82	42	7	34
Daily average income	9300	4000	900	8500

Discussion:

Based on the above survey conducted by us it seems like the overall hygienic condition of the area is fairly good. We travelled through the entire street especially focusing on the areas infront of the shops. They kept it pretty clean. However,our grocery shop which draws most of the customers did spill some rotten potatoes on the street. Out of all the shops in our locality our beauty parlour was definitely the most clean and hygienic. The pandemic has only made them more conscious about this. However, our grocery shops occasionally did spill on the streets. But at the end of the day the shopkeepers put them all in theirbins. Out the four shops 2 shops generated liquid wastes they are the sweet shop and the beauty parlour. They all drained this liquid wastes into the drains. However, while their waste disposal mechanism is pretty good we can't say the same about our drainage system. The drains here are clogged due to the deposition of plastic and also leaky simply because they are quite old. This creates much inconvenience during monsoon season as they get filled up with the slightest rains and start to overflow. This leads to a dangerous situation as toxic wastes start flooding the streets giving rise to unsanitary conditions. We would suggest the KMC takes initiatives to renovate our old drainage system. The KMC itself is quite regular and efficient in this locality.

When it comes to individual shops our binding and printing shop is the most eco friendly shop. The only non biodegradable waste generated is used gum bottles and ink bottles. Everything else is eco friendly. They also generate the least amount of wastes and almost all of them are reused. This shop was the only one that separated biodegradable and non biodegradable waste and employed the concept of recycle and reuse. Before the pandemic struck papers, threads and pieces of cloths generated were stored in jute bags for 1 to 2 weeks and then sold to local scrap dealers for re use. However, our printing shop has been hit quite hard economically by the pandemic and thus wastes generated could be stored up to 1 month and then sold for reuse. The rest of the shops however mainly depended over the KMC over their waste disposal except the liquid waste. Almost all of them were aware of plastic pollution and faulty waste disposal mechanism. However, none of them went out of their way to reduce the usage of non biodegradable products or employ the concept of recycle. The beauty parlour owner in particular said it would be the end of her business if she employs the concept of reuse as customers expect everything around them to be new and disposable as it truly involves a lot of human touch and especially due to the pandemic and people's paranoia regarding touch everything in her parlour is 'use and throw'. The beauty parlour is the only shop that could not avail the morning KMC service as they dispose of their wastes by the end of the day. There's a stationary KMC truck infront of the crematorium that is used for dumping wastes beyond the normal collection time in the morning.

Out of the non biodegradable wastes polythene bag was the most common waste generated from almost every shop except the printing shop, followed by plastic spoons and forks which came out of the sweet shop. However, the sweet shop also used wooden spoons along with plastic spoons. Plates were the next most abundant after spoons and they were of either thermocol or paper. However due to the pandemic a new addition to almost every waste load is used bottle of hand sanitizers and tissues and also disposable hand gloves which mainly came out of the beauty parlour. Out of the bio degradable wastes vegetable peels, rotten eggs, potatoes took the first spot, followed by discarded bad milk and cheese curd. Fried oil was the most abundant liquid waste generated followed by water. The parlour also had their own unique biodegradable wastes like hair, thread and unused and used wax. In case of day to day variation overall wastes came mostly sweet shop followed by the beauty parlour and then by the grocery shop with the printing and binding shop taking the lowest spot. During the weekends the grocery, sweet and beauty parlour saw way more customers than in the week days and that co related positively with the amount of waste generated. Situation in the printing shop was not predictable as it seemed the number of customers did not really depend on whether it was a working day or a holiday.

However, after the termination of our state election on 2nd May and a dangerously and rapidly rising covid graph in the state and overall country made people realize the dreaded second wave of covid 19 is finally here. There was a looming threat of lockdown which made people rush to grocery shops and various other shops to buy essentials once again. Thus the last two days we visited our grocery shop saw an exponential rise in customers and consequently waste products. Our sweet shop saw a slight increase in customers than the normal number in week days. Our printing shop and beauty parlour too saw an increase of customers. Especially our printing shop saw a substantial increase in customers rushing to print important documents before everything shuts down. In the shopkeeper's own words "we are feeling like we're back to normal cause we're suddenly getting the same influx of customers as it was before covid struck". The last two days the printing shop resorted to weekly garbage clearance like before.

In general, all the solid wastes whether biodegradable or non biodegradable wastes are collected by the KMC and dumped in Dhapa, the open landfill used to dispose waste in our city. As a result of which our locality is in an overall good hygienic condition.

Fig.8 :The deplorable condition of the Dhapa Landfill (Source:https://citizenmatters.in/kolkata-solid-waste-management-dhapa-howrah-belgachhia-landfills-segregation-12951)

Conclusion:

Thanks to the efficiency of KMC our locality is in a fairly good condition. However, as time is running by our municipality should really take some measures to repair our drainage system as it can in future give rise to toxic water conditions ultimately lead to outbreak of deadly disease especially in the monsoon. However, the larger problem lies with the city's backdated land fill site. The Kolkata metropolitan city is capital of the state of West Bengal. It is situated in eastern India on the banks of River Hooghly. The city has a population over 14 million (Goel and Hazra, 2009). The Dhapa landfill was set up in 1941(Chattopadhyay et al., 2009). But waste generation in 1941 was minimal, as compared to today, as the city is generating 5,000 metric ton of waste every day. More than 4,000 metric ton of waste is dumped at the Dhapa landfill every day, which has turned into a garbage mountain (Bhaskar and Dutta, 2017; Ali and Ahmad, 2019). According to the KMCin 2015, Dhapa had already crossed the dangerous height of 50 feet and exhausted its capacity to take in any more waste. These landfills are toxic sites where the air, water and soil are all polluted due to the continuous disposal of untreated waste and garbage. This is precisely why CPCB guidelines state that landfills must be in areas away from population to minimize the toxic impact of waste on public health. Unfortunately the big population at Dhapa is at daily risk due to the municipal corporation failing to come up with a waste management solution. In monsoon, the site becomes no less than a living hell. Daily fires are a common occurrence, due to emission of extensive methane and the residents are left with no choice than to breathe in the toxic

fumes. Unless and until the government comes up with a solution the future of the city's hygiene looks bleak. The whole waste disposal mechanism should be replaced with new scientific and eco friendly ways (Das and Bhattacharya, 2011). The local population should be rehabilitated as soon as possible as they are in direct contact with these toxic fumes and unsanitary water leaking from these dumpsites in the groundwater. The population is truly inhaling and ingesting poison on a daily basis. Hence there should be no delay in efficient removal of this population and the government should also provide them some decent means of earning their livelihood instead of picking rags and scraps and selling them to local scrap dealers which they currently do. Recycling plants should be set immediately. As recommended by the external agencies, the KMC can identify small temporary spots for garbage disposal in the meantime. It is also highly important that the whole landfill is reconstructed using scientific methods such as base made of clay, drainage layers constructed of soil and vegetative layers to minimize soil erosion.

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Checklist of Invasive Plant Species in Barbila Beel of Nalbari District, Assam

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Abstract

Barbila beel is an important wetland located at western part of Nalbari district. The beel is rich in terms of floral and faunal diversity. The beel is a source of livelihood for many people living near the beel. The beel is known for its rich fish diversity. But in due course of time, the diversity of this beel is dwindling alarmingly due to different causes like habitat alteration, pollution effects, overfishing, overexploitation of aquatic bio-resources, lack of management, blockage of water channels etc. The beel suffers luxuriant growth of many invasive plant species which covers huge portion of the beel. It affects the biodiversity, productivity and water quality of the beel. The current study aims to document presence of different invasive plant species in the aquatic habitat of Barbila beel. The study reveals presence of 14 plant species that belong to 11 families. Species such as, Eichhornia crassipes, Monocharia vaginalis, Ipomoea aquatica, Ipomoea carnea,, Alternanthera philoxeroides, Pistia stratiotes, Salvinia sp, Ludwigia sp are found abundantly. Most of the beel area is disturbed by these invasive species. The improper management of the invasive plant species creates hazardous conditions within the beel area which needs proper management.

Keywords: Invasive aquatic plants, Barbila beel, aquatic environment, diversity.

Introduction:

Biological invasion is a very serious problem which alters the ecosystem of a particular area. It is the second worst factor after habitat destruction which creates lot of problems to the existing biodiversity and affects agriculture, forestry and functioning of aquatic ecosystem. It inflicts great social and economic damage (Singha and Kalita, 2019; Mack et al., 2000; Pimentel et al., 2005). Invasive species means an alien species which becomes established in natural or semi-natural ecosystems or habitats, is an agent of change, and threatens native biological diversity (IUCN, 2000). According to Convention on Biological Diversity (2005) in India, about 40% floral diversity belongs to alien species out of which 25% are invasive in nature in any type of ecosystem. In 2001, economical report in India reported that there is loss of $91 billion in a year in agriculture and forestry sector due to invasive species. In freshwater ecosystem, invasive species creates havoc by causing serious biodiversity loss and altering the functioning, hydrology and structure of the ecosystem (Rai and Singh, 2020; Dudgeon and Arthington, 2006; Strayer, 2010). Species endangerment and extinction, displacement of native species, alteration of hydrological as well as nutrient cycles, alterations in food web dynamics, introduction of new diseases and parasites, hybridization with native species are some of the main impacts of aquatic invasive plants to the wetlands (Sala et al., 2000; Sandilyan et al., 2018).

Invasion of different floral species has become a major cause of biodiversity loss in the wetlands of Assam. Many non-native species are introduced in Assam's wetlands (locally termed as '*beel*') as well as low-lying, water logged areas intentionally or unintentionally. These species create different ecological and environmental problems in the lentic water bodies of Assam. Such disturbances in ecosystem invite many opportunistic invasive species to spread in a large area within short period of time (Singha and Kalita, 2019). However studies related to this is still limited. Nalbari district of Assam harbors many water bodies which are potential sites in terms of aquatic fauna and flora. But, in recent years, these water bodies also face drastic loss of biodiversity due to luxuriant growths of invasive species. Reports regarding aquatic invasive plants from different wetlands and water bodies of Nalbari district are scanty. The first report of invasive plant diversity from Nalbari district was reported by Kalita et al., (2019) where they have reported 69 exotic and invasive aquatic and ecotone species from different wetlands, low-lying waterlogged areas and rice fields. Another study on Gageli wetland of Nalbari district reported presence of 24 aquatic and semi-aquatic plant species belonging to 17 families (Kashyap, 2020). These studies have revealed the risks and hazards caused by the abundant growth of different invasive aquatic plants. Barbila beel which is an important beel of Nalbari district also received heavy anthropogenic impact and problems due to uncontrolled growth of aquatic macrophytes as (Deka et al., 2014; Kalita et al., 2019). Studies related to the aquatic floral invasion within the beel are limited. So, the present study aims to document the different species of invasive aquatic plants collected from the beel.

Materials and Methods:

Selection of the Area:

Barbila Beel is selected for this study. This beel is situated at the intersection 26.15′10″N parallel of latitude and 91.18′30″E meridian of longitude. It is about 90 kms from Guwahati and 23 kms from Nalbari town. The beel covers an area of 55 hectors which was 407 hectare earlier (Deka & Dutta, 2013). The average depth of the beel is reported 3-4 m in monsoon and 2-2.5 m during lean season (Deka & Sarma, 2014). The beel receives flood water during rainy season. In winter, 35% of the beel area is cultivated for crop production. The beel is connected to rivulet 'Narkura or Khanda Jan' through a man-made channel. This rivulet is connected to another rivulet 'Alpa' which is connected to river Burhadia, a tributary of mighty Brahmaputra. The beel is surrounded by Burhadia river, Barbila village and Helacha-Kharsutha Subway from North; Helacha-Sorabori Road, Sorabori and Barbila villages from East; Sarthebari-Tihu PWD Road, Karakuchi and Gomura villages from West and Narkura Jan (Khanda Jan), Barbila and Helacha villages from South.

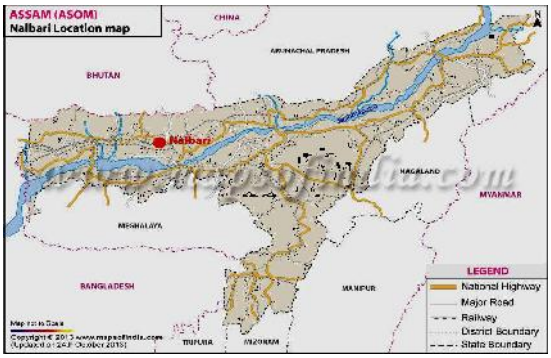

Figure: Map of Assam

Figure: Map of Nalbari district

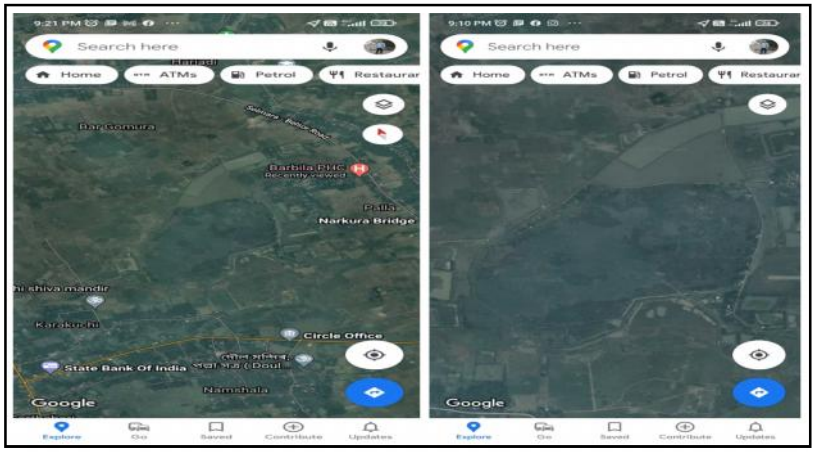

Figure: Location of Barbila Beel on Google Map

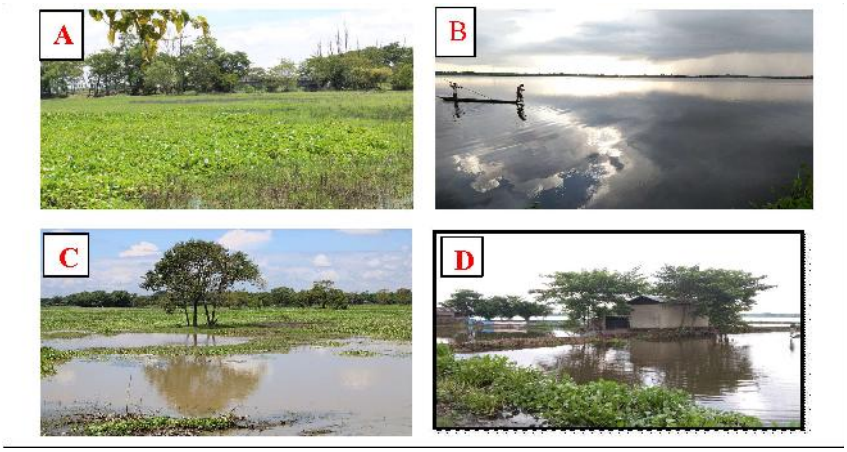

Figure A: Invasion of a part of Barbila beel by *E. crassipes*; Figure B: Barbila beel Figure C: A part of Barbila beel; Figure D: Human settlement in beel area

Collection and identification of the plant specimen:

Field survey for different invasive plant species was conducted from March, 2021- May, 2021. Within this period, the beel was visited twice in a week at morning hours. Plant species were collected from different parts of the wetland with the help of local fishermen. Before the survey, proper permission was taken from the beel management committee as well as the village head of Barbila village. Herbariums of the collected plants were prepared by following the methods described by Haynes (1984), British Columbia Ministry of Forests (1996) and Lake Stewards of Maine (2019). All collected plants were identified by consulting with the Botany Department of Tihu College, global database on invasive species (www.issg.org) and ENVIS database (www.bsienvis.nic.in). Nomenclature of the identified specimens was determined through the websites of Plants of the World Online (https://powo.science.kew.org/), Tropicos (www.tropicos.org) and the Plant List (www.theplantlist.org). Local (Assamese) names of some collected plants were also recorded during survey which also helps in identification and scientific nomenclature. Due to lack of proper monitoring and surveillance network agency for invasive species in Assam, diverse sources such as interactions with locals and fishermen (Annexure-I), field observations, review of available literature accessed from different journal sites were used for gather information as well as identification of different plants.

Results :

A total of 14 plant species were collected and identified which invade major portion of Barbila beel. The invasive nature of these species to different water bodies of India was mentioned in different earlier reports (Rai & Gaur, 2004; Kalita et al,. 2019; Pandey, 2020). The recorded plant species were aquatic and semi-aquatic in nature and belongs to 11 different families.

Table 1: Different invasive plant species recorded from Barbila beel

Serial No	Scientific Name	Vernacular Name (Assamese)	Family	Habit	Habitat	Life-Span
1.	*Alternanthera philoxeroides*	Nolduba, Pani-Kaduri	Amaranthaceae	Herb	Aquatic	Perennial
2.	*Eichhornia crassipes*	Bih-meteka	Pontederiaceae	Herb	Aquatic	Perennial
3.	*Ipomea carnea*	Amarlota, Bor-Kolmou	Convolvulaceae	Shrub	Semi-aquatic, Aquatic	Perennial
4.	*Ludwigia octavalis*	Long-bon	Onagraceae	Herb	Aquatic	Annual
5.	*Ludwigia adscendens*	Pani-khutura	Onagraceae	Herb	Aquatic	Perennial
6.	*Polygonum amphibium*	Jhal-fehu	Polygonaceae	Herb	Semi-aquatic	Perennial

Serial No	Scientific Name	Vernacular Name (Assamese)	Family	Habit	Habitat	Life-Span
7.	*Cyclosorus interruptus*	Bihdhekia	Thelypteridaceae	Herb	Semi-aquatic	Perennial
8.	*Monocharnia vaginalis*	Pani-Meteka, Deshi-Meteka	Pontederiaceae	Herb	Aquatic	Annual
9.	*Pistia stratiotes*	Bor-puni	Araceae	Herb	Aquatic	Annual
10.	*Salvinia molesta*	……	Salviniaceae	Herb	Aquatic	Perennial
11.	*Ceratophyllum demersum*	……..	Ceratophyllaceae	Herb	Aquatic	Perennial
12.	*Typha latifolia*	Maduri-bon, Mutha-bon	Typhaceae	Herb	Aquatic, Semiaquatic	Perennial
13.	*Typha angustifolia*	Maduri-bon	Typhaceae	Herb	Aquatic	Perennial
14.	*Ottelia alismoides*	Pani-kola, Sen-tepa	Hydrocharitaceae	Herb	Aquatic	Perennial

Table 2: Different families of invasive plant species

Serial No.	Families of invasive plant species	Numbers of species
1	Amaranthaceae	1
2	Araceae	1
3	Ceratophyllaceae	1
4	Convolvulaceae	1
5	Hydrocharitaceae	1
6	Onagraceae	2
7	Polygonaceae	1
8	Pontederiaceae	2
9	Salviniaceae	1
10	Thelypteridaceae	1
11	Typhaceae	2

Discussion:

Lack of proper understanding and documentation create difficulties to provide a comprehensive overview and information about the route of infestation of invasive plant species to different wetlands of Assam. Improper management, confinement of wetlands, anthropogenic activities are the major causes

of invasive plants to grow abundantly. Wetlands of Assam nurture many floral species which have positive impacts on their ecology and smooth functioning. But if these species are not managed properly their robust growth can eventually affect the hydrology, diversity and functioning of the wetlands. The invading species can be a local one or an exotic species. In both the cases, subsequent accumulation of organic debris as well as their luxuriant growth threats the aquatic environment, its productivity, diversity and area coverage of the wetland. In India, invasive plants not only cause infestation to vast tracts of agricultural and forest land but find its way to different aquatic ecosystems including wetlands. They first infested in a new environment, then undergo robust growth and multiplication, block the inlet and outlet channels, halt nutrient supply, accumulate organic debris, alter the hydrology and initiate succession. Due to rapid growth and long viability of the reproductive parts, they cover huge portion of the wetland area and gradually shallow the water body. This infestation brings hydrological alteration and outnumbered the native diversity in terms of resource utilization, space, nutrient supply and sunlight. Finally, it makes a resourceful, productive wetland into an unproductive hydrocere. The role of invasive plant species in altering the ecology, hydrology, diversity and quality of water bodies was studied by many researchers earlier (Vila et al., 2010, Zedler and Kercher, 2004; Chamier et al., 2012; Brundu, 2015). But proper monitoring and surveillance network for invasive species in India as well as in Assam is still lacking. In this study, 14 plant species from Barbila beel was recorded which invade major parts of the beel. The study on invasive plant species in three different wetlands of Assam was conducted by Singha and Kalita in 2019 where the confinement of wetlands as well as viability and reproductive potentiality of exotic plant species were the main causes of invading aquatic environment. The pioneer study regarding invasion of plants in water bodies of Nalbari district was reported by Kalita et al., (2019) where they have reported 69 invasive plant species. Their study clearly described the complete invasion of aquatic weeds in wetlands of Nalbari district and the changing characteristics of many wetlands into marshy lands. Another investigation in Nalbari district reported presence of 24 local and exotic plant species that invaded the aquatic environment of Gageli beel and altered the dissolve oxygen content of the beel (Kashyap, 2019). The report of the current study was found similar with the earlier reports. During the study, species such as *E. crassipes, M. vaginalis, A. philoxeroides, I. carnea, L. adscendens, L. octavalis, P. stratioles, Salvania molesta* were observed more as compared to other species. Among the 11 recorded families during the study, major invasive species were under family: Typhaceae, Onagraceae and Pontederiaceae. The connecting channel of the beel to the rivulet Narkura Jan is almost blocked by *E. crassipes* and *M. vaginalis*. Alteration of hydrology and its effect on water body due to blockage of water channels by invasive species was reported by Kalita et al., in 2019 where they mentioned that blockage of channels by invasive species changed the hydrological regime of the water body, making it shallow and facilitate invasion of more aquatic and terrestrial plant species. Similar effect was observed during the survey of Barbila beel where productivity and coverage of the beel has reduced due to abundant growth of many aquatic and semi-aquatic invasive plants. The beel

also received various anthropogenic disturbances, less management, dense human settlements near the beel which also facilitate growth of different invasive aquatic plants. The role of these factors in invasion by aquatic plants was described by many earlier reports (Pandey et al., 2020, Kalita et al., 2019, Singha and Kalita, 2019, Kashyap 2019, Deka and Sarma, 2014).

Conclusion:

Aquatic invasive plant species has the ability to grow rapidly and colonize a particular area within short period. It hampers normal functioning of any wetland and destroys native bio-diversity of that wetland if not managed properly. Wetlands of Nalbari district are also invaded by various invasive plant species which affect the native floral and faunal diversity. However, studies related to this are limited. The current study is a preliminary investigation of different aquatic invasive plants of Barbila beel. The study showed gregarious growth of many aquatic plant species that invaded the beel as well as blocked the water channel. This definitely affected the fish diversity as well as other aquatic diversity of the beel. Manual or mechanical eradication is needed within the beel and the connecting channel in order to minimize the risks caused by these species. In addition, proper management strategies need to adopt to reduce other anthropogenic activities on or near the beel which also facilitate growth and infestation of many invasive plants.

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ANNEXURE

Format of Questionnaire for data collection from the people inhabiting near the beel

Questionnaire (SET-A)

General Information

1. Name of the village: ……. 2. Date: ……/……../……

3. District: ……..…..…..…..…..…. 4. Name of the Respondent: ……

5. Age/Gender: …… 6. Occupation: ……

Questionnaire (SET-B)

Information Regarding Invasive Aquatic Plants

1. Name of the plant observed: ……..

2. Life-span: ……..…….

3. (A) How long the species has been observed: ……..…….

3. (B) Ocurrence, Availability: ……

4. Any problem: Yes/No…… If yes: ……

5. Reason for occurrence of the plant: ……..…….

7. Any management strategies: Yes/No …… If yes: ……..

8. Any earlier survey: Yes/No …… If yes: ……

Note:

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……

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Signature of Interviewer Signature of Respondent

Study on The Impact of Brick-kiln Aerosol on Some Toxicological Parameters in The Larvae of *Philosamia ricini* Boisd.

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Abstract

Healthy caterpillars of Philosamia ricini Boisd. were reared in the months of April-May feeding on green variety of Ricinus communis (Castor) leaves up to 3rd instar. On attaining 4th instar the larvae were divided in three groups namely Normal-Control Group-Group-I) and Experimental Groups (Group-II & III). The larvae of Normal-Control Group were reared fed on clean castor leaves and the larvae of Experimental Groups II & III were fed on castor leaves with application of ether-extract (non-polar portion) and ethanol-extract (polar portion) of brick-kiln aerosol. The treatments were done up to 3rd day or 5th instar. In tissues namely Skin, Mid-gut and Silk-Gland of both Normal-Control and Experimental Larvae the assays of lipid peroxide (LPO), protein peroxide (PPO), cytochrome P450 (CYP) and glutathione-S-transferase (GST) were done. Significant increase of LPO and PPO were observed both in these tissues on treatment. Enhanced activities of GST and CYP also been observed in treated groups. Ethanol-extract from the trapped aerosol was found to be more toxic than the ether-extract of these.

Key words: Silk worm**,** Aerosol, Peroxidation, Toxicity

Introduction:

Brick-industry in Assam is totally dependent on burning of coal to burn the bricks manufactured from clayish soil. As Dhubri district is in the lower basin of the river Brahmaputra and as it is only about 34 m above the mean sea level,[1] most of the low laying lands annually been flooded by Brahmaputra and its tributaries flowing through the district during the rainy season. So, the clay content of the soil of these lands is always rich and ideal for brick-manufacture. Brick-industries are one of the main industries of the district and there are so many such industries been established here during last few years and the number of these industries been increasing year by year. Though some of these are of permanent setups with Chimneys of recommended by the authorities concerned, it has also been observed that most of the cases bricks are burnt in shallow pits which are not equipped with any Chimney. Again, the number of the brick-industries are too more to this locality as per its area. So, the air of the district, especially in the brick-burning sites is heavily loaded with aerosols along with other polluting gases. Coal combustion

generated aerosol formation was studied by some workers and reported the attendance of 0.3-2.2 % aluminum, 0.44-3.8 % calcium, 0.01-0.13% chlorine, 0.03-1.2% iron, 0.01-0.32% potassium, 0.03-0.39% magnesium, 0.01-1.60% sodium, 0.38-4.7% silicon, 0.02-0.13% titanium, 4.1-13.7% moisture, 33-40% volatiles, 33-55% fixed carbon, 4.1-20% ash, 0.34-1.9% sulfur etc.[2, 3] Among sulfurs- 0.02-0.24% sulfate sulfur, 0.35-0.68% pyritic sulfur and 0.48-0.75% organic sulfur been reported.[4]

Philosamia ricini Boisd. is a domesticated lepidopteran insect which can be reared indoors. It is a multivoltine insect and can complete four to six cycles in a year. The larvae feed mainly on *Ricinus communis* from which they have acquired the name. After a larval period of 28 to 29 days, through five instars, when the insect is ready to pupate and starts spinning silk and goes into retreat inside the cocoon.[5] As this commercially important insect widely been reared in this locality till some years ago and not been reared today due to their high mortality during larval stage, not due to known diseases, hydrophobic sticky aerosol-dirtied host-plant leaves been be thought as the reason behind. Again, *Philosamia ricini* Boisd. is comparatively resistant species among the sericogenous insects, so been chosen to use as animal model for this study.

In intoxication free radicals including $H^{\cdot}$ and $OH^{\cdot}$ are formed which in turn bring lysis of the lipid bi-layer of the cell membrane by oxidative degradation of lipids. It is the process in which free radicals "steal" electrons from the lipids in cell membranes, resulting in cell damage. This process proceeds by a free radical chain reaction mechanism. It most often affects polyunsaturated fatty acids, because they contain multiple double bonds in between which methylene $-CH_2-$ groups lie, that possess especially reactive hydrogen molecules. This phenomenon is known as "lipid peroxidation (LPO)".[6] When these free radicals damage membrane protein the phenomenon is called "lipid peroxidation (PPO)".[7] As a result of these, the cells of tissues are destroyed. As a fundamental toxicological study the observation of lipid and protein peroxides had been done in insects too by many workers.[6, 7, 8, 9 & 10]

Glutathione S-Transferase (GST) and Cytochrome p 450 (CYP) are two main enzymes responsible for xenobiotic metabolism. These enzyme's Activity levels rise when there is toxic stress to cope up the crisis so are used as marker of toxic stress in toxicological studies.[11, 12 & 13]

This work was designed to study on the impact of brick-kiln aerosol on tissue LPO and PPO in the larvae of *Philosamia ricini* Boisd. with supporting evaluation of the activities of xenobiotic metabolism enzymes GST and CYP on treatment.

Materials and Methods:

The Aerosols were trapped from the brick-field areas of Alomgonj, Dhubri on evening hours in absorbent cotton gauges placed in an adepter (a chamber of 1L capacity made up of stainless steel sheet) fitted to a vacuum-cleaner pump. Aerosol-trapped cotton gauges were washed in diethyl ether and methanol respectively to collect the non-polar and polar parts of the aerosol. The solutions were separately kept in air tight bottle to settle down of dust particles and supernatants were air-dried and kept for treatment to the silk-worms.

Healthy caterpillars of *Philosamia ricini* Boisd. (Borduwar variety) were reared in the months of April-May 2016, maintaining temperature about 25 ± 2^0 C, feeding on green variety of *Ricinus communis* (Castor) leaves up to 3rd instar. On attaining 4th instar the larvae were divided in two groups namely Normal-Control Group (Group-I) and Experimental Groups (Groups-II & III). The larvae of Normal-Control Group were reared fed on clean castor leaves and the larvae of Experimental Groups II and III were fed on castor leaves with application of non-polar part and polar part of Brick-Kiln Aerosol respectively. For application of aerosol the leaves were cut into approximately about 1 square inch size and the aerosols are applied to these pieces maintaining a ratio of about 500 µg/g of leaf approximately. It was observed that larvae did not prefer the leaves on application of overage of (non-separated) aerosol over this amount. The treatments were done up to 3rd day or 5th instar. The tissues namely Skin, Mid-gut and Silk-Gland of both Normal-Control and Experimental Larvae (of Group II & III respectively) were dissected out and separately kept in labeled micro-centrifuge tubes. Measured amount of tissue were homogenized in fixed amount of deionized water, centrifuged at 5000 RPM at hematological centrifuge and the assays of lipid and protein peroxides were done by the measurement of molar extinction coefficient of thiobarbituric acid.[14] Centrifugation of the homogenates were done at 40,000 x g for the assays of GST[15] and CYP[16]. Total protein was also estimated in the homohenates[17] and the results of PPO, GST and CYP are converted and expressed per mg of protein.

Results:

Results obtained so far were statistically analyzed[18] with the help of Microsoft Excel and presented in the Table-1

Table-1: Shows amount of Lipid Peroxide (n mol/mg) in Skin, Mid-Gut and Silk-Gland of the 5th instar larvae of *Philosamia ricini* Boisd.

Toxicological Parameters	Experimental Silk-Worm Groups		
	Group-I Normal-Control Larvae	Group-II Larvae fed with Non-Polar Part of Aerosol	Group-II Larvae fed with Polar Part of Aerosol
Lipid Peroxide (LPO) in Skin n mol/mg	203.64 ± 0.138492	222.734 ± 0.635402 + 9.37635% *	237.88 ± 1.662348 + 16.81399% *
Lipid Peroxide (LPO) in Mid-Gut n mol/mg	183.382 ± 1.823273	216.892 ± 1.245417 + 18.27333% *	225.77 ± 1.543519 + 23.11459 % *
Lipid Peroxide (LPO) in Silk-Gland n mol/mg	172.56 ±1 .314462	197.11 ± 0.920554 + 14.22694% *	224.18 ± 0.920375 + 29.91423 %
Protein Peroxide (PPO) in Skin n mol/mg	143.87 ± 0.392084	187.35 ± 1.079106 + 30.22173% *	227.11 ± 0.758709 + 57.85779% *
Protein Peroxide (PPO) in Mid-Gut n mol/mg	143.926 ± 0.684555	164.532 ± 1.2521 + 14.31708 % *	192.274 ± 0.578443 + 33.59226% *
Protein Peroxide (PPO) in Silk-Gland n mol/mg	155.208 ± 1.049978	172.908 ± 0.380663 + 11.40405% *	194.548 ± 1.034405 + 25.34663% *
GST Activities in Skin (µmol/min/mg of protein)	0.2146 ± 0.000872	0.2354 ± 0.001568 + 9.692451 % *	0.2558 ± 0.00120 + 19.19851% *
GST Activities in Mid-Gut (µmol/min/mg of protein)	0.2346 ± 0.00103	0.2528 ± 0.0012 + 7.757886 % *	0.2728 ± 0.000583 + 16.28303 % *
GST Activities in Silk-Gland (µmol/min/mg of protein)	0.2142 ± 0.00086	0.2348 ± 0.00086 + 9.61718 % *	0.2536 ± 0.00051 + 18.39402 % *
CYP Activities in Skin (µmol/min/mg of protein)	311.52 ± 0.05831	338.06 ± 0.913564 + 8.519517 % *	355.72 ± 1.320379 + 14.1885 % *
"*" indicates Significant at p<0.001, "+…%" indicates percent increase.			

Discussion:

In this study it had been observed that in the 5th instar larvae of the Normal-Control Group (Group-I) the lipid peroxidation in Skin, Mid-Gut and Silk-Gland were 203.64 ± 0.138492, 183.382 ± 1.823273 and 172.56 ±1 .314462 respectively. On feeding of non-polar part of aerosol applied leaves the lipid peroxide is marked with + 9.37635 %, +18.27333% and + 14.22694 % augmentations (significant at $p < 0.001$) respectively from their normal-control levels. On feeding of polar part of aerosol applied leaves the Lipid peroxide is marked with + 16.81399 %, +23.11459 % and + 29.91423% augmentations (significant at $p < 0.001$) respectively from their normal-control levels.

Protein peroxidation in Skin, Mid-Gut and Silk-Gland were 143.87 ± 0.392084, 143.926 ± 0.684555 and 155.208 ± 1.049978 respectively. On feeding of non-polar part of aerosol applied leaves the protein peroxide is marked with + 30.22173 %, + 14.31708 % and + 11.40405 % augmentations (significant at $p < 0.001$) respectively from their normal-control levels. On feeding of polar part of aerosol applied leaves the protein peroxide is marked with + 57.85779 %, + 33.59226 % and + -26.6907% augmentations (significant at $p < 0.001$) respectively from their normal-control levels.

GST activities in Skin, Mid-Gut and Silk-Gland were 0.2146 ± 0.00087, 0.2346 ± 0.00103 and 0.2142 ± 0.00086 respectively. On feeding of non-polar part of aerosol applied leaves the GST activities is marked with + 9.692451 %, + 7.757886 % and + 9.61718 % augmentations (significant at $p<0.001$) respectively from their normal-control levels. On feeding of polar part of aerosol applied leaves the GST activities is marked with + 19.19851 %, + 16.28303 % and + 18.39402 % augmentations (significant at $p<0.001$) respectively from their normal-control levels.

CYP activities in Skin, Mid-Gut and Silk-Gland were 311.52 ± 0.05831, 311.42 ± 0.159374 and 313.56 ± 2.060728 respectively. On feeding of non-polar part of aerosol applied leaves the CYP activities is marked with + 8.519517 %, + 8.002055 % and + 6.659013 % augmentations (significant at $p < 0.001$) respectively from their normal-control levels. On feeding of polar part of aerosol applied leaves the CYP activities is marked with + 14.1885 %, + 14.72609 % and + 13.17132 % augmentations (significant at $p < 0.001$) respectively from their normal-control levels.

The polar-part of the aerosols is found to be more toxic to the non-polar part to the silk-worms.

Conclusion:

From this study it could be concluded that Brick-Field Aerosols may be the- threat to Sericulture industry. These may be threat to insect larvae feeding on plant-leaves; threat to Biodiversity and threat

to Life as well. As the number of brick-fields is too more to the area of Dhubri district it may be advised to minimize the number by engaging the people concerned with other means of livelihood and generating awareness among people, otherwise law and legislation will not be able to mitigate the problem.

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Study of environmental degradation in three wetlands of Goalpara District, Assam

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Abstract

A study was carried out in three wetlands namely Kumribeel, Urpodbeel and Hasilabeel of Goalpara district (Assam) during the period from September, 2019 to April, 2021. The main objective was to investigate the major threats causing environmental degradation of these wetlands. Information were collected both from primary and secondary sources. The various anthropogenic threats observed in the wetland were dumping of coal in the peripheral area, use of pesticide and fertilizers, construction of brick industry, construction of personal ponds in the wetlands, use of beel area for agriculture, overexploitation of fishes, use of unsustainable fishing gears particularly during breeding seasons, heavy macrophyte infestation, construction of house, dumping of municipality waste etc. Water spread areas of the selected beels are gradually deceasing along with shrinkage of total land area. Due to the various threats and decrease of water spread area, fish faunal diversity of the wetlands is constantly decreasing. It is the need of hour to conserve these wetlands from human encroachment and steps should immediately be taken for their restoration.

Key words: Degradation, threats, wetlands, Goalpara, Assam

Introduction:

Floodplain wetlands locally known as *beels* in Assam, form an important fishery resource and plays an important role in boosting the rural economy of the state. Besides, wetlands help in reducing flood intensity by storing surface water and provide habitats for diverse life forms. They trap pollutants and can remove toxic residues. Assam has a total area of about 100000 hectare of *beel*s constituting approximately 61% of the total lentic water bodies of the State. There are about 1392 enlisted *beel*s in Assam of which 423 are registered and the remaining 969 are un-registered (Sugunan and Bhattacharyya, 2000). Goalpara district of Assam situated in the lower Brahmaputra valley has 299 natural wetlands/ waterlogged areas covering 33,221 ha. of total wetland area. There are 44 lakes/ponds (locally called *beels*) covering 2,339 ha, which is about 7.04 % of total wetland area of the district (National Wetland Atlas, Assam, 2010).

Sustainability of wetland ecosystem is necessary for various important functions such as food storage, water quality continuation and providing habitat for different species of flora and fauna (Deka et al., 2011). But, the conditions of most of the wetlands have deteriorated due to increased population and anthropogenic pressures. They are under threat due to various natural and man-made causes which needs to be managed properly. Therefore, there is an urgent need to formulate suitable conservation

and management strategies for sustainable development and optimum utilization of the *beels*. Keeping this in mind the present study was undertaken to highlight the causes and consequences of threats pertaining to three wetlands of Goalpara district so that proper conservation measures could be formulated.

Materials and methods:

Study area:

The geographical location of Goalpara district is between latitude 25°53¹ to 26°30¹N and longitude 90°07¹ to 91°05¹E and situated on the south bank of the river Brahmaputra. The district is bounded by West and East Garo Hill districts, Meghalaya on the south and Kamrup district on the East, Dhubri district on the West and mighty river Brahmaputra all along the North comprising a total area of 1,824 sq. km. The wetlands are located unevenly in the district but concentration is more near the Brahmaputra River. There are 11 registered and 64 unregistered *beel*s (Kalita, 1999) in the district. The notable *beel*s are Urpod, Hasila, Kumri, Saitara-Naitara, Dhamar-Risan, Sidli and Sekcheki (Alam, 2016).

The Kumri *beel* of Goalpara district lies between 26°14'N latitude and 90°13' E longitude. It is a natural wetland covering an area of about 200 hectare. The wetland habours large numbers of aquatic flora and fauna including varieties of migratory birds. Urpod *beel* is riverine wetland located at 26°05'05"N to 26°06'45"N and longitude 90°34'08"E to 90°37'45"E with an area of about 1000 ha. This wetland has already been included in wetland directory (Scot, 1989) due to its aquatic avifaunal diversity. The third wetland i.e. Hasila beel is located very near to the Goalpara town at $26^{0}15$'N latitude and $90^{0}14$'E longitude. It is also a riverine wetland, considered to be dynamic system in which aquatic plants and animals not only interact but also influence the habitat profoundly.

Methods of study:

The study was carried out in the three wetlands during the period from September, 2019 to April, 2021. To investigate the causes and consequences of degradation of the wetlands, information were collected both from primary and secondary sources. For primary data collection, a survey schedule was prepared and relevant information were collected from the fishermen engaged in the three selected wetlands. A semi-structured questionnaire was prepared following the methodology of Hargreaves and Seale (1981) and Kishi et al., (1995) with minor modification. The beels were visited at every alternate month to collect all the ground level data on degradation. The respondents were from the neighboring villages of the beels, who mostly belong to the fishing community. They are totally dependent on these water bodies for their livelihood. Secondary data related to fish production, fish diversity, water spread

area etc. were collected from various published documents like research articles, Government websites, survey reports etc.

Results and discussion:

Wetlands are the precious part of our cultural and natural heritage, providing and extremely important resource for many human interest and activities, as well as habitats that support a rich diversity of animal and plant life. In the present study, all the three wetlands are under serious threats due to various natural and anthropogenic factors. The major threats prevailing in the studies wetlands are summarized in the table 1.

The Kumri beel witness the natural threats such as siltation, decomposition of the organic matter in water and sediments by rain and sewage run-off during monsoon season. The other anthropogenic threats prevailed in this wetland are dumping of coal in the peripheral area, use of pesticide and fertilizers, construction of brick industry, construction of personal ponds in *beel* area, use of *beel* area for agriculture, over-exploitation of fishes and fishing during breeding seasons. These threats cause degradation of water quality of the *beel*. The human activity on the *beel* has increased due to the rise of population which has caused destruction of the natural ecosystem. Water pollution resulting from dumping of garbage, dumping of coal in the near by areas (Jogighopa), drainage of sewage and waste product, surface run off carrying pesticides and fertilizers from the nearby crop fields, pollutants from the near by brick industries etc. are matters of serious concern for the diversified organism of the *beel* (Nath et al., 2010). Common impacts of coal residue drainage include low dissolved oxygen, higher sulphate content and turbidity which affect the aquatic life and reduce fish diversity to a great extent (Mylliemngap and Ramanujam, 2011). According to the fishermen, the fish diversity has now been decreased in an alarming rate. However, a total of 49 fish species were recorded from this wetland by Das et al., (2020).

Sl. No.	Major threats	Occurrence		
		Kumri*beel*	Urpod*beel*	Hasila*beel*
1	Dumping of garbage	-	-	√
2	Construction of house	-	√	√
3	Dumping of coal	√	-	-
4	Drainage of sewage		√	√
5	Use of Pesticide & fertilizer	√	√	√
6	Construction of brick industry	√	√	-
7	Construction of pond	√	√	√
8	Farming (piggery) activities	-	√	-
9	Macrophyte infestation	-	√	√
10	Conversion to agriculture land	√	√	√
11	Overexploitation of fishes	√	√	√
12	Fishing during breeding season	√	√	√

Table 1: Major threats observed in the three *beel*s of Goalpara district, Assam

It has been observed that the size of Kumri *beel* is gradually shrinking due to the conversion of the land into agricultural land. Bhattacharyya (2016) reported the similar trend in some wetlands of Goalpara district. He also reported the fish production of this *beel* in the session 2012-13 was 46,666 Kg, which was decreased to 36,666 Kg in the next session (2013-2014). At the same time water spread area is also decreasing day by day due to the man made threats. This might eventually hamper aquatic biodiversity of the *beel*. Degradation of a wetland has a direct impact on the fish production. According to the fishermen, the overall fish production of the *beel* has been reducing in an alarming rate.

In the Urpod beel, the major anthropogenic threats are encroachment for various purposes like construction of house, drainage sewage, use of fertilizer and pesticide, setting of brick industry, construction of personal ponds, piggery on the bank area, heavy macrophyte infestation, wetland used for agricultural activity, increased fishing activity and wanton fishing during breeding seasons. At the periphery of *beel*, people are constructing pig farms, personal ponds etc. occupying the *beel* area causing shrinkage of the actual *beel* area. The pollutants from brick industry and pesticides from the nearby agricultural practices directly flow in to the water body degrading its water quality causing a hazardous environment for the aquatic flora and fauna. Most of the *beel* areas are used for paddy cultivation. The inflow of inorganic fertilizers from the adjoining paddy fields has resulted into eutrophication in the *beel* which is harmful for the aquatic organisms thereby hampering the function of the ecosystem.The pesticides ranging from high to extremely hazardous categories like Organochlorides, Organophosphates and Carbamates have been used by the farmers of the neighbouring villages. The inhabitants of the nearby villages ofthe wetlands namely Urpod and Kumri apply pesticide and chemical fertilizer in agriculture which may cause severe degradation of these two wetlands. The amount of fertilizer used in cultivation by each family varies from 10-100 kg in the Kumri and Urpod wetlands (Kalita, 2020).

The brick industry growing at the embankment area of Urpod *beel* might be the reason of reduction of water spread area of the *beel* gradually. It is seen that the *beel* had 71.9% water spread area in 1978, which was left with only 29.8% of water spread area in 2014 (Bhattacharyya, 2016). Forest cover change in the adjoining reserved forests has also resulted into siltation in the wetland causing decline of the water depth also (Saud et al., 2012). Apart from these, heavy infestation of aquatic macrophytes (*Eichhornia* etc.) also posing threat to the *beel*, which may reduce the productivity rate. Moreover, increase in human settlements has increased the rate of dumping of domestic garbage into the *beel* affecting the natural condition of the wetland, thus becoming a major threat to its diversified organism. Thus, rapid urbanization, industrialization, intensification of agriculture along with irrigation and such other anthropogenic activities placing a great demand on water availability in the wetland, water area and degradation of water quality resulting in fish depletion is a fact (Das et al., 2012; Deka et al., 2005).

Figure 1 (A – J): Photographs of some threats observed in the wetlands, **A**- construction of brick industry (Urpod), **B**-construction of personal house (Urpod), **C**-Fishing during breeding seasons (Urpod), **D**-Paddy cultivation in Urpod*beel* area, **E**-construction of personal pond (Urpod), **F**-A view of Urpod*beel*, **G**-Agriculture activity in Hasila*beel*, **H**-Macrophyte infestation in Hasila*beel*, **I**-construction of house at the centre of *beel*, **J**-pond construction at the periphery of Hasila*beel*.

The Hasila *beel* of Goalpara district has been facing numbers of man made threats causing shrinkage of the *beel* area as well as depletion of fish production. Most of the areas of the *beel* are now occupied by human and used for agricultural activities. Only a small fragment of this wetland remains as *beel* at the centre. The major threats are human encroachment, construction of house, construction of personal pond, heavy load of macrophytes, over-exploitation of fish resources etc. It may mention that the *beel* is a dumping place for municipality wastage by the Goalpara Municipality Board posing serious threats to the aquatic biota of the wetland. According to Bassi et al., (2014), the freshwater bodies are often subject to changes in land use in their catchments leading to reductions in inflows and deteriorating quality of the run-off traversing through agricultural fields and urban areas. This wetland is very near to the Goalpara town and all the sewage of the town area flowing to the *beel* through all the channels causing high organic load to the *beel*. It results eutrorphication, which might also be the reason for less production of aquatic resources. Apart from these, wanton fishing activities and use of unsustainable fishing gears are also the reason for gradual depletion of fish diversity in the *beel*.

Recommendations:

- Management activities should be planned and executed with community participation through a local Implementation Committee including traditional fishers, landless laborers, farmers, local leaders and professionals, etc.
- There should be participatory planning with villages around the *beel* to identify problems and work out possible solutions, particularly conservation measures with the least potential for adverse impacts on the existing social relations.
- Encroachment of the *beel* for cultivation and other purposes should be recovered from the people through cordial discussion, providing alternative land to the encroacher.
- Protection of existing aquatic resources of the *beel* through community participation, resting shed and watching tower can also be constructed to make the *beel* (Urpod and Kumri) as recreational site or tourist destination.
- There should be restriction in use of unsustainable fishing gears in the wetlands particularly during the breeding seasons.
- Dumping of municipality waste into the wetlands should immediately be stopped; drainage system linked to the wetland should be diverted taking other suitable measures.

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Impact of Environmental Pollution on Animal Health: A Review

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Abstract

Environment is the sum of all those conditions which affect the life of an animal. Ignoring the influence of geographical factors in human life is a serious problem to make a mistake, but in the interpretation of any situation, it is an equally big mistake to demand the most effective geographical factors. Environment affects the life as well as development of living organism. A large portion of contaminants like and particulates are commonly poured in the air which makes air polluted. The pollutants existing in the air are in the form of dust, frostier, fog, volcanic, radiation, and changing climate and other human activities make effect on living organism. Number of studies have proved that sudden increase of air pollution have loss wild life and forest fire damaged living organism with huge immense. Even uncertain optical and plastic make water polluted which harms living organism under water and it's surrounding. Too much use of pesticides damages food system of animals. This paper reviews the effects of chemical, physical, and biological pollutants on the environment which later have direct and indirect effect on health related diseases of animals. Environmental pollution has negative impact on biodiversity hence, proper and structure plan as well as activities is must to prevent harmful hazards and to save living organism.

Key words: living organism, Environment, pollutants, pesticide, contaminant.

Introduction:

Environment is a complex term that forms a range of physical and chemical factors and their combination. Air, water, and land are the basic physical aspects of nature and its environment which provide the basic needs for assisting human organism. The fact that retort to these physical conditions by living organism is unequal as environment is polluted by living organisms. Today we are passing through the most transition period of environmental insecurity and pollution. Therefore, a thorough study on environment is need of the hour. Environment is nothing but the nature given around us. Hence, all that affects and surround living organism is called environment.

Nature has given us a healthy, beautiful and sweet environment which creates life. The passion of our aspirations has sharply changed the way of living in a natural way, as a result of which the environment provided by nature has been affected and monstrous problems have arisen in front of us. The life of sea creatures has become difficult due to the mud brought by the rivers. There has been a shortage of clean water for us and it has also become difficult for us to live the necessary organism, which provides an important role in the fulfillment of our food requirement.

The interference of nature by man was not seen as a destructive process on nature until the end of the 19th century. But in the twentieth century, the inter relationship of man and the earth was made the central subject of their study by society ideas and scientist and the development of environmentalism as a systematic discipline and the need to judiciously combine the inter relationship of nature.

Pollution:

The word 'pollution' is derived from the Latin word 'polluere' which means to soil or defile. (Mahendra Patel, et al., 2018).

Pollution is defined as the human alternation of physical or chemical characteristics of the environment to a harmful degree to the living organism. Some forms of pollution exert a destructive effect on human, animal, plants, wildlife by impairing the health of the individual. (Ahmed, D.E. 2007).

'The presence of a substance in the environment that because of its chemical composition or quantity; prevents the functioning of natural processes and produces undesirable environmental and health effects.' (EPA, 1992).

'Pollution' is generally considered as an extension of substances; it implies that environmental harm will, or might, be caused by the contamination. Furthermore, pollution is typically associated with human activity related to substances and other chemical forms.' (John Rieuwerts, 2015).

Environmental Pollution:

'Environmental Pollution is defined as the contamination of air, water or food in such a manner as to cause real or potential harm human health or well-beings, or to damage or to harm non human nature without justification'.(Peirce, Weiner, and Vesilind, 1998)

Environmental pollution is the bringing about unwanted changes in the equilibrium state available between nature and the organism for the development of life, whether by any unwanted factors.

Pollutants and their Sources:

A pollutant is a substance that is produced by the use of things in an undesirable form. For example the discarded material of the things used by human being is called pollutant. This material is either thrown away or drowned. In the future, it makes a serious attack on the environment.

On the basis of origin, pollutants can divide into two categories: natural pollutant or man-made pollutant.

Under natural pollutant, the damage caused due to the physical causes by which nature itself tries to repair by its own system and such changes are also corrected gradually. Whereas under the second, extremely dangerous regions are born in solid, gas, and liquid form of discarded material from man-made objects. It is fatal because it destroys the self-control system.

Types of Environmental Pollution:

1. Air Pollution
2. Water Pollution
3. Sound Pollution
4. Soil Pollution
5. Radio Active Pollution
6. Electro Magnetic Pollution
7. Social Pollution

The mentioned types of environmental pollution have both natural and man-made indulgence within them. They have direct or indirect impact on living organism, especially on animal health.

Impact of Environmental Pollution:

Environmental pollution has significant impact on living organism, including health and physiology of human beings, animal beings, plants and other natural resources. Pesticides, heavy metals, fluorine, and other agro chemical are the major cause of environmental toxicity, which affects living individuals and organisms on the planet. (Ahmed, D. E. 2007)

Mahendra Pal and his colleagues (2015) in their study have shown different harmful pollutants like prenatal disorders, infant mortality, respiratory disorders, allergy and likewise which reflect direct or indirect impact on animal health. Likewise, reinforcing the impact of water pollution on Marine life, the CMS COP 11 conference meeting (2014) estimated huge amount of litter are lost or discarded every day that remain Marine debris revealing widespread water pollution. The meeting further reported that around 2.5 trillion pieces of plastic debris are in the ocean and this number of debris is harmful to animals living under water as they cause injuries, or blocking their digestive systems.

According to Swarup and Patra (2005), studies in India and Indian sub burn have highlighted loss of domestic and wild life due to urbanization, industrialization, and indiscriminate and improper use of chemical such as pesticides and drugs have resulted in increased contamination and degradation of environmental leading to adverse health effect on living being and problems associated with residues in food of animal in origin. They further also added due to the process of modernization and changes in living, have imparted different environmental issues which made significant impact on living organism, especially, animals. The deleterious health effects may be observed in the form of overt clinical signs and higher morbidity and mortality or as subtle or subclinical effects.

Caterine Armstrong (2017), studied about the direct impact of environmental pollution on animal health. According to her in this case of pollution, animals are directly affected most commonly by synthetic chemicals, oil, toxic metals, and acid rain. Having reference to Marine Bio.org, she further added that oil spills affect wild life in ocean instantly, with a very large death toll. Immediately after the Exxon Valdez oil spill, more than 100000 sea birds died, along with more than 1000 sea otters. At least 144 bald eagles are known to have died as well. The oil pollutes not only affected life in water but also plants and other lives on beaches. This statistical analysis of Catherine indicates that direct pollution and its pollutants have major impact on animal health and in most circumstances, took lives of animals.

Many domestic and wild animals have natural instinct and behavior to protect themselves against environmental hazards like grazing, remunerating generally reject harmful plants, horses excrete in certain areas, which they avoid for grazing and dog instructively vomit to protect themselves. Birds are usually sensitive to odorless coal gas and other air pollutants in coal mine. Other animals and individual like Pleasants, fish and other birds do have sense of occurring and use to change their way. Even after, different pollutants and their existence in water, air and in surrounding cannot be detected by these lives and are clutched. (Anon, 2012).

R Van den Hoven (2011) in his study, "Air Pollution and Domestic Animals", has narrated different animal practice and their breathing ratio along with pollution impact. According to him, horse in rest time hours use to take 60-70 L breathes per minute. But during a race, the ventilation rate of horse increases up to 1800 L/ min. with this huge amount of air moving in and out the respiratory track, large quantities of dust particles are inhaled and may sediment in the airways. This large amount polluted inhaled air by the horse affects lungs and its function. Horse is domestic animal and is kept for different purposes. Horses and their stables are next to men houses and residents. Though tobacco smoke and other respirators have no direct impact on horses breathing, but have chances for respiratory diseases as horses are kept in stalls and other chorine. Besides, horses in New Zealand have less impact of respiratory dieses as they are kept in open places. This shows that human existence as well as dwelling of horses in stables and stalls makes impact on their respiratory due to air pollution.

Heavy metals pollution of the environmental is a serious problem in most countries of the world. Various anthropogenic activities, such as burning of fossil fuel, mining metallurgy, industries and transport redistribute toxic heavy metals into the environment, which persist for long period and translocate to different components of the environment including biotic segment. These toxicants accumulate in the vital organs, including liver and kidney, and extent adverse effect on animal individuals. (Abu-Arab, A.A.2001).

The use of synthetic chemicals to control pests, principally insects, weeds, and fungi became an integral part of agriculture and disease control after World War II. These chemicals had their credit as they served inexpensive means for increasing crop product and preventing spoilage in stored food items and grains. Later, pesticides like aldrin, dieldrine, heptachlor, and chlordane have been detected for their implementation in farms and for farm animal products including milk, meat, and other uses in India. Pesticides though are useful for production but are harmful for animal growth, production and immune disease. (Kathpal, et al., 1994).

Conclusion:

The standard of living life on the planet is related to the standard of atmosphere and solid environment around the living organism. All kind of living organism have direct or indirect impact of pollution either in air, or in water, or in land or soil and other factors. Human being since his intellectual implementation always attempted to overcome the nature and for his development and development of his society and country, he made number of inventions in the form of industrialization and modernization. Consequently, industrial pollution and other forms of environmental pollutions challenged sustain and to cope with environment. Environmental pollution including pesticides, poisoning, chemicals, plumbs, dust, sound, rain with sulfur have posed serious health problems for domestic and wild animals. Healthy life is a mean to survive and live happily for both human and nonhuman living individuals. What hazard is unnecessary use of chemicals, pesticides, and other factor causing environmental pollution. Present knowledge is sufficient to think and make action and needs stronger foundation and planning

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A study on Role of certain NGOs of Assam, India in protection of Environment and its various challenges

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Abstract

Presently, environment and its protection are the most commonly discussed topics for the wellbeing of all the living beings including human. The simple meaning of Environment is the physical surrounding of any living organisms, i.e., the interaction of biotic and abiotic factors in certain habitat. Our environment has been degrading gradually due to various natural and man-made causes, like volcanic eruption, UV-ray radiation, flood, deforestation, urbanization, globalization and various pollutions. However, for a healthy wellbeing of human, a stable environment is very necessary. Hence, it is a challenge for the human civilization, as we need development as well as wise utilization of the natural resources. It is realized that changing values of the society leads to extensive utilization of the resources, which is harmful for the health of our environment. Therefore, the term "sustainable development" is evolved, in which a balance is maintained in economic and social progress with a concern for the environment. It is the responsibility of every citizen to protect and value our environment. Ignorance, lack of environment education and awareness, greediness, failure to visualize the consequences of any developmental activities related to unscientific assessment are the hindrances in the path of environment protection. It is observed that various NGOs have been working together to overcome these challenges in Assam for the protection of environment. Therefore, this topic is selected to focus a few successful case studies of NGOs in the field of environment protection and the challenges, they are facing while working in this field. It is observed that the NGOs like Aaranyak, Nature's Foster, Nature's Beckon, Manas SouchiKhongor Eco-tourism Society, Manas Bhuyanpara Conservation Society, Manas Agrang Society, Kaziranga Wildlife Society, Early bird have been working for the protection of environment as well as helping to create connection between the local community and government. These NGOs are using various conservation practices in different environmentally threatened areas and are able to restore the environmental condition of those areas. In spite ofthe challenges like community non-cooperation, lack of fund, damaged roads, threats to life from various sources, these NGOs have beencontinuing their relentless efforts for social and environmental justice along with the protection of environment, including flora and fauna.

Keywords: Environment degradation, NGO, Sustainable development, Conservation.

Introduction:

Environment is the physical surrounding of any living organisms, i.e., the interaction of biotic and abiotic factors in certain habitat. Any unwanted changes of the components of the environment leads to deterioration of the quality of environment, resulting various health hazards to living organisms, including human being. Our environment has been degrading gradually due to various natural and man-made causes, like volcanic eruption, UV-ray radiation, flood, deforestation, urbanization, globalization and various pollutions. Rapid development process, which is ultimate goal of nation's prosperity, causes serious threat to environment. Although, urbanization, industrialization, globalization, green revolution

etc. play a very crucial role in economic development of a nation, adverse impact of these phenomenon cannot no be repaired without proper planning. In order to meet up the scenario, various organizations (Government and Non-Government), educational Institutions, research organizations etc. are working together for exploring proper planning for sustainable development. The term "sustainable development" is evolved, in which a balance is maintained in economic and social progress with a concern for the environment.

Educational Institutions play a great role in prescribing syllabus on various environmental issues and help indeveloping scientific temperament in student's minds. Governmental organizations as well as Non-Governmental Organizations (NGOs) also play a pivotal role in conducting various research activities for sustainable development and helping in policy making. Most of the NGOs are also working as an in term ediatory among government and society. A number of environmental NGOs and institutes like International Institute of Health and Hygiene (IIHH), The Energy and Resource Institute (TERI), Wildlife Protection Society of India (WPSI), Orissa Environmental Society, Wildlife Trust of India (WTI), Indian Environmental Society (IES), G. B. Pant Institute of Himalayan Environment and Development, Centre for Environmental Studies (CES) etc. are working on various environmental issues. These organizations are working on the issues like health and hygiene, energy and resources, to combat various pollutions like air, water, air, wildlife and forest, illegal wildlife trading, natural environment, Wildlife protection, Environmental education, Climate change, Ozone layer depletion, Biodiversity conservation and solid-waste management etc.

There are various reasons for environmental degradation. In a very nutshell, ignorance, lack of environment education and awareness, greediness to fast harnessing of natural resources, failure to visualize the consequences of any developmental activities related to unscientific assessment are the hindrances in the path of environment protection. It is observed that various NGOs have been working together to overcome these challenges in Assam too for protection of its' environment. Therefore, this topic is selected to focus a few successful case studies of NGOs in the concerned environmental field and to address the challenges they are facing.

Objectives of the study:

1. To find the activities of NGOs towards environment protection and conservation.

2. To find the difficulties of NGOs that faced during their activities.

Methodology:

Descriptive survey method is used by the author at the time of study as well as secondary sources like Newspapers and different journal papers are used during the data collection.

Fundings from literatures and discussions thereon:

NGOs from different corners of world play a very significant role in environmental protection and conservation. It is observed that after Stockholm Conference in the year 1972, the formation and activities of NGOs are significantly increased to deal with the issues of environmental protection and conservation. More than thousand NGOs participated in the Earth Summit, 1992, reflects the activities of NGOs in worldwide with a goal to save mother earth from various devastations. Gradually numbers of NGOs in national and local level are increasing worldwide to focus on environmental protection and conservation by initiating various scientific methodology (Bhattacharjee J., 1993). At present more than 3.3 million NGOs are recorded in India in 2009, working on various education and environmental welfare activities (Shukla, 2010). A few of them are doing exceptional works in the field of environment and few of them are passive for a prolonged period of time.

Assam records 152 NGOs (according to the directory of Centre for Environment Education, North East), which are working on environment protection. Out of them, 9 NGOs are solely concerned with environment while the others (about 143 NGOs) are working on environment protection as only one among a range of other activities they are concerned with. According to the Directory of NGOs on environment of World-Wide Fund for Nature (WWF), Assam records 66 NGOs which are engaged in environmental protection, 58 of which are registered societies and 2 registered as trusts (Bhattacharjee J., 1993). The NGOS are located all over the state and some of them are extending their activities outside Assam and the North-east.

It is very difficult to discuss all the activities of NGOs in Assam, therefore a few prime NGOs are selected purposefully for the study.

Aaranyak, Assam:

Aaranyak is a leading NGO of Assam, working on conservation of biodiversity in Northeast India through research, environmental education, capacity building and advocacy for legal and policy reform to usher a new era of ecological security (aaranyak.org). It works on preservation and restoration of ecological balance within N.E. India with their expertise knowledge in the field of ecology and wildlife as well as by creating awareness on ecological balance in the community level. The activities of the NGO's expand to all the sectors of the community likewise students, researchers and general public. Their activities focus on wildlife security, elimination of illegal trade on wildlife comprising floras and faunas of the region and sustainable development in the rural areas adjacent to the National parks, National sanctuaries, reserve forests and important rich biodiversity areas. Aaranyak is such a wonderful NGO, where peoples from different professional like scientist from life science, veterinary as well as lawyers and field workers consisting of students, local youth are gathered together for protection and

conservation of wildlife. They are working on various projects related to wildlife conservation and education in collaboration with various funding agencies, educational institutions and government. Aaranyak has various research projects in different aspects of biodiversity in the region,such as project on north east threatened species, community-based project for general awareness and sustainable development. It conducts various trainings and workshops for youth capacity building in the field of wildlife and provides legal guidance to the forest officials working in the wildlife sanctuaries and national parks of Assam. The organization has been working in various national parks of Assam in different aspects, such as in Kaziranga national park for elimination of rhino poaching, Manas national park and Nameri Wildlife Sanctuary for animal conservation and for save forest land from encroachment (aaranyak.org).

Aaranyak has published many research articles, books, guidebooks and educational materials to enrich knowledge in the field of wildlife in Northeast India and to create awareness and ethical sense to all spheres of society. The organization has recently installed 18 km of solar-powered fence to facilitate human-elephant coexistence at Nagrijuli in Baksa district, which will ensure food security and commendable reduction in incidents relating to humans and elephants and will also benefit approx 12 villages with 35 hamlets and 15000 villagers (NORTHEAST NOW. 7th Feb, 2021).

Aaranyak has successfully performed captive breeding of the Greater Adjutant Stork *(*Hargila*)*, an "endangered" bird according to International Union for Conservation of Nature (IUCN), *in* collaboration with the Assam State Zoo. Aaranyak had been awarded with many regional, national and international awards in recognition of its excellent activities in the field of wildlife, such as "Indira Gandhi Paryavaran Award" from MoEFCC, Govt. of India in year 2012, "Best Scientific Institution in Assam" under the category of "State Awards for Scientific Excellence, 2017" by the Science & Technology Department, Government of Assam in year 2017. This organization is also recognised as a Scientific and Industrial Research Organisation (SIRO) by Department of Scientific and Industrial Research, Ministry of Science and Technology (*NORTHEAST NOW. 9th Sept, 2020).*

Nature's Beckon:

This NGO came into existence in the year 1982, established by Soumyadeep Datta and has been working in the field of conservation of wildlife, awareness creation, environmental education, scientific research and documentation and socio-economic development of the forest fringe villages). Habitat conservation is the main focus of the NGO and it is reported that existence of golden langur (Presbytis geei) in the hill reserves of Chakrashila was discovered by this organization (*Datta, Soumyadeep, 1998, Ghosh, Tapan, 1993, Nature's Beckon*. Retrieved 7th Sept, 2020, *Status Survey of Endangered Species-Report 1". ZSI, 1994, WildTrails Recent Sightings | The One-Stop*

Destination for all your Wildlife Travels. 23rd sept, 2017). The organization plays an active role in Chakrashila Wildlife Sanctuary Movement and the Rain Forest Conservation Movement of Assam, Dehing Patkai Wildlife Sanctuary (*Ashoka International Website,* Bhattacharjee J., 1993,Datta, Soumyadeep Datta, 1996, 2003, *Nature's Beckon,* Retrieved 7th sept, 2020, *Rainforests of Assam. Nature's Beckon. 2013, Sage Publications. 1998, Wolvekamp, Paul, 1999),* Community participation in the field of wildlife conservation, afforestation, creating awareness among the people, environmental education and belonginess to nature are the few objectives of the organization (https://en.wikipedia.org/wiki/Nature%27s_Beckon).

Nature's Foster:

Nature's foster is one of the leading NGO of Bongaigaon district of lower Assam, established in the year 1991. It has been working towards environmental protection and conservation with the involvement of local youth and community participation. The organization has been working diligently for restoration and conservation of environment by initiating afforestation movement, applying scientific approach towards the biodiversity conservation, motivating students of various college and schools towards environmental conservation. The main focus of the NGO is to promote and practice of the principle of "BETTER WORLD" for the coming generation. The organization has been recently engaged in forest conservation, wetland conservation, capacity building of the youth towards sustainable development, community development and participation. Nature's foster has been playing an important role in providing training and guidance to educate and aware students community and local people on different aspects of environmental protection and conservation, conservation of endangered species and to deal with various factors related to mitigate the human-wildlife conflict. Conservation of Golden langur of Kakoijana reserve forest is one of the success stories of this organization. The organization has great contribution in Water bird survey of wetland of lower Assam (https://naturesfoster.org/). This organization has been also working on various issues of Manas National Park by forming alliance with other organizations, such as Green Forest Conservation, Kokrajhar, Biodiversity Conservation Society, Ultapani, Kokrajhar, New Horizon, Koilamoila, Ecotourism and Social Welfare Society, Kaklung, Chirang. Nature's Foster organized "Manas Biosphere Conservation Festival" in the year 2005 at Ultapani, to initiate nature and community interaction and livelihood protection of the community adjacent to the protected areas (Bhattacharjee J., 1993).

The organization has completed many major projects on different aspects of environment conservation in collaboration with BRPL, Bongaigaon, Rotary Club of Bongaigaon, Salim Ali Conservation of Nature and Natural History (SACON), Ministry of Environment and Forest, Government of India, Margot Marsh Biodiversity Foundation, USA, U S Fish & Wildlife Service etc (https://naturesfoster.org/projects/).

Environ:

Environ is one of the pioneer organizations of Assam, founded by Dr. Amarjyoti Kashyap in the year 2003 to deal with solid waste management in urban areas, basically working with an aim to convert waste to wealth for sustainable development. Environ has been working for conservation of environment through scientific management of solid waste and trying to create a pollution free environment as well as to promote organic farming. The organization is also actively working on biodiversity conservation through habitat restoration and community conservation initiatives and also importance is given to water, sanitation & health education for healthy environment by organizing awareness programme and also initiated to promote eco-tourism and other village-based industries for economic development (https://environ.org.in).

Green Heritage:

Green heritage is another frontline NGO working in the field of conservation of wildlife, Environmental Education, Research and Awareness creation since its beginning, 1995. The organization has been working for preservation and restoration of natural heritage in the NE India through scientific research and by involving people from the community. It also raises its voice for the protection of indigenous and forest dwelling people. This organization has an expert group in the various fields of biodiversity like plant, orchid and wildlife biodiversity research, indigenous fish biodiversity research, wetland and bird census, agro-biodiversity, environmental impact analysis of river dam etc. (https://sites.google.com/site/greenheritageassam).

Kaziranga wildlife society:

Kaziranga Wildlife Society, oldest NGO in the NE India was formed in the year 1969 for the protection, preservation and promotion of wild life habitat of kaziranga national park and other important wildlife habitat of NE India along with the protection of its fringe villagers. The organization is actively engaged in various research works in different issues related to wildlife conservation. It has published numerous articles, news bulletin and other popular write up to create awareness on environment conservation (http://www.kazirangawildlifesociety.in/section/about-kws).

Apart from the above-mentioned NGOs, there are many other NGOs,which are working for holistic developmental activities for environmental protection and conservation. Few of them are: Early Bird, CEE (Centre for Environment Education, North East), Aranya surakhya somiti, Green society, Assam wildlife rescue and research organisation etc. All these NGOs are working on environmental protection, conservation, and awareness and issues like waste management, pollution, livelihood and sustainable development, disaster management, wildlife protection and habitat restoration, income

generation, protection of indigenous localities (livelihood and culture), conservation of rare and endangered species have been addressed by these NGOs. These NGOs are also helping the government and concerned department in framing policies for environment protection and implement of various programmes for the conservation and sustainable development (Mundhe, 2021).

Most of the environmental NGOs have Role in protection for the environment. The NGOs creates a worldwide network interacting with governments and internal inter-governmental organisation in shaping International environmental policies (Mundhe, 2021). These are working on various aspects of environment protection and conservation, such as:

1. Creating awareness among the public on current environment issues and solutions.
2. Community participation on different environmental issues.
3. Solid waste management and technology development for waste recycling.
4. Afforestation and habitat restoration
5. Sustainable development by managing natural resources,
6. Information sharing by publishing guidebook, newsletter, bulletin, articles and journals in vernacular medium to reach all category of people.
7. Livelihood protection
8. Bioenergy generation
9. Biodiversity conservation
10. Capacity building through organizing workshop, training on various environmental programmes.

Problems faced by the NGOs:

It is observed from the reports of the different NGOs that all are working sincerely with their own objectives for the sake of environment protection and conservation by adopting various indigenous as well as newly developed technology. These organizations are facing various unwanted issues during their activity. These are:

1. Lack of community support: For successful restoration of a habitat, community participation is must and if the NGO is familiar with grassroot level infrastructure, then it can fully support that

system. But it is one of the biggest challenges to involve community with a targeted objective. Awareness creation on various issues and inculcating proper information to the mind of the people as well building the capacity of communities for combat the depletion of environment are the foremost activity of the NGO. If they would fail to hear the pulse of the community, then the organization could not achieve its own goal.

2. Political interference: To deal with various environment issues, NGOs cannot work alone without the assistance of political power. Further, for implementation of various programmes political favour is very important. Sometimes, due to bad government guidance, the objectives of the NGOs could not be fulfilled.

3. Insufficient Fund: Insufficient Fund is the hindrance of the activities of the NGOs.

4. Inattention of problems: There are serious environmental related issues, yet neglected by common people and government level due to lack of cheapest alternative. For example, use of plastic cups, plates and other materials. However, time to time government serves some notice to reduce their amount, yet it could not be banned completely to reduce pollution. In urban area, garbage dumping and solid waste management is a serious threat to the environment, yet it is not recognized by both the government and the members of society. Hence. the NGO, Environ is taking initiative to work on the issue. However, due to lack of consciousness of the community, yet the problem has to be settled.

5. Lack of sincerity of the members of NGOs: Role of the members of the NGO is very important to successfully run an NGO. Sometimes, Inefficient member of an NGO create problem to achieve the goal.

6. Lack of scientific temperament of the members of NGOs: Environment related issues could only be solved if the members of the NGO has well versed knowledge on field and competent to solve the problems. Hence, for being a member an environmental NGO, one should possess scientific mind.

7. Legal drawback: Legal gap to address the environmental issues is also an important challenge to the NGOs activities.

Conclusion:

The major activities of the environmental NGOs are related to conservation of environment. Further, most of the NGOs are collaborating with various government departments as well as with international organization to raise their voice for the protection of biodiversity and environment. All the environmental

NGOs are working in adopting various methods, such as providing scientific expertise, capacity building or educating people, students and other community people on different aspects of environment, conducting awareness programmes, workshops, trainings and take a leading role in environment movement for environment security and if needed, they can raise their voice against the government and other vested interested organizations for the conservation of environment. Recently, in Assam, 25 environmental NGOs get together to form an environmental NGO Forum to deal with all environmental issues of the state. These NGOs will monitor different activities and initiatives of the government/non-government agencies in environmental prospects and they will work together for the smooth and transparent implementation of the schemes if these are beneficial for the conservation prospects (Das J.K., 2012).

It is observed that most of the NGOs have been successful in advocating various environmental issues. However, a few NGOs mislead people with manipulated information. Sometimes it is seen that some NGOs only entertain certain issue, which give them massive publicity. They subsidise the real problem and sometime target MNC to get quick publicity. It is also reported that some of the NGOs are funded by corporate houses and they are using them as a platform to secure favourable deals or use a weapon to target their competitors and adversaries (Sandhu and Arora, 2012). Since, degradation of environment is continuing from several decades, it is only hope that collaborative efforts of government and NGOs with community can successfully save mother earth and make the earth worthy of healthy living of all organisms.

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Environment Protection and the Role of Educational Institution: A Study of National Service Scheme

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Abstract

The concept of the National Service Scheme (NSS) is started in the year 1969 to build a sense of social responsibility through teacher and students involved in constructive service with the motto of "Not Me But You". NSS organizes activities of Environment Enrichment and Conservation, such as plantation of trees, Construction of sanitary latrines, cleaning of village ponds and wells, construction of Gobar Gas Plants, use of non-conventional energy, Environmental sanitation, and disposal of garbage & composting, Watershed management and wasteland development. For many years environmental degradation that has occurred is marked by a large extraction of natural sources, Loss of forests, extinction of animal and plant species, depletion of the ozone layer, air, water and soil pollution, loss of marine life, and bio-diversity and so on. These have posed a serious threat to the very survival of life on earth. Protecting the natural environment for the benefit of humans is the need of the hour. Environmental protection has gained momentum in recent times. In this direction, the Government and NGO have initiated many programmes to protect the environment. One of the significant initiatives is the National Service Scheme implemented by the Government of India, under the Ministry of Youth Affairs & Sports are popularly known as NSS which was launched in Gandhiji's Birth Centenary Year 1969. So, this study tries to focus on how NSS provides a platform for the students to support the best environmental practices. This study involves in identifying the importance, aims, and objectives of NSS in higher education for environmental protection which in turn creates social responsibility among the students.

Keywords: Environment Protection, Environment Enrichment, Educational Institution, NSS.

Introduction:

Environmental Protection or Environment conservation is the practice of us humans saving the environment from the loss of species, and the destruction of the ecosystem, primarily due to pollution and human activities. Environment Protection or Conservation is vital in saving and helping both animals and trees as we are all dependent on one another for survival. Environmental protection is one of the basic pre requisites for the overall development of any country in the world. It is known to all that we only have one planet on which we live. The planet is full of resources, some renewable and some not, but unfortunately, we have an ever-growing population that poses a huge threat to all these resources. It is therefore unclear what future generations will find, if ever, and what life will be like for them if we exploit all the current resources.

Simply speaking Environment means all the natural surroundings such as land, air, water, plants, animals, solid material, wastes, sunlight, forests and many other things (Singh 2015). Healthy environment maintains the nature's balance as well as it helps in growing, nourishing and developing all the living

things on the earth. However, now a days, some manmade technological advancement spoiling the environment in many ways which ultimately disturbs the balance or equilibrium of nature and consequently it keeps our lives in danger as well as existence of life in future on this planet. In recent passing years mankind's consciousness has been aroused very strongly about the need for environmental protection and ecological preservation. Now people aware of the fact that if economic growth and development are to be established, and there is no country in the world that does not want to do so, biodiversity must be contributed. As awareness of environmental protection is developed, human awareness is also developed about the need to preserve the environment by preventing adverse impacts on nature (Sinisa 2018). Law, as a scientific discipline, plays a significant role in these endeavors.

Methodology:

This study is descriptive and analytical in nature. In this study only secondary sources of data have been used. The secondary sources include books, journals, article, research paper and internet sources.

Historical understanding of the formation of NSS:

National Service Scheme (NSS) was introduced in 1969 with the primary objective of developing the personal character of the student youth through voluntary community service (Deshwal 2017). The National Service Scheme was launched by the Government of India which embraces different social activities particularly design for the student community and also for the upliftment of the society. Initially it was launched in 37 Universities involving about 40,000 volunteers. However, with the passage of time and as a Pan Indian programme, the number of educational institutions covered under NSS has been increasing year after year. Currently more than 36.5 lakh volunteers are enrolled in 39,695 NSS units spread over 391 Universities/ +2 Councils, 16,278 Colleges and Technical Institutions and 12,483 Senior Secondary Schools.

Since its inception, over 4.78 crore students have benefited from NSS. Each NSS volunteer is required to put in minimum 120 hours of service per year for two years, i.e., total 240 hours. This work is undertaken in villages/ slums adopted by NSS unit or in school/ college campuses usually after study hour during weekends/ vacations. Besides, Each NSS unit organises a Special Camp of 7 days' duration in adopted village urban slums during vacations, with some specific projects, by involving the local communities. Each volunteer is required to participate in the Special Camp once during the 2-year period. Thus, about 50 percent of the NSS volunteers in participate in a particular Special Camp. NSS units can take up any activity that has relevant to the community. The activities continue to evolve in response to the needs of the community. The core activities could be in the field of education and literacy, health, family welfare and nutrition, sanitation and cleanliness, environment conservation, social

service programmes, programmes for improving status of women, production-oriented programmes, disaster relief and rehabilitation, campaigning against society creating awareness about Flagship Programmes of the Government like Digital India, Skill India, and Promotion of Yoga etc.

NSS is a Central government programme yet the Central government, the States/UTs and the Educational Institutions are the 3 pillars of this programme. It would have been impossible to effectively run a programme directly from the Union Ministry of Youth Affairs and Sports, dealing with over 29,000 educational institutions across the country. The implementation of the programme has been possible due to effective collaboration/ partnership between the Centre and the States on the one hand and the States and Educational Institutions on the other. As mentioned earlier, NSS was introduced with the primary objective of developing the personality and character of the student youth through voluntary community service 'Education through Service' is the purpose of the NSS ideological orientation of the NSS is inspired by the ideals of Mahatma Gandhi. Very appropriately, the motto of NSS is "NOT ME, BUT YOU". An NSS volunteer places the 'community' before 'self'. This is part of the third dimension of education, namely, value education which is becoming increasingly important.

Role of Educational Institution in Environment Protection through NSS:

Education is a key part of strategies to improve individual as well as the societies' economic and social development (Das 2020). The National Service Scheme (NSS) is a tool for best social service programs initiated by the Government of India for the students to serve the society at large. NSS provides the undergraduate and post graduate students with opportunities to devote their free and valuable time to their varieties of social services and developmental activities. As a result, both the student community and the society as a whole are highly benefited.

As environmental protection or environment sustainability is becoming an increasingly important issue for the world, the role of institutions of higher education in relation to environmental protection as well as environment sustainability initiatives is becoming more and more prevalent (Jadhay 2014). It is the role of colleges and universities to educate members of society. Every college or university is unique and has its own traditions, culture and geographical area. They are familiar with their surroundings. They can use their existing knowledge and trained man power to address problems and issues concerned at the local level, as well as related to the national and global community. College and Universities can exchange the information by establishing a strong regional information network. These can promote good neighborly relations and respect for human rights. Subsequently it can lead in promoting environmental equilibrium.

Environment degradation is a reality which cannot be negated. Due to the rapid increase in pollution of every imaginable form has resulted in this situation, every passing day the situation is worsening,

so much so that there is a threat of utter devastation (Kanodia 2019). Lack of waste management mechanisms has reduced the nation into a dump of toxic solid, liquid and gaseous waste. Seven of the world's ten most polluted cities are in India. In this regard, since its formation, NSS has been playing a significant role for environment protection by organizing various activities such as awareness programme, plantation programme, cleaning programme, and so on and so forth.

At present, as the NSS is one of the integral parts of educational institution, it plays a massive role in protection of environment. Now a day's almost all the college and universities has the NSS unit and it has been engaging the youth not only for environment protection but also helping people of the society in their crucial time such as in case of health emergency, natural disaster and so on. It has developed a sense of responsibility among the youth for making a humanitarian society. In this regard, all the higher educational institution be it a college or university must use this great opportunity through NSS for serving the society.

The NSS Cell organizes plantation programme in educational institution as well as in the in other places on various occasion such as World environment Day, Gandhi Jayanti (the birth day of Mahatma Gandhi) and so on and so forth. Moreover, NSS also organizes cleaning programme throughout the year in their convenient time. But, in most cases the activities are not become fruitful due to various reasons. It is found that some institutions do not take it seriously due to which the main motive behind the formation of NSS could not get success. Most of the time clicking picture and sending photos to appropriate authority gets more importance than proper fulfillment of its vision. Therefore, it could be said that if we can engage NSS volunteer in true sense with regard to environment protection, we will be able to provide a great contribution towards the society.

In present scenario, as we know that environmental damages is causing loss to the national economy in billions in the form of deforestation and soil erosion only. On the other hand water air and noise pollution are causing havoc to the health of the nationals. In spite of government policies and number of laws, nothing concrete has been done at the individual level to fight the environmental pollution. The role of N.S.S. becomes very important in this context as constitution of India also envisages that it is fundamental duty of every citizen to protect and improve the natural environment [Art. 51A (g) states to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures]. In this context, NSS activities play a big role in creating awareness on protection of environment.

Further, NSS volunteers have been making very valuable contribution to the Society, besides developing the personality. During the previous year, NSS units organized 12,628 special camps in adopted villages/ slums across the country. NSS volunteers undertook 91 lakh volunteer-hours of

Shramadaan, donated 1.98 lakh units of blood and planted over 13.27 lakh saplings. The volunteers were instrumental in organizing about 7,051 Health, Eye and Immunization and also 30,011 awareness programmes through rallies and campaigns on various important government programmes and social issues. NSS volunteers facilitated pulse polio immunization of about 6 lakh children. The volunteers have playing key role in Swachh Bharat Mission, spreading digital literacy and in popularization of Yoga. On the occasion of International Day of Yoga last year, about 11.19 lakh NSS volunteers participated in yoga programmes across the country.

Constraints faced by NSS:

There are certain constraints faced by NSS. For smooth functioning of NSS and do their duties actively, all these constraints need to be removed.

1. Since N.S.S. is a government sponsored scheme, it suffers from bureaucratization and financial crunch. Low participation due to poor incentives for the students and teachers impedes its successful implementation.

2. Lack of authority given to the Programme Officer in spending financial incentives is another important constraint. The incentive that is given to the college basically hold by the Principal's Office. So, if there is any lack of coordination between Principal and Programme Officer, it creates problem for successful implementation.

3. Discontinuation of the work done by the volunteers and functionaries on account of constantlychanging Programme Officers and placements of work defeats the objective of the creation of durable community assets. This converts the social experience of the volunteers into an ad hoc affair and leaves no scope for conceptualization.

4. In the highly competitive educational environment students can hardly spend time in social work, or even think of transforming social reality. The situation has become graver because career consciousness is overtaking idealism and service orientation. Due to this, student's participation in social activities becomes very less in true sense of the term.

5 Indian youth is confronted with a dearth of normative role models (Sinha, 1997). Absence of inspiring role models may not encourage youth to enroll in a programme like the N.S.S. that shuns fun and excitement and painstakingly addresses community issues.

Suggestions and Conclusion:

After going through this discussion, it could be said that the N.S.S. is a useful exercise which provides student youth with a social apprenticeship. The philosophical base of NSS has degenerated

due to lack of intelligent leadership. The scheme should be given in the hands of able and committed persons to train the students as sensitizers. For the better conceptualisation and successful implementation of the scheme, permanent and dedicated programme officers (POs) should be appointed. Since POs have to perform complex task of human engineering and adolescent psychology, the government of India should establish training and orientation centres to plan, supervise and evaluate N.S.S. activities and to train and orient the POs in the philosophy of the scheme. Moreover, in case of financial assistance, the POs should be given autonomy. Apart from that like NCC, the NSS students also should be given preferences in getting job and other aspects so that the interest of student in serving society could be increased.

Now a day's NSS is considered as one of the useful social service programs which have been initiated by the Ministry of Human Resource and Development, Government of India for the student of educational institutions by rendering different Social Services activities in the society including environment protection. It provides opportunity to the students to make them aware on Swachhta, environment protection and so on. As of now, the global warming has been impacting the whole world, so environment conservation is the need of the hour to lessen its impact. In this regard the younger generation through NSS plays a major responsibility to create social awareness in society. Apart from that Shortage of blood at blood banks and hospitals is another major issue that can be addressed by mass awareness. NSS volunteers apprised the villagers about donation of blood at least twice a year can save two lives and it also purifies the blood system of the donor. At last, it can be said that if we can properly use this NSS Cell in an effective way and involve more and more students we can definitely contribute to environment protection which will essentially help to establish a green world.

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Survey on Pesticide Usage Pattern in Cachar District of Assam and Assessment of Profenofos-induced Acute Toxicity in *Clarias batrachus*

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Abstract

The principal aim of present study is to assess the Pesticides usage pattern against agricultural crops in Cachar District and to study the effects of one of the most commonly used pesticide on non-target aquatic vertebrate organism. The market survey, collection of other data and interactions with local farmers culminated in the selection of commercial organophosphate pesticide Celcron (Profenofos50% E.C.) out of 30 commonly used pesticides and subsequently assessment of its acute toxicity was conducted in freshwater air breathing fish species Clariasbatrachus. LC_{50} for the Pesticide was determined and the fishes were exposed to sub-lethal concentration (50µg/L, 1/5thof LC_{50}) of Profenofos for 96 hours. Assessment of acute toxicity was based onchanges in morphological, behavioural response together with haematological parameters like RBC & WBC Count, Hb%. Significant changes in behaviour like abnormal surfacing phenomenon, gulping of air, reduction of opercular movement, excessive mucous secretion etc.were observed. Behavioural characteristics were obviously sensitive indicators of toxicant effect. Interestingly, 96 hr exposure to the pesticide resulted in increase in RBC and WBC count as well as Hb%. The physico-chemical factor of the water sample was also monitored during the experiment which shows a gradual decrease of the Dissolved Oxygen and increase of the free CO_2 present, the p^H becomes slightly acidic. Together with identification of some of the potent pesticides such as Rogor, Ustaad, Profenofos, Tricel etc., which are widely applied against host of multiple insect pests in agricultural field,this study confirms that even sub-lethal concentrations of most commonly used synthetic organophosphate pesticide have deleterious effects on a robust air-breathing fish species like Clariasbatrachus. Therefore, we conclude that excessive use of pesticide in the absence of suitable bio-control measures may not only result into environmental degradation, but also have life-threatening impacts on many non-target aquatic organisms which may consequently lead to imbalance in ecosystem functioning. The authors suggest that vigorous collaborative research on the issue, Government initiatives, and large scale Farmers' Awareness probably will pave the way for sustainable agriculture with minimum degradation of quality our environment and thus will indirectly ensure human welfare.

Keywords: Profenofos; Acute toxicity; $LC_{50;}$ Organophosphate Pesticide; Haematological Parameters; Clarias batrachus

Introduction:

Toxicology (Greek word – *toxin or toxicum or toxicon* = poison + *logos* = discourse of knowledge) is the branch of pharmacology which deals with the various aspects of poisons and poisoning and to study the toxic effects of a chemical is known as toxicity of xenobiotic. Barnes (1963) defined the toxicity of a chemical or xenobiotic as its capacity to cause injury while the hazard attributable to a

xenobiotic or chemical represents the probability it will do so. The overall effects produced by a xenobiotic in experimental animals may be used to predict the possible and probable effects in human. This toxicity tests are also known as bioassays.

Acute Toxicity:

These toxicity tests may be conducted at various levels in accordance with the need. In order to examine the various effects associated with various length of exposure, the ideal and most widely accepted testing framework includes the Acute toxicity test.

The most common use of the term '**acute**' in toxicology relates to exposure on one occasion only i.e. single exposure. However the term acute is sometimes considered for multiple exposures during a short period of time (Hagan, 1959). The period set for multiple exposures starts from 24 hours to basically 96 hours. The results of acute toxicity are generally represented in terms of LC_{50} (median effective concentration). Its first and foremost objective is that

- It helps in the prediction of hazardous effects on non-target species.
- It helps to assess the toxicity in target species when the pest is a vertebrate species.
- It provides information on the mechanism of toxic action.
- It provides data on which user risk-benefit relationship may be assessed.
- It helps in observation of the behavioural changes and also to assess LC_{50} and toxicity index of various toxicants.

For the experimental design for Acute toxicity tests the following procedures are basically conducted:-

- Selection of animal species
- Route of exposure
- Dosage and number of Animals
- Observations and Examinations

1.2 LC_{50} value:

LC_{50} value represents the ppm or mg/l or % per liter concentration of the toxicant in the media that would kill 50% of population of a particular aquatic species, viz., fishes and insects. Median lethal concentration or LC_{50} is the usual method of reporting acute toxicity results. LC_{50} merely is a convenient reference point for expressing the acute lethal toxicity of a given toxicant to the test animals. Determination of the LC_{50} value under a set of experimental conditions can provide valuable information about the toxicity of a compound and along with it can compare the toxicity among chemicals. Obviously, the safe concentration which permits successful reproduction, growth and all other normal life processes in animal's natural habitat is usually much lower than LC_{50}. LC_{50} values are calculated by either of the two methods:

- Graphical interpolation
- Statistical method

Experimental fish- *Clarias batrachus Linn.:*

For the experimental design of acute toxicity test and to determine the median lethal concentration using aquatic organism, selection of the fish is done for the experiment. In India, the following fish species are more commonly used for acute toxicity studies:-

1) *Puntius sps. (sophore ticto)*
2) *Mystus sps. (cavasius vittatus)*
3) *Heteropneustes fossilis*
4) *Clarias batrachus*
5) *Chanda sps. (nama and ranga)*
6) *Channa sps. (striatus punctatus and gachua)*

The fish should be small, hardy and preferably air – breather. Here, *Clarias batrachus* is chosen to study the toxicity of xenobiotics.

Physiology and anatomy of *Clarias batrachus :*

Clarias batrachus, belonging to the order Cypriniformesis found in fresh and brackish waters throughout India. It feeds on clams, crustaceans and insect larvae and also acts as a scavenger. *Clarias* is mostly found in Africa and South and West Asia. The general colour of the body is uniform brown or grayish black. It is a scaleless fish measuring upto 45 cm in length. They usually possess barbles which are of four pairs. Dorsal fin is long without spines. Organs of respiration are gills but accessory respiratory organ is also present. The accessory respiratory organs are branched tree-like in the branchial chamber. It can live without water for a long time with the help of its accessory respiratory organs. The air bladder is connected to the internal ear by Weberian ossicles. Air bladder is also connected with the alimentary canal by a duct. Heart is venous and two chambered and is imperfectly divided into two parts. The kidney is mesonephros. The gonad possesses true gonoducts.

Organophosphates:

In this bioassay, the pesticide that has been used is an organophosphorous pesticide named Profenofos 50% E.C. Organophosphorous pesticide compounds are essentially polar, hydrophilic and are derivatives of the mineral acid i.e., phosphoric acid. In case of Profenofos the oxygen atom are replaced by sulphur atoms. These sulphur derivatives of pesticides may not be active themselves but are activated only by the enzymatic transformation taking place within the organism.Structure of Profenofos or 4-bromo-2-chloro-1-[ethoxy(propylsulfany) phosphoryl] oxybenzene shown in Fig.1.

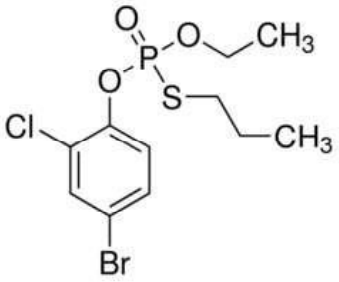


Fig 1:- Structure of Profenofos.

Mechanism of action of Organophosphate-Profenofos. :

In principle the organophosphate compounds react with the active site of acetylcholinesterase enzyme (AChE). During the normal process of muscular contraction the acetylcholine at the neuromuscular junction gets split into acetyl CoA and choline by the ChE enzyme. This splitting of ACh by ChE prevents the accumulation in the neuromuscular junction and thus assists muscle relaxation. Since the organophosphate compounds are structurally similar to Ach it competes and binds with the ChE, thus inhibiting its normal function. These events bring about an accumulation of excess of ACh, which in turn produces repetitive muscle contraction and the organism finally dies.

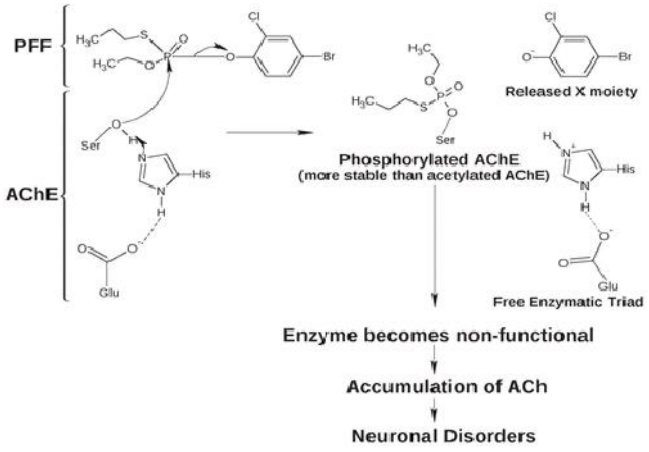


Fig 2: Mechanism of action of Profenofos.

Review of Literature:

Several studies were conducted to assess the acute toxicity of organophosphate pesticides in freshwater fishes. In one such studies (Pandey et al., 2011) conducted Acute toxicity of organophosphate pesticide Profenofos to freshwater fish, *Channa punctatus*, in a static bioassay. This study estimated 96 hour LC_{50} of Profenofos to be 2.68 μgL^{-1}. On the basis of the obtained LC_{50} values for 96 hour exposure intervals, Profenofos can be rated as highly toxic to *C. punctatus*. Fish exposed to Profenofos showed hyper excitability, discolouration, erratic swimming, and secretion of excess amounts of mucus on the body and gills with eventual exhaustion and death.

A research was conducted on behavioural and acute toxicity of pyrethroid insecticide, λ-cyhalothrin on *Clarias batrachus*. Bioassay tests were conducted to evaluate the acute toxicity of synthetic pyrethroid λ-cyhalothrin insecticide by determining their LC_{50} after 24, 48, 72 and 96 hour (Rani and Kumaraguru, 2014). The safe concentration of this biocide was calculated on the basis of LC_{50} for 96 hours. From the results obtained it was observed that the LC_{50} values for 96 hours were found to be the lowest among all the exposure periods. The 96 hours LC_{50} values provide a useful means of comparing the relative acute lethal toxicity of specific toxicants to organisms under specific conditions. Susceptibility of catfish, *Clarias batrachus* to lethal effect of synthetic pyrethroid was found to be duration and concentration dependent as mortality was increased with an increase in its concentration in the present study. Behavioural characteristics are obviously sensitive indicators of toxicant effect. Many chemical contaminants target specific physiological systems and exert their effects on behaviour. Fish in toxic media exhibited irregular, erratic swimming movements, hyper excitability, loss of equilibrium, spiralling, loss of balance, rapid respiration, slight discolouration, surfacing and gulping air. Their investigation was designed to elucidate the toxic effect of λ-cyhalothrin insecticide on the toxicity and behaviour of air breathing fish *Clarias batrachus*.

A study was carried out to investigate the LC_{50} of two different pesticides such as monocrotrophos and lambda cyhalothrin on the freshwater fish *Labeo rohita* (Muthukumaravel et. al., 2013). Monocrotrophos caused 100% mortality of *L.rohita* at 0.0044 ppm and 50% mortality (96 hours) at 0.0036 ppm, and for lambda cyhalothrin, the lethal effect was at 0.0029 ppm and LC_{50} at 0.0021 ppm. The LC_{50} values obtained at 24, 48, 72 and 96 hours were 0.0041, 0.0039, 0.0037 and 0.0036 ppm respectively, whereas the LC_{50} value of lambda cyhalothrin for 24, 48, 72 and 96 hours were 0.0026, 0.0022 and 0.0021 respectively.

To assess the acute toxic effects of Triazophos to common carp (*Cyprinus carpio*) fry along with the changes in their behaviour during the test, the LC_{50} was determined. The 24, 48, 72 and 96 hour LC_{50} values of Triazophos to *Cyprinus carpio* were found to be 3.26, 2.79, 2.59 and 2.04 mg/l respectively. The mortality rate *Cyprinus carpio* varied significantly ($p<0.05$) with the increasing concentrations irrespective of exposure times (24, 48, 72 and 96 hours) at all the doses. The treated *Cyprinus carpio* showed different irregular behaviours like excess mucous secretion, erratic movement, gulping of air followed by sudden death syndrome (flaring of operculae, convulsion, loss of equilibrium and death) with the increasing concentrations of toxicants and progress of time of exposure. The opercular movement increased significantly ($p<0.05$) at the higher doses at all the exposure times. At a particular concentration the opercular movements increased significantly ($p<0.05$) at 48 and 72 h but with the passage of exposure time, the opercular movement decreased significantly ($p<0.05$) at 96 hour (Sarkar et. al., 2016).

In a recent study, Profenofos induced histopathology and recovery patterns in silver barb (*Barbonymus gonionotus* was assessed (Moniruzzaman et. al., 2017). Histopathology is promising field for research in aquatic toxicology as it provides the real picture of the toxic effects of xenobiotics in vital functions of a living organism. Liver and kidney of silver barb were examined histologically after exposure to sub-lethal concentrations (0.01 ppm, 10% of LC_{50} and 0.05 PPM, 50% of LC_{50}) of Profenofos for 0, 7, 15 and 30 days. Histological recovery was also studied by maintaining the pesticide-exposed fish in a freshwater system for an additional 7, 15 and 30 day. Kidney and liver of exposed individuals exhibited some remarkable changes in their histology in comparison to control and recovery group. Hepatic lesions in the liver tissue of fish were characterized by cloudy swelling of hepatocytes, lipoid vacuoles, pycnotic nuclei and focal necrosis. Epithelial hypertrophy, narrowing of the tubular lumen, atrophy of the glomerulus, broader Bowman's capsule, necrosis in the epithelial cells and pycnosis in the hematopoietic tissue were observed in kidney tissues of experimental fish. These lesions grew with increasing concentration. Although some of the changes were reversible, the rest were less pronounced after a recovery period.

In an ecotoxicological review of pesticides induced toxicity in fish, Sana Ullah and Zorriehzahra (2015) reported that throughout the world pesticides are widely employed in agriculture sector in order to elevate crop yields with low labour and efforts. Pesticides exposure leads to toxicity in many non-target organisms, fish being one of the most prominent among these. Most of the time acute concentration of these pesticides leads to mortality while sub lethal concentration of these pesticides result in different lethal changes. These changes may be in behaviour of the exposed fish such as change in feeding behaviour, attack or avoiding behaviour and reproductive behaviour, or other types of alterations such as changes in histology (liver, kidney, gills, muscles, brain, and intestine), haematology (RBCs, WBCs, or plasma), anti-oxidant defence system (Glutathione reductase, Peroxidase, Catalase, Superoxide dismutase, Glutathione peroxidase, Glutathione-S-transferase etc), changes in nutrient profile (Protein, Lipids, Carbohydrates, Moisture content and Ash etc) and worth of the fish, hormonal or enzymatic alterations, oxygen consumption, and DNA damage or damage at genes level (genotoxicity). Different environmental agencies are working on this aspect and that is why there are a large number of banned chemicals. Still these chemicals are available in markets. Certain newly synthesized pesticides (insecticides or fungicides etc.) and extensive use of these chemicals are always there to maximize the problem for aquatic organisms especially fish. This article focuses on the same aspect of ecotoxicology and reviews some major induced toxicological aspects of pesticides in fish including behavioural changes, histopathological damages, haematological alterations, biochemical changes, and fluctuations in acetylcholinesterase activity, vicissitudes in protein contents, induced genotoxicity, and alterations in feeding biology, oxygen consumption and oxygen stress all across the world.

In another study conducted to investigate the phytochemical composition of the *Adeniacissampeloides* stem extract, its acute toxicity and biochemical effects in *Clarias batrachus* fish, a total of 144 *Clarias batrachus* juveniles of average weight, 122 g, were randomized into six different groups and exposed to 0.0, 1.25, 2.50, 5.0, 10.0 and 20.0 g/l of the extract, respectively, for 72 hours. Extract concentrations were changed after every 24 hours. For the sub-acute toxicity tests, *Clarias batrachus* juveniles were exposed to 0.0, 0.625, 1.25, 2.5 and 5.0 g/l of *Adeniacissampeloides* extract for 8 hours. Four fish were sampled from each group at 1 hour interval. Blood samples were collected from incisions made at the thoracic cavity of the fish using syringes. The serum was used for the biochemical assay of AST, ALT, ALP, protein, bilirubin, malondialdehyde determined using standard methods. The results showed that *Adeniacissampeloides* stem-bark has high contents of tannin and flavonoids, alkaloids, and glycosides; the 24, 48 and 72 hour LC_{50} was 5.0, 2.5 and 2.5 g/l, respectively. There was a significant increase ($p<0.05$) in the concentration of total protein, unconjugated bilirubin, malondialdehyde and cholesterol. Though there was an increase in the activities of ALT, ALP and SOD, these were not significant ($p>0.05$). But the GST activity showed a significant reduction ($p<0.05$). The results show that *Adeniacissampeloides*is toxic to *Clarias batrachus* (Ibiam et al., 2018).

The genotoxic and hematological effects of chloropyrifos exposure on freshwater fish *Labeo rohita* was investigated by Ismail et. al., (2014). Chloropyrifos is a commonly used organophosphate insecticide that causes toxicological effects in fish. This study determined the effects of chloropyrifos on the genotoxic and haematological parameters of freshwater fish, *Labeo rohita*. The genotoxic effects of different sublethal concentrations of chloropyrifos were investigated in the erythrocytes of *Labeo rohita* (commonly known as Rohu) using the Micronucleus test. Effects of chloropyrifos on the haematological parameters of the fish were also observed. Fish specimens were exposed to three sublethal concentrations of chloropyrifos viz, sublethal l (SL-l, $1/6^{th}$ of LC_{50} = ~73.8 µg/L), sublethal ll (SL-ll, $1/4^{th}$ of LC_{50} =~110.7 µg/L) and sublethal lll (SL- lll, $1/2^{nd}$ of LC_{50} =~221.4 µg/L) for 96 hours. Blood samples were collected at every 24 hour and were subjected to the Micronucleus assay. The observed micronucleus frequencies were concentration and time dependent. The MN induction was significantly highest ($p<0.01$) atall the concentrations on 96-hour exposure. During the experimental period, haematological parameters like total erythrocytes count, haemoglobin and packed cell volume decreased, whereas total leukocytes count increased. This study indicated that the Micronucleus assay is useful tool to detect genotoxic potential of chloropyrifos in fish.

Ramzy et al., (2014) conducted a research on the biomarker studies of potential hazards of chloropyrifos to Nile Tilapia, *Oreochromis niloticus*. The introduction of organophosphorous insecticide into the aquatic ecosystem will adversely affect many non-target organisms including fish. Fish is an important organism of any aquatic system and so is one of the major sources of protein for human beings in Egypt. This study investigated the impact of acute and chronic exposure of chloropyrifos on

freshwater fish, *Oreochromis niloticus.* Results indicated that the exposure to 0.3 and 0.8 mg/l of chloropyrifos for 24 hour induced significant decrease in some investigated metabolites as total lipid, AChE, T3, Na^+ and Cl^-. While, cholesterol, cortisol, T4 and K^+ revealed marked elevation during acute period when compared to control value whereas total protein was fluctuated during acute exposure. Furthermore, the chronic exposure of Tilapia to 0.5 mg/l of chloropyrifos showed significant increasing in total lipid, cholesterol, total protein, cortisol, T4 and K^+. There was marked reduction in AChE, T3, Na^+ and Cl^-. The depuration process indicated that Nile Tilapia is trying to restore their metabolic parameters, thyroids and electrolytes levels but still did not reach the control one.

Although there are many works related to testing of toxicity of organophosphate pesticide on other species, limited data on toxicity of Profenofos on *Clarias batrachus* are available. Therefore, the principal aim of the present study is to perform toxicity experiments on *Clarias batrachus* to evaluate the degree of response of a target species, produced by a specific level of stimulus. These tests provide a database that may be applied to assess the risk associated with a situation in which the selected toxicant, the species and exposure conditions are well-profiled. Toxicity tests are experiments or trials designed to assess or evaluate the doses/concentration of xenobiotics and the duration of exposure required to produce a criterion effect. The criteria of the effect may be mortality or death of the target species or any other parameter such as histological, physiological, biochemical, behavioural, immunological, haematological parameters etc.

Aim and objectives:

The principal aim of present study is to study and explore the pesticide usage pattern in Cachar district of Assam and assessment of acute toxicity of commercial organophosphate pesticide Profenofos (50% E.C.) in freshwater air breathing fish species *Clarias batrachus.* In order to achieve the aim, the following objectives were taken into consideration for this study.

I. Collection of data regarding the different kinds of pesticides, insecticides and herbicides being sold in shops through Market Survey.

II. Collection data about dosage and exposure of the pesticides used by vegetable farmers of different areas.

III. Collection of scientific data of various kinds of pests found in vegetable crops in Cachar district from Krishi Vigyan Kendra, Arunachal.

IV. To study the changes in physico-chemical factors (pH, DO & free CO_2) of water used for the experimentation.

V. Determination of LC_{50} of the Profenofos.

VI. To determine the Acute toxicity of the Profenofos in terms of Physical, Behavioural and Morphological changes induced in experimental organisms.

VII. To study acute toxicity with respect to changes in Haematological parameters like Hb%, RBC & WBC count of the exposed fishes.

Materials & Methods:

I. Collection of data regarding the different kinds of pesticides, insecticides and herbicides being sold in shops through Market Survey.

For this extensive survey was carried out in some famous shops of Silchar town dealing with all such agro-chemicals. During such survey, interactions with the shopkeepers were conducted regarding the pesticide choices of farmers along with recording the available pesticide and insecticide being sold on daily basis.

II. Collection data about dosage and exposure of the pesticides used by vegetable farmers of different areas.

In order to collect the data on the dosage and frequency of application pesticides used by vegetable farmers of different areas, three different vegetable crop fields under three distinct areas have been visited. These include a) Baghpur Part-1 (Sonai), b) Baroinagar, Ranighat (Kathigorah) and c) Doodhpatil (Udharbond). Through interaction with the local farmers of concerned vegetable fields, various types of data have been collected, such as type of vegetables cultivated, the dose and frequency of the insecticides used, spraying techniques and equipments etc. Photographs were taken during such visits and interactions. The distances of Baghpur, Ranighat and Baroinagar area were about 21kms, 11.6 km and 9 km respectively from Silchar town.

III. Collection of scientific data of various kinds of pests found in vegetable crops in Cachar district from Krishi Vigyan Kendra, Arunachal.

With a view to collection of scientific and authentic data regarding various kinds of insect pests found in vegetable crops in Cachar district, Krishi Vigyan Kendra of Cachar District located at Arunachal was visited. The list of different types of insects and pests (Table-3) found in Cachar district data and photographs of Insect Pests were collected from the Museum with the able guidance and assistance of Subject Matter Specialist (SMS) of Agricultural Entomology Dr. N. Saikia.

IV. To study the changes in physico-chemical factors (pH, DO & free CO_2) of water used for the experimentation.

Determination of pH:

pH was determined using digital pH meter after proper calibration of the instrument with standard solutions of pH 7, 9.2 and 4.

Determination of Dissolved Oxygen in water sample was done by Winkler's Iodometric Method.

The experimental water sample had been filled up in a glass stoppered bottle of known volume (100-300 ml) carefully, avoiding any kind of bubbling and trapping of the air bubbles in the bottle after placing the stopper. Then 1ml of $MnSO_4$ solution and alkaline KI solution had been poured well below the surface from the walls. A precipitate was formed. After placing the stopper it had been shaken well so that the contents get mixed up well by inverting the bottle for some time to settle down the precipitate. Then 1-2 ml of concentrated H_2SO_4 had been added and well shaken to dissolve the precipitate. 100 ml of the content was taken on a conical flask for titration preventing any kind of bubbles to avoid further mixing of oxygen. The content was then titrated within one hour of dissolution of the precipitate against sodium thiosulphate solution using starch as an indicator. At the end point, initial dark blue colour changes to colourless.

Calculation:

When only a part of the contents has been titrated:

$$\text{Dissolved Oxygen, mg\L} = \frac{(\text{ml} \times \text{N}) \text{ of titrant} \times 8 \times 1000}{V_2 (V_1 - V \setminus V_1)} \qquad (1)$$

Where, V_1 = volume of the sample bottle after placing the stopper

V_2 = volume of the part of contents titrated.

V_3 = volume of $MnSO_4$ and KI added.

Determination of dissolved CO_2 in water sample.:

The experimental water sample had been filled up in a glass stoppered bottle of known volume (100-300 ml) carefully, avoiding any kind of bubbling and trapping of the air bubbles in the bottle after placing the stopper. 100 ml of experimental water was taken in a conical flask. Few drops of phenolphthalein indicator water added in the experimental water. After this 0.05N of NaOH was taken in a burette and was titrated against the experimental water. At the endpoint the colourless water turns pink.

Calculation:

$$\text{Free } CO_2 \text{ mg\L} = \frac{(\text{ml} \times N) \text{ of NaOH} \times 1000 \times 44}{\text{ml of sample}} \quad (2)$$

V. Determination of LC_{50} of the Profenofos.

Fishes were collected from local fish farmers and acclimatized in the laboratory for at least 7 days in glass aquaria. After 7 days, the 20 fishes were evenly allotted to four aquaria.. 10 L of tap water was then poured into the aquariums containing the fishes. After this, Profenofos was added gently at four different concentrations viz., 0.05, 0.5, 5.0 and 50.0 mg/L, using gloves. The aquaria were kept for around 48 hours. The number of dead fishes were counted after 48 hours in all the experimental set ups. The values of % of death were plotted against concentrations and the value of LC_{50} was determined using the linear trendline and y=mx+c equation for the same.

VI. To determine the Acute toxicity of the Profenofos in terms of Physical, Behavioural and Morphological changes induced in experimental organisms.

At first the experimental fishes were briefly dipped in 0.1% solution of potassium permanganate. Then they were kept for acclimatization for at least 7 days. After this they were transferred to respective aquaria. The water was replaced every 24 hr for both control and exposure set ups.These experimental fishes were starved for at least 48 hours period to reduce the rate of metabolic activities. After the determination of the LC_{50} value, a concentration below the LC_{50} concentration ie., 50µg/L was added in four different aquaria for 24 hours, 48 hours, 72 hours and 96 hours respectively. The behavioural patterns, morphological changes and the physical changes were recorded from time to time.

Measurement of Body weight:

At first the fishes were taken in a bucket and they were shifted to a blotting paper. The excess amount of water from the surface was blotted with the help of blotting paper. After de-blotting the fishes they were then inserted in a polythene bag. The digital weight balance machine had been plugged in and the weights of the fishes were taken one by one and the readings were noted.

Study of the Behavioural Pattern like Opercular movements and Surfacing phenomena:

The fishes which were kept under experimentation procedure were observed carefully from time to time. With the help of a stopwatch the rate of their opercular movement was monitored every 15 min for several hours and noted down. Any kind of irregular, jerky or erratic swimming behaviour and surfacing phenomena were recorded and noted down and photographs were also taken with the help of a digital camera.

VII. To study acute toxicity with respect to changes in Haematological parameters like Hb%, RBC & WBC count of the exposed fishes.

Fig-3: Insecticide/Pesticide: Celcron (PROFENOFOS 50% EC.)

Fig-4: Aquarium & species *Clarias batrachus*

Fig-5: Experimental fish experimental fishes.

Determination of the haemoglobin percentage:

First of all the graduated haemoglobin tube was pulled out of the apparatus and was cleaned with distilled water and then with methylated spirit or 90% alcohol and was kept for drying. With the help of a dropper, therefore some amount of N\10 HCl was poured in the dry graduated tube.The blood was taken from the experimental fish by puncturing the heart of the fish with the help of a syringe. Immediately the blood was transferred to the EDTA tube and shaken well so that it did not coagulate. With the help of haemoglobin micropipette the blood from the EDTA tube was sucked upto 20cumm mark. Excess amount of blood that was adhered to the haemoglobin micropipette was wiped with the help of blotting paper. The blood was then transferred from the micropipette into the graduated tube of Haemometer containing N\10 HCl. In order to wash all the blood from the haemoglobin pipette into the haemoglobin tube, some of the liquid from the haemoglobin tube was sucked and blown back into the haemoglobin tube. The contents were then stirred with the help of glass stirrer and allowed it to stand for 10-20 minutes. Then distilled water was added drop by drop into the solution. With the addition of each drop the solution was stirred and its colour was matched with that of the standard sealed tubes. This process had been continued until the acid haematin formed in the solution just faded away and matches to that standard comparison tubes. The mark upto which the blood was diluted gave the percentage of haemoglobin in blood or gm weight of haemoglobin per 100 ml of blood. (Verma & Srivastava, 1994).

Determination of the number of red blood cells present in 1cubic mm volume of blood:

At first, the R.B.C. pipette with 1% solution sodium citrate (1gm in 100ml of distilled water) was sucked and kept to avoid coagulation of blood in the pipette. With the help of syringe the blood was taken from the experimental fish by puncturing the heart of the fish. Immediately the blood was transferred into the EDTA tube from the syringe and shaken well to avoid coagulation. The blood was

then sucked up from the EDTA tube with the help of micropipette upto 0.5 mark. It was to be kept in mind that no bubble should enter the pipette. Excess amount of blood was wiped off sticking to the tip of the pipette. The diluting fluid was then sucked upto 101 mark. Then by closing the open end of the pipette with thumb or index finger of my right hand, the blood was mixed with the diluting fluid thoroughly by rotating it for 3 to 4 minutes.The function of the red glass bead present inside was to help in the mixing process. The fluid from the stem upto mark ten was blown out as that had not mixed properly with the diluting fluid and so was not useful for the experiment. The pipette was then kept with an angle of 45^0 with the platform of the slide. Then a drop of diluted blood from the bulb of the pipette was blown onto the surface of the slide. That had to be done carefully otherwise blood might overflow into the grooves of H. A coverslip was placed on top of it taking care that no air bubbles should enter. The slide was ten kept for five minutes so that all the cells settle down.

For counting the central squares of the slide were focused under high power of the microscope. Counting had been done in 5 of the 25 small squares. For the sake of convenience, 4 small squares at the corners (marked R_1 , R_2, R_3 , R_4) and the central small square (marked R_5**)** were selected for counting Red Blood Corpuscles. That meant counting of the Red Blood Corpuscles was done in 5 x 16 = 80 smaller squares in which volume of blood was 1\4000 cumm per square.

- Calculation:

The calculation may be done by the following method:

$$\text{Number of R.B.C.s per cubic mm} = \frac{\text{Number of cell counted x dilution x 4000}}{\text{Number of small squares counted}} \qquad (3)$$

Determination of the number of white blood cells per cubic mm blood:

First of all the W.B.C. pipette was rinsed with 1% solution of sodium citrate to avoid any kind of coagulation of blood in the pipette. The blood was then taken from the experimental fish with the help of syringe by puncturing the heart of the fish. Immediately the blood was transferred to an EDTA tube to avoid any kind of coagulation by gently shaking the blood. After inserting the W.B.C. pipette inside the EDTA tube the blood was sucked upto 0.5 mark. Excess of the blood that present outside the pipette was wiped off with the help of blotting paper. Then the diluting fluid was sucked upto 11 mark. The open end of the pipette was closed with the help of right hand thumb or index finger and the blood and the diluting fluid was mixed thoroughly in the pipette by rotating it for 3 to 4 times. The white glass bead present inside the bulb help in proper mixing. The fluid which was present in the lower stem of the pipette was blown out upto 10 mark as those portion of fluid had not mixed properly and thus it was not useful for the experiment. The pipette was then kept on the surface of the platform of the slide making an angle of 45^0 respectively. A drop of the diluted blood from the bulb of the pipette was poured on the

surface of the slide carefully otherwise blood will overflow into the grooves of the H. A coverslip was kept on the top of it and it was kept for atleast 5 minutes to let the blood cells settle down.

Counting was done under the microscope. It was done in four chambers marked W of each platform.

- Calculation:

$$\text{Number of W.B.C.s per cubic mm} = \frac{\text{Number of cells counted} \times \text{Dilution} \times 10}{\text{Number of 1 sq. mm counted}} \quad (4)$$

The calculation might be done by the following method:

Result:

Market Survey of the various kinds of pesticides used in Cachar district:

Market Survey:

Data on thirty numbers of various pesticides and insecticides were recorded from market survey of five famous shops of the town as listed in the following Table.

Table 1:- List of the best-selling insecticides and pesticides in Cachar district:

Name of the insecticide, pesticide or herbicide found in the shops with their technical names.			***Name of the shops***				
Sl No.	**Trade Name**	**Technical Name**	**Seed House**	**Agro Tea Service**	**Green House**	**Tuhina seeds**	**Punna-Mayee Sabjinigam**
1	Ustaad	Cypermethrin 10% EC	Yes	Yes	No	Yes	No
2	Tricel	Chloropyriphos 20% EC	Yes	Yes	Yes	Yes	No
3	Tafgor	Dimethoate 30% EC	Yes	No	No	No	No
4	TATA fen	Fenvalerate 20% EC	Yes	No	No	No	No
5	Roundup speed	Glyphosate 41% SL	Yes	Yes	No	Yes	No
6	Rogor	Dimethoate 30% EC	No	Yes	Yes	Yes	Yes
7	Malathion	Malathion 50% EC	No	Yes	Yes	No	Yes
8	Gramoxone	Paraquate	No	Yes	Yes	Yes	No
9	Glycel	Glyphosate 41% SL	No	Yes	Yes	Yes	No

Name of the insecticide, pesticide or herbicide found in the shops with their technical names.			***Name of the shops***				
Sl No.	**Trade Name**	**Technical Name**	**Seed House**	**Agro Tea Service**	**Green House**	**Tuhina seeds**	**Punna-Mayee Sabjinigam**
10	*Profenofos*	*Profenofos 50% EC*	*No*	*No*	*Yes*	*No*	*No*
11	Delete	Delete 2.5% EC	No	No	Yes	No	No
12	Ramfit	Pretilachor 50% EC	No	No	Yes	No	No
13	Profex	Profenofos 40% EC+Cypermethrin 4% EC	No	No	No	Yes	No
14	Karate	Lambda cyhalothrin 5% EC	No	No	No	Yes	No
15	Ampligo	Chlorantraniliprole 100g+Lamda-Cyhalothrin 50g	No	No	No	Yes	No
16	All Clear	Paraquate dichloride 24% EC	No	No	No	Yes	No
17	Glycid	Acephate	No	No	No	Yes	Yes
18	2-4D	2-4 Dimethyl amine salt 58% SL	No	No	No	Yes	No
19	Mera 71	Chlorpyriphos 20% EC	No	No	No	Yes	No
20	Record	Cypermethrin 10% EC	No	No	No	No	Yes
21	Tango	Profenofos 40% + Cypermethrin 4% EC	No	No	No	No	Yes
22	Encounter	Emamectin benzoate 3%+Thiamethoxam 12%WG	No	No	No	No	Yes
23	Cannon	Chlorpyriphos 50% + Cypermethrin 5% EC	No	No	No	No	Yes
24	Ennova	Acetamiprid 20% SP	No	No	No	No	Yes
25	Shield	Thiophenate methyl 70% WP	No	No	No	No	Yes
26	Matco	Metalaxyl 8% + Mancozeb 64% WP	No	No	No	No	Yes
27	Antracol	Propineb 70% WP	No	No	No	No	Yes
28	Saaf	Carbendazim 12% + Mancozeb 63% WP	No	No	No	No	Yes
29	Parawin	Paraquate dichloride 24%EC	No	No	No	No	Yes
30	Glycides	Glyphosate 41% SL	No	No	No	No	Yes

Field Survey:

The following Table presents the data collected through agricultural field visit and interaction with local farmers regarding use of various pesticides in respective agricultural fields.

Table 2:- List of the Farmers, vegetables cultivated, type, dose and frequency of pesticide used in some major and potential agricultural fields of the district.

Sl No.	Area	Farmer's Name	Vegetable cultivated	Name of the pesticide used	Dose	Frequency of the dose
1	Baghpur part-1	S.R. Barbhuiya and A.K.Laskar	Cauliflower, Beans, Chilies, Pumpkin, Capsicum, Mustard, cabbage, etc.	Ustaad, Rogor, Thydine, Furadon, Celcron.	50 grams in 16L of water	1 – 3 times/ month
2	Baroinagar, Ranighat.	I.R. Laskar	Bitter gourd, pumpkin, Mustard, Beans, Cauliflower, Cabbage, Broad beans.	Ustaad, Potash, Celcron	1 scoop in 5 L of water	Twice/ month (in case of excessive pests) or else Once/month
3	Doodhpatil	Q.U. Chaudhury	Chili, capsicum, brinjal, cucumber, coriander, cauliflower, beans, onions, tomato, mustard, pumpkin, French beans	Karina Nigra, Celcron	1 scoop in 5L of water.	Thrice/ month

A visit to Krishi Vigyan Kendra, Arunachal:

The list of insect pests of various agricultural crops of Cachar District is presented in the following table.

Table 3:- List of the vegetable pests or insects that are prevalent in Agricultural fields across Cachar district.

Sl No.	Type of the vegetable	Common names of the pests or insects	Scientific name of the pests and insecticides
A.1	Cole crops	Diamond black moth	*Plutellaxylostella*(Linn)
A.2		Cut Worm	*Agrotisipsilon*
A.3.		Cabbage semilooper	*Plusiaorichalcea*(fabr)
A.4.		Cabbage butterfly	*Pieris brassica* (Linn)
A.5.		Tobacco butterfly	*Spodopterialitura*(Linn)
A.6.		Cabbage borer	*Hellulaundalis*(fabr)

Sl No.	Type of the vegetable	Common names of the pests or insects	Scientific name of the pests and insecticides
B.1.	Potato	Potato tubermoth	*Pthorimiaeaoperculla*(Zellar)
B.2.		Red ant	*Dorylusorientalis*
B.3.		Spotted leaf beetle	*Aepilachlavigintioetopunctata*(fabr)
C.1.	Tomato	Tomato fruit borer	*Helicoverpaarmigera*(Hue)
C.2.		Brinjal Stem borer	*Ozopheraverticella*
C.3.		Leaf minor	*Tutaabsoluta*
C.4.		Cobite fly	*Bemisiatabaci*
D.1.	Brinjal	Fruit and Shoot borer	*Leucinodesorbanalis*
D.2.		Brinjal Stem borer	*Ozopheraverticella*
D.3.		Brinjal lacewing	*Urentiussintis*
E.1.	Chili	Chili thrips	*Scirlothrips dorsalis*
E.2.		Miner	*Liriomyzatrifolli*
E.3.		Mite	*Pelyphegotarsonpmus*
E.4.		Aphid	*Myzaspersicie*
F.1.	Pumpkin	Red pumpkin beetle	*Aulacophorafoveicollis*
F.2.		Fruitfly	*Decascucurbitae*
G.1.	Onions	Thrips	*Thrips tabaci*

Changes in the Physico-chemical factors of water used during experimentation:

The physico-chemical factors like pH, Dissolved Oxygen (D.O.) and free Carbon dioxide (CO_2) in the water sample were monitored to understand the changes in these parameters during entire experimental period.

Changes in p^H:

The p^H of the water samples of both control and experimental (pesticide exposed) was determined with the help of p^H meter at 0 hour and 24 hours. Clearly, it can be observed from the table that at 0 hour the water sample of controlled was more alkaline than experimental one and after 24 hours the water sample was acidic of both controlled as well as experimental one.

Changes in Dissolved oxygen (D.O.)

The dissolved oxygen present in the water sample was determined and calculated at 0 hour and 24 hours by following Winkler's Iodometric method. Usually the range of D.O. present in water should lie between 3-5mg/L. The D.O. of the of the water samples at 0 hour were nearer to the range but after 24 hours the D.O. level drops down. This shows an increase in the B.O.D. level of the water samples.

Changes in free CO_2 :

The amount of free CO_2 present in the water sample was determined and it was found out that the amount of free CO_2 present in water samples of both controlled and experimental increased considerably in 24 hours.

	Mean pH ±SE		Mean D.O.±SE		Mean free CO_2±SE	
Time	Control	Exposure	Control	Exposure	Control	Exposure
O hr	7.50 ±0.041	7.04±0.15	2.97±023	3.71±0.04	13.2±0.02	18.34±0.17
24 hr	6.85±0.1	6.85±0.01	1.34±0.018	0.74±0.12	97.54±0.13	81.4±0.19

Estimation of LC_{50} of the pesticide used in the experiment:

To start the Acute toxicity of any xenobiotic, determination of LC_{50} is required. It is the Median Lethal Dose where 50% death of the organisms occurs. To determine $LC_{50,}$ the fishes were exposed to four different concentrations of Profenofos for 48 hours. With the help of the data obtained the value of the LC_{50} was obtained by the Graphical Extrapolation Method. The value of LC_{50} was found to be 2.5mg/L.

Table 5:- Different doses for the determination of LC_{50} of the xenobiotic used.

Sl No.	Aquarium	Time duration	Dose	Number of fishes	Number of death fishes	Number of alive fishes
1	Aquarium A	48 hours	5 x 10^4 µg/L	5	5	0
2	Aquarium B	48 hours	5 x 10^3 µg/L	5	3	2
3	Aquarium C	48 hours	5 x 10^2 µg/L	5	2	3
4	Aquarium D	48 hours	5 x 10 µg/L	5	0	5

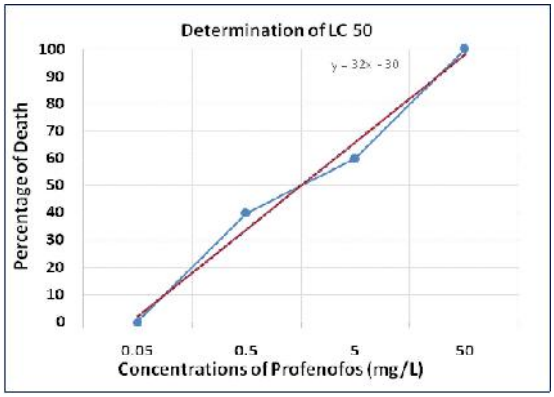


Fig- 6: Graphical Extrapolation method for the for the determination of LC_{50}.

To determine the Acute toxicity of the Profenofos:

Changes in Body Weight of experimental fishes

The result indicates that the body weight of experimental fishes was slightly reduced at 96 hours in both control and experimental fishes.

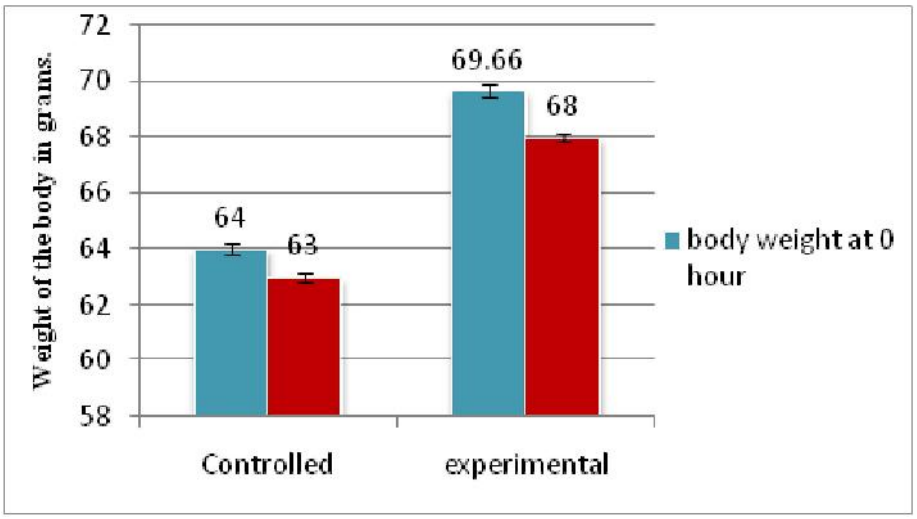


Fig-7: Showing changes in the Body Weight of fishes.

To study the behavioural changes of the experimental organisms:

Behavioural changes like opercular activity, surfacing phenomenon were observed in case of controlled and experimental ones. Results show that the rate of opercular movement decreases and that of the surfacing phenomenon increases considerably.

Table 6:- Rate of opercular movement of fishes underexposure and controlled.

	Mean Rate of opercular movement of the fishes (No. of times/ 15 minutes)		Surfacing Phenomenon. No. of times/15 minutes	
Time	Control	Exposure	Control	Exposure
0 hr	900	825.66	06	10
6 hr	892.33	714.66	08	17

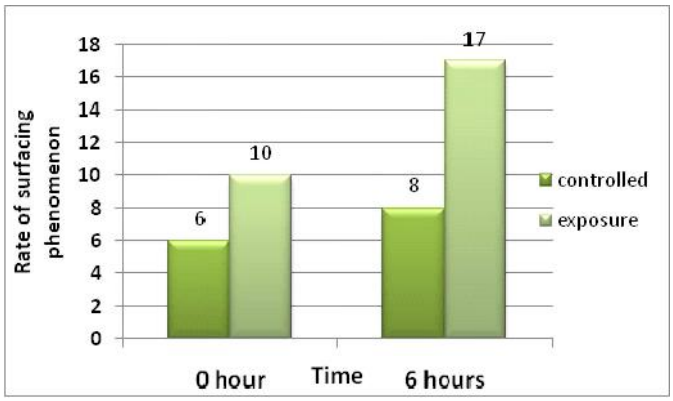


Fig 8:- Depicting the surface phenomenon in controlled and experimental fishes.

To study the morphological changes of the experimental organisms:

No such morphological changes were observed except for some secretion of slime from the dermal layer.

Changes in Haematological parameters:

Haemoglobin percentage:

The haemoglobin percentage of the fishes that were under controlled and experimental conditions were taken after 96 hours. Interestingly, the Hb% found to be increased in the exposed fishes compared to control.

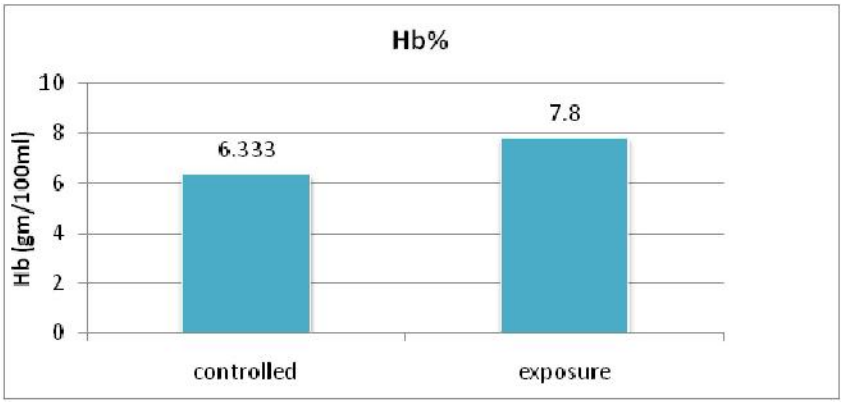
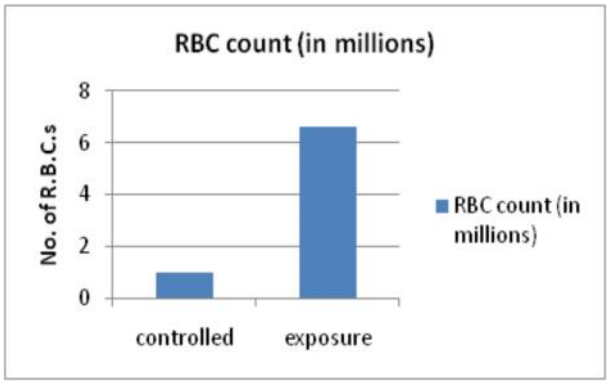


Fig 9: Showing Hb% in control and exposed fishes

To determine the number of red blood cells present in 1cubic mm volume of blood:

Results shows that there is an increase in total count of R.B.C. in exposed fished compared to control.

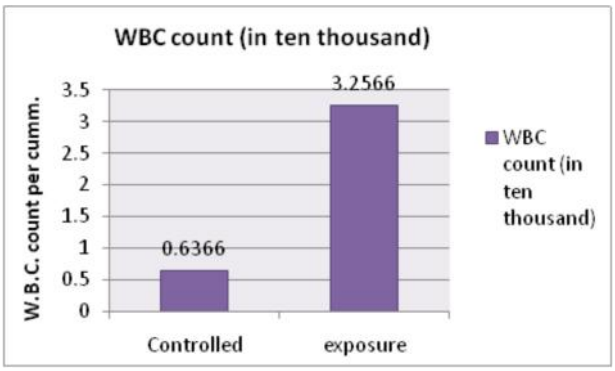


Total count of R.B.C. in (in millions) Mean±Standard Error	
Control	**Exposure**
1.003±0.272	3.636±0.49

Fig 10: Depicting the changes in total no. of R.B.C.s in 1 cumm of blood.

Changes in WBC count:

Results indicate that there is an increase in WBC count in exposed fishes compared to control.



Total count of W.B.C. in (in ten thousand) Mean±Standard Error	
Control	**Exposure**
0.6366±0.39	**3.2566±0.31**

Fig 11: Depicting the changes in W.B.C. count per cumm of blood in control and exposed fishes.

Discussion & Conclusion:

This paper presents results of a preliminary survey on pesticide usage pattern in Cachar District of Assam against various agricultural pests combined with that of acute toxicity test on air-breathing robust fish species *Clarias batrachus*. This study has been undertaken at the backdrop of a concern that enormous use of pesticide in agricultural fields to meet the demand of crop production may have a devastating effect on aquatic ecosystem. However, before concluding on the impact of pesticide on a particular ecosystem, it is very important to assess the actual pesticide burden taken by the environment of a particular region. Here, we presented a list of at least 30various insecticide and pesticides which are commonly sold and thus utilised for pest control. However, the ones which are recognised the farmers' best choices are also identified through interactions with local farmers. Therefore, the primary aim of assessing the pesticide usage trend in a particular locality and impact of pesticide on aquatic environment has been fulfilled to a great extent through this fundamental study. Since fishes provide important source of protein the impact assessment on bioaccumulation of organic pesticides in fish tissues and their possible health hazards in human cannot be ignored, but this paper remains silent on this issue as such assessments are beyond the scope of the present study.

Interestingly, the present survey of agricultural fields of the district and interaction with farmers revealed an alarming fact on pesticide usage in this region. It was found that the amount and the frequency at which the farmers were spraying pesticides in their crop fields was too high as compared to the prescribed dose of a particular pesticide. Farmers clearly claimed that their crops suffer if they follow the prescribed dose of pesticide. Moreover, selection of pesticide for acute toxicity study was also based on farmers' views on most effective one in their fields. Profenofos (Celcron) had been considered the most powerful and effective one.

In the present work, a sub-lethal concentration (50 µg/L) as low as 1/50th of LC_{50} was used to assess the 96 hr acute toxicity in a very hardy air-breathing fish. So, from the outcome of this acute toxicity study it can be easily presumed that the exposure to this kind of pesticide at a very low concentration can have harmful consequences on other fish and sensitive invertebrate species including phyto- and Zoo-planktons. These effects of low concentrations on other delicate aquatic organisms need to be studied to understand the extent of interference with primary productivity in an aquatic ecosystem, which may be enough to distort the food chain and food web.

The results of acute toxicity showed presumably an unusual physiological response in terms of increase in RBC, WBC count and haemoglobin percentage. This responses may be considered as stress responses in which the body probably tried develop a mechanism to cope up with the sudden stress. The genotoxic and haematological effects of chloropyrifos on freshwater fish *Labeo rohita* also revealed such increase in leucocyte count Muhammad Ismail et. al., (2014). This results thus supports the present findings. However, the behavioural responses like increase in gulfing and surfacing phenomena or decrease in opercular movements together with loss in body weight for both control and exposed fishes can be justified as normal stress response.

Therefore, more studies are required to be conducted to finally come to a conclusive remark on the various stress responses exhibited by the organisms. When elaborate assessment of histological, genetic and molecular effects of various types of organic xenobiotic are of utmost necessity, it is equally important to apply other environmentally safe bio-control methods and techniques to combat the menace of pests in agricultural fields. Use of bio-control agents like Entomopathogenic Nematode (EPN) can be a very useful tool to promote sustainable agriculture in this valley of Assam. Synergism in Research collaborations, Government initiatives, Peoples' participation and Awareness activities only have the potential to save our environment specially, aquatic ecosystems from the uncontrolled use and thus from dire consequences of such synthetic chemicals.

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Green Libraries towards Green Sustainable Development

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Abstract

Environmental protection is a practice of protecting the natural environment on individual, organizational or governmental levels, for the benefit of both the natural environment and humans. Libraries are not far behind in protectingthe environment.The Concept of Green Libraries is gradually attracting the attention of library administrators worldwide and the efforts to develop green libraries are on rise.This paper begins with an explanation of Sustainability, Environmental Sustainability, concepts of Green Library and highlights the Indian scenario for green libraries. Further, this paper also demonstrates the various sustainable strategies for green library building to provide user friendly behavior to the users. The adverse impact of new technologies on the environment also increases the requirement of green practices/ services within libraries.This paper also provides a different approach for librarians to achieve green practices/ servicesand to ensure the improved library services of the available resources efficiently and effectively within the library.

Keywords: Environmental Sustainability, Green Library, Green Practices, Parameters of Green Library Role of a Librarian, Standards for Green Libraries.

Introduction:

Our beautiful nature is continuously degraded by human beings and causing problems like global warming and climate change. Shrinking glaciers, melting ice caps and wide ranges in temperature provide evidence that something is happening with our climate. Libraries don't come into our mind when we think of problems like global warming and climate change.

Libraries are not only repositories of knowledge, but are also important information resources for raising awareness about environmental concerns.The diversity of activities covers many facets of environmental sustainability in libraries and librarianship.

Emergence of new technologies and its applications in libraries in everyday tasks raise the risk to environment .To overcome these, a healthy environment is needed. Green library not only saves the earth but also help in achieving sustainability.

Green buildings and green practices in the libraries gives pleasant atmosphere to all type of users and enhance better quality of life within and outside the library.

So it's high time for the library professionals and administrators of the Institution to play a major role for the betterment of environment by implementing the concept of Green Library.

Meaning and Definition of Environmental Sustainability and Green Library:

Environmental sustainability:

Environmental sustainability is the concept that advocates a balance between economic growth, social equity and ecology that meets the needs of the present without compromising the ability of future generations to meet their own needs.

According to Environmental Strategy for the First Decade of the 21st Century (OECD, 2001) there are four specific criteria for environmental sustainability: regeneration (renewable resources shall be used efficiently and their use shall not be permitted to exceedtheir long-term rates of natural regeneration), substitutability (non-renewable resources shall be used efficiently and their use limited to levels which can be offset by substitution with renewable resources or other forms of capital), assimilation (releases of hazardous or polluting substances into the environment shall not exceed their assimilative capacity) and avoiding irreversibility.

Green Library:

Green library refers to a library which is designed to reduce negative impact on the natural environment and upgrade indoor environmental quality via proper site selection, consumption of natural and eco-friendly construction materials and biodegradable products, conservation of natural resources like water and other resources like paper and energy and responsible waste disposal or recycling etc.

Apart from these green libraries, helps in achieving all the five laws of Library Science.

According to New World Encyclopedia, "Green library, also known as a sustainable library, is a library built with environmental concerns in mind. Green libraries are a part of the larger green building movement."

The Online Dictionary of Library and Information Science *(ODLIS)* defines green/sustainable libraries as, "A library designed to minimize negative impact on the natural environment and maximize indoor environmental quality by means of careful site selection, use of natural construction materials and biodegradable products, conservation of resources (water, energy, paper), and responsible waste disposal (recycling, etc.)".

Green Library Building:

Green Building refers to the design, construction, operations, maintenance, reorganization and demolition of an organization's environmentally responsible and effective processes throughout the building's life cycle. The Green buildings are followed by Green Architecture, or green design, which is

an approach to building that minimizes the harmful effects of construction projects on human health and the environment.

Parameters for Building Green Library:

The green buildings can have tremendous benefits in the form of water saving, biodiversity enhancing, energy saving and waste management effective by designing in a way that maximizes the use of natural and renewable resources.

Site Location: A proper site selection is very necessary for a green library as compared to other types of buildings. Library Building Location in a populated area, reach ability location, parking and local conditions like storms, erosion, moisture and dust, etc. are also to be considered before finalizing site.

Water Conservations:- Use of roof water harvesting, green toilets, water recycling, etc. can save lot of water for proper landscaping and greenery in and outside the library building.

Energy Conservation:- It is most important aspect in green revolution. Use of wind and sun can manage temperature and light in place of electricity. Sufficient number of windows and skylights allow natural light instead of electric light during day time. Planting Solar system on the roof top of the library can conserve electricity for use during night time.

Building Material:- Use or recycle of waste products will reduce damage to natural Environment. Less use of wood will save many trees. Use of locally available material will save transport cost and fuel. It also includes use of biodegradable materials, non use of plastics and other such products. Many modern building technologies have emerged which are more eco friendly and should be used in new library buildings.

Indoor Air Quality:- Lack of ventilation at public places can cause many harmful effects such as bacterial infections, etc. The air should be recycled and should not be stagnant. Least use of air conditioners will reduce emission of harmful gases responsible for holes in ozone layer and intern global warming.

Standards for a Green Building:

Green buildings are measured according to building standards given by following various councils all over the world and in India also.

(USGBC) Standard:

The United States Green Building Council (USGBC) has developed Leadership in Energy and Environmental Designing Rating System (LEED) in the year 2000. LEED certification is recognized across the globe as the premier mark of achievement in green building. LEED rate on 100 points and certify the buildings on the following criteria:

- 40-49 points as Certified
- 50-59 points as Silver
- 60-79 points as Gold
- 80+ points as Platinum 6

LEED also uses various categories to judge the buildings sustainability through design elements like site location, water conservation, building materials and resources, indoor air quality, energy efficiency, and innovations in design.

Chicago Illinois Standards:

Chicago is one of the first cities to incorporate environmentally friendly practices in to public buildings and developed its own standard. This standard is highly influenced by LEED Green Building Rating System. According to it, Green building and sustainable building both refer to the design and construction of buildings that have a minimal impacton the environment. Green building encompasses all phases of design, materials selectionand construction including life-cycle analysis and energy efficiency.

Brown Green Standard :

California Governor Jerry Brown discussed the emerging trend of green libraries and proclaimed that the libraries were on the cutting edge of Green design. New or renovated state buildings over 10,000 sq. feet will have to reach the U.S. Green Building Council's LEED Silver Certification or higher as well as incorporate clean energy generation.

GBC Indian Green Building Council Standard :

The Indian Green Building Council (IGBC), part of the Confederation of Indian Industry (CII) was formed in the year 2001 to promote and rate Green buildings in India.

The council offers a wide array of services which include developing new green building rating programmes, certification services and green building training programmes.

Leadership in Energy and Environmental Design (LEED-India):

· USGBC has also established a LEED hub in India to further accelerate the adoption of LEED in India. USGBC and IGBC continue their collaboration in advancing the uptake of green buildings in India. LEED India projects registered with IGBC till June 2014 would be certified by IGBC. LEED projects in India registered after June 2014 would be certified by the Green Building Certification Institute (GBCI).

Green Rating for Integrated Habitat Assessment (GRIHA) :

TERI (The Energy and Resources Institute, New Delhi) is another organization that is in forefront of the Green building movement in India. It was TERI who predicted the need for development of an indigenous tool for rating of green building in India which led to the foundation of 'GRIHA'.

Green Collection Development:

Collection development is ongoing process, undertaken by librarian and library staff with input from faculty and students. Environmental themed information resources will provide knowledge and awareness for the patrons in the library in emerging multidisciplinary areas such as environmental, global, and health studies. Scholarly information materials acquired in digital formats, including electronic journal back files, electronic books, digital video, image collections, data sets and a variety of special collections will help in growing collections.

Green Printing and Copying:

Globally paper consumption is constantly growing rapidly; paper use has reached almost 400 million tons of paper per year. Even the rapid advancement and development of modern technologies for information transfer and information storage centres cannot overcome ever-growing consumption of paper. Digital and Electronic archives, electronic-mail, and the Internet cannot compete without printed documents being produced out in every library and information centre.

Environmental sustainability and preservation of natural resources are becoming a priority and an effective initiative for libraries of all sizes and types.

Some benefits of green printing-

Cost-effective: Green printing has many benefits for the environment and also for the savings on printing costs. When fully achieved in a library or even at home, the expenses can be reduced by up to 70% or more depending on the eco friendly strategies applied.

Preservation and conservation: When the point comes to environmental concerns, green printing can help in preservation and conservation of the natural resources. By saving paper, we can save a tree in a year and globally, we can save an entire forest.

Paper Recycling: Paper recycling pertains to the processes of re-processing waste paper for reuse. Recycled paper is the greenest option as it uses less energy, water, and produces lower carbon emissions than the manufacturing of non-recycled paper.

Reducing the Impact of Printing: The printing of publications and production of paper both use large amounts of natural resources, such as water, tree, and energy, as well as potentially hazardous materials. The printing process itself also involves numerous inks, solvents, acids, lacquers, dyes, driers, varnishes, shellacs, and many other solutions, that can be hazardous to both humans and the environment.

Ink Scheme: Ink printers and their inks are made up of several ingredients, most of the chemicals that have the potential to be damaging to us and the environment. Manufacturing just one single toner cartridge emits around 4.8kg CO_2 Greenhouse Gases per cartridge. There are many adverse effects of just throwing away an old ink or toner cartridge. The heavy metals and chemicals which present in these inks or toner cartridge will pollute the soil and water when they reach landfills. This large abundance of waste can be reduced, or practically eliminated by reusing and recycling. If we recycle our printer cartridges, we conserve energy and natural resources, as we reduce the energy needed for the materials.

Suggesting different printing options:

- Read articles online and take notes instead of printing the entire article.
- Read article abstracts of the article before printing to make sure the article is really useful.
- Scan the text into a computer instead of making photocopies and then read it online.
- Convert documents to pdf files for paperless document sharing.
- Help the library to reduce paper waste by making two-sided copies whenever possible.
- No prints, share by e-mail.
- Borrow from libraries instead of buying personal books. This saves money and also the paper that goes into printing new books.

Going Digital:

Libraries can prefer e-mails instead of mailing out paper newsletters and notices, use fax modems to send and receive paperless documents, create email campaigns to announce special events and keep in touch. Libraries these days are offering electronic services through messages (SMSs) and emails, releasing library metadata to the open web, cutting down on paper notices and making it easier for patrons to keep up with their accounts by making them accessible online. Libraries are being part of

eco-environment movement and supporting paperless library by going digital in every aspect. Libraries have also started adding green taglines / environmental emailsignatures to e-mails with aim to keep e-mail paperless.

Energy saving Practices:

Libraries follow some energy saving practices like, preferring Laptops or LCD monitors, switching off the computers and other machines at the end of each working day and at weekends, switching the lights off when not needed, and upgrading computers with thin clients, energy rated CPUs and efficient servers.

Waste Management:

- Recycle computers: Safely recycle computers instead of harming the environment when you throw them away. Buy recycled ink cartridges and other supplies.
- Discard weeded books by selling it to used book dealers, exchange library materials with other participating libraries or donate to other libraries.
- Get rid of waste by composting and stop using plastic bags.

Environmental Awareness and Education Programs:

This is the new role of a library in connecting public with the environmental awareness and education on recycling, sustainable living and waste reduction by organizing programs like:

- Organic gardening
- Recycling and up cycling craft competitions
- Eco-essay competition
- Discussion events on environmental topics, book discussions
- Public debates on ecology and sustainability
- Library tree plantation activity
- Celebrating environmental theme weeks and event
- Organizing lectures on environmental issues.

Role of Green Librarian:

The Green Librarian must be aware of himself/herself as well as create awareness among the library users to be environment friendly and keep the library ever green.

- Encouraging users to use e-books, e-journals etc which can work as space, paper saving tools.
- Using different electronic and online media tools for communications.
- Working under eco-library system and identifying the people who wish to work.
- Promoting green library tools, techniques to encourage others.
- Organizing seminars, conferences and discussions towards green Library.
- Taking necessary steps for conservation of energy, water, paper etc.
- Use wooden furniture and material because these are bio degradable materials.
- Using recyclable paper insulation to make environment friendly building.

Green Library Movement in India:

The Green library movement is a cooperation of persons that are dedicated to reducing the environmental degradation and try to green libraries. This movement involves librarians, library staff, library users, librarians along with students and teachers from educational institutions as well as interested people from villages, town and cities. Very recently, Indian libraries started to have provisions for natural lights as much as possible, energy saving bulbs in the reading rooms and other places within library premises, provision of natural air, emphasis on cleanliness, hygienic toilets, adequate provision of waste bins at appropriate places, proper disposal policies for weeded library materials / equipments etc.

TERI has been in the forefront of the Green Library movement in India. This organisation has created first USGBC rated Green Building in India namely CII-Godrej Green Business Centre in 2001. TERI thought of the need for development of an indigenous tool for rating of green buildings in India. This rating system - GRIHA - has been created by the government of India as the National rating system. In Kerala COSTFORD (Centre of Science and Technology for Rural Development) a non-profit organization established in 1985 focuses on development of housing and made significant gains in providing alternative philosophy and technologies in order to take major responsibility in improving Green Library Movement in India.

Green library initiatives in India:

In India, green library building concept has started growing slowly. Many of the Indian Libraries have already started on conceptualizing and implementing provisions for natural lightings, energy savings, and provision of natural air, cleanliness and proper disposal of waste products of libraries. Noted Green Libraries in India are:

Sl No	Name of the Library	Initiatives
1.	CHENNAI'S GREEN LIBRARY-ANNA CENTENARY LIBRARY	The vision of this library is to be an urban library internationally recognized known for excellence in learning, innovative research and community engagement that contributes to the economic vitality, environmental Sustainability and quality of life in the Chennai region and beyond. In July 2010, the library building received the LEED NC Gold rating from IGBC becoming the first library building in Asia to reach this. This project has achieved 43 LEED points, highest amongst any government buildings in Tamil Nadu.
2.	DELHI UNIVERSITY LIBRARY	The Library Building is naturally cool and pleasant with broad opening for natural lights. To prevent excessive heat of the Delhi Summer desert coolers are being used whichhave pads with indigenous material ' Khuskhus' which prevents heat from coming inside.
3.	KARNATAKA UNIVERSITY LIBRARY	No books, book shelves, chairs or tables but benches are installed under the trees so that students can sit and read the books taken from the university library.
4.	NIT, SILCHAR	The initiatives for Greening the library taken by NIT, Silchar is probably the first of its kind in the entire North East Region of India. The New Library Building under construction is designed according to LEED certification system of U.S which can be the role model for developing green libraries in Barak Valley.
5.	PERNA KARPO LIBRARY, LADAKH IN INDIAN HIMALAYAS	Solar panels, surrounded by white lotus garden, innovative technologies.

Role of UGC-NAAC in development of Library:

NAAC accreditation is mandatory for all the higher learning institutions. Without NAAC accreditation, universities/colleges are not eligible for UGC grants, RUSA grants, financial aid etc.

As per the latest NAAC Institutional Accreditation- Manual for Self Study Report, in criteria –IV- Infrastructure and Learning Resources, in 4.2 Library as a Learning Resource- The library holdings in terms of books, journals and other learning materials and technology-aided learning mechanisms which enable students to acquire information, knowledge and skills required for their study programmes are asked.

In Criterion VII: - Institutional Values and Best Practices in 7.1 Institutional Values and Social Responsibilities, the National Assessment and Accreditation Council (NAAC) have started to assess the academic Institutions on environmental benchmarks. As per the universities/colleges are judged on social impact factors of its extension programmes on the community. The institutional initiatives towards energy consciousness like whether it conducts a green campus audit and activities like energy conservation, use of renewable energy, water harvesting, efforts for carbon neutrality and e-waste management, carbon neutral, green practices etc. have also been incorporated. Libraries are integral part of academic institutions and therefore there has to be green practices implemented in the library in support of this NAAC activity.

Challenges in greening the libraries:

Notwithstanding the green library movement and sustainable practices are realized across the world, still there are some challenges to be dealt with:

- Though cost of constructing green building has become affordable to other entities, libraries will face issues in meeting green goals as they are subject to stringent budget cuts especially when re-engineering or reconstructing library structures one cannot forget the cost associated with it.
- Library buildings are most neglected part especially in colleges. At most places librarians are helpless as he has to work in an allotted space even when new buildings are being proposed or are under constructions. Architects too do not bother for well constructed green library buildings.
- Green practices in sustainable manner require considerable degree of expertise or competency from general management to ordinary level of maintenance throughout library functions. It is likely to expect lack of awareness in green technology and among the employees who have been recruited with traditional knowledge and skills.

- Attitudinal barriers play significant role in slowing down the sustainable practices inlibraries. There are possibilities to convince the administration who would otherwise object the idea executing green library practices due to their unawareness. A well laid plan for green library building will remove resistance to change.

Suggestions:

Following suggestions are made for green Libraries in India and to protect our environment and thereby making libraries sustainable.-

- UGC should take steps to improve library buildings in academic institutions and convert them green libraries by providing grants.
- UGC/Approving Agencies should make it mandate for all colleges and Universities to get the approval to go for Green Libraries and also green buildings.
- Government should take steps to promote green libraries through award and financial aid to maintain such libraries.
- Libraries can use a variety of tools to popularize the 'green concept' and educate their patrons about the features of their green buildings.
- Library buildings should be properly planned using Green Building Standards.
- Librarians should be aware of new in green library initiatives and be part of planning of buildings for institutions.

Conclusions:

Green Library contributes towards maintain the natural ecological balance in the environment and preserving the planet and its natural systems and resources. Green Buildings has very important role in the environmental protection. To become as sustainable, libraries can play their important role by performing well on all aspects of green practices such as providing green library services, and implementing environmentally supportive and sustainable activities within the library. It is a wakeup call for all the librarians to play a role leader to construct modern Green Buildings to save our natural environment and also to provide information to the users.

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Population Status of Vultures in D'Ering Memorial Wildlife Sanctuary, Arunachal Pradesh, India

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Abstract

The continued surveys from 2016 to 2019 to assess the population status of vultures in Arunachal Pradesh have resulted in sighting of total 344 individuals of vulture in D'Ering memorial wildlife sanctuary, Arunachal Pradesh, India. Only four vulture species have been recorded during the study period and these are WRV, SBV, LBV, and HV. Among the species, HV were the most abundant (n=174), followed by WRV (n=96), SBV (n=57), and LBV (n=7). Total of 28 individuals in 2016, 75 individuals in 2017, 202 individuals in 2018, and 29 individuals in 2019 were recorded. A total of 30 point counts and 5 opportunistic sighting were carried out over the span of study period. These regular sighting of vultures in the sanctuary indicates that the region has a suitable habitat for the vultures. The finding suggested that the overall population status of the vultures in the sanctuary is somewhat stable. The habitat degradation, food shortage and intentional hunting were found to be the major potential threats to vultures in the sanctuary. Therefore, there is need of more intensive monitoring of vultures' population and its ecology to provide safeguard to the persistingvultures in the sanctuary. Also, the finding urges the policy makers and managements to take required initiatives for protection of these birds in the sanctuary.

Keywords: Arunachal Pradesh; vulture; distribution; population size; threats

Introduction:

A regular monitoring on vulture's population can tell the status of any vulture species in their habitat, that whether they are in declining, stable or increasing state. The indices obtained from such surveys can help wildlife managers and conservationists to take appropriate measures to save and protect these species, whenever there is necessity. Vultures are among the most threatened raptors in the world (Chaudhary et al., 2012; Ogada et al., 2012). They are considered to be nature's most successful scavengers, and provide an array of ecological, economic and cultural services (Markandya et al., 2008; Pain et al., 2003). The most notable one is being the disposal of carcass. By removing the carcass, the vultures help in keeping the environment clean and safe; prevent the spread of deadly diseases caused by pathogens that thrives on putrefied carcasses. So far, nine species of vulture are recorded from the Indian sub-continent (Ferguson-Lees & Christie, 2001; Grimmett et al., 2014; Prakash et al., 2003), and eight species from Arunachal Pradesh (Kumar, 2010; Mize et al., 2014, 2016; Lepage, 2021a). of these, four species namely White-rumped vulture *G-ypsbengalensis*, Slender-billed vulture *Gypstennuirostris*, Long-billed vulture *Gyps indicus*, and Red-headed vulture *Sarcogypscalvus* have been categorised as critically endangered species (CR); Cinereous vulture *Aegypiusmonachus*, Bearded vulture *Gyp aetusbarbatus*, and Himalayan vulture *Gyps himalayensis*

as near-threatened species (NT); and Eurasian griffon *Gyps fulvus* as least concern species (LC) by International Union for the Conservation of Nature (IUCN, 2019). Arunachal Pradesh (26º28' - 29º30' N and 91º30'- 97º30' E) situated in north-eastern most part of India harbours varied forms of fauna and flora in it. The topographic characteristics, climatic conditions, varied vegetation and vast forest cover supports the rich biodiversity. The state is among 200 globally recognised eco-regions of the world (Myers et al., 2000; Olson & Dinerstein, 1998). Also, the state is a part of Eastern Himalayan biodiversity hotspot region (Myers et al., 2000; Sen & Mukhopadhyay, 1999), which makes it a region for conservation priority. There are 13 protected areas (2 national parks and 11 wildlife sanctuaries, for the protection of wildlife in the state (WII, 2021). D'Ering memorial wildlife sanctuary (DEMWLS) is one of such protected areas located in East Siang district of Arunachal Pradesh. The sanctuary is mostly a riverine landscaped region. The published checklist suggests that the sanctuary has 109 bird species (Lepage, 2021b). Six vulture species have been reported to be present in the sanctuary, so far and these are White- rumped vulture (WRV), Slender-billed vulture (SBV), Long-billed vulture (LBV), Himalayan vulture (HV), Cinereous vulture (CV), and Eurasian griffon (EG) (Mize et al., 2014; Lepage 2021b). Sighting of these vultures in the sanctuary indicates that the region has a suitable habitat for the vultures to live and has the potential for any in-situ approaches in near future. The earliest report on vultures' occurrence in the sanctuary can be traced back to the work of Katti et al., (1992). They reported the sighting of White-rumped vulture and Long-billed vulture from Mehao wildlife sanctuary and Siang region (which also encompasses DEMWLS). Following the years, other authors also have reported the presence of vultures in the sanctuary (Biswas et al., 2005; Kumar, 2010; Mize et al., 2014, 2016). Except Kumar (2010), all the other works were mere sighting reports, and lack detailed investigation on vultures, such as their current population trend or status, ecology, behavioural study from the sanctuary. Kumar (2010), reported 33 individuals of three species (WRV, SBV and HV) in the sanctuary and this was the only work that gave us information on vultures' population from the sanctuary. At present context, the population status of vulture in the sanctuary is not known. Therefore, the present work aimed to find out the population status of vulture species found in the sanctuary over the study period. Also, it aimed to find out any potential threats to the vulture populations in the sanctuary.

Materials and methods:

Study area:

The present work covered the areas of D'Ering memorial wildlife sanctuary (DEMWLS), East Siang district, Arunachal Pradesh (Fig. 1). The sanctuary being one of the Important Birds Area (IBA) in Arunachal Pradesh (Rahmani et al., 2016), lies at between 95°22´ E - 95°29´ E and 27°51´ N - 28°05´ N and span over an area of 190 km^2. The altitude ranges from 100 m to 150 m amsl that gradually decreases from north to south. The sanctuary is bounded and criss-crossed by Siang River and Sibya River. The sanctuary is divided into three managerial ranges namely Anchalghat, Namsing and Borguli. Two major types of habitat are prominent, grassland (about 80%) and riverine forest

patches (20%) (Rahmani et al., 2016). *Phragmiteskarka*, *Imperatacylinderica*, *Arundodonax*, *Erianthusravannae*, *Neyraudiareynaudiana*, *Saccharumspontaneum* and *Saccharumarundinaceum* are some of the dominant species of grasses found in the sanctuary. *Zizyphusmauritania*, *Dalbergia sisoo, Albizzia procera,Bombax ceiba*, *Daubanga grandiflora*, *Terminaliamyriocarpa*, *Dellinia indica*, *Gmelina arborea*, *Amoora wallichi*, *Talauma hodgsonii*, *Solanum torvum* and *Ficus* dumosa are some of the prominent trees species found in the sanctuary (Mize et al., 2014). DEMWLS experiences a tropical climate with distinct hot and cold season round the year. The winter starts from November to March, characterised by very low rainfall and humidity. Summer starts from April to August and are characterized by heavy rainfall, high temperature and high humidity. June, July and August are the wettest months.

Methodology:

We conducted modified point count following Bibby et al.,(1992) and opportunistic sightings to collect the data on population status of vultures in the sanctuary. 10 points were randomly chosen inside the sanctuary, where the two adjacent points were separated by a minimum distance of 1 km. The surveys were conducted from 0800 hours to 1700 hours. In total 30 point counts were carried out, following 3 visits per year at each point. Also, 5 opportunistic sighting were carried out, based on prior communication on vultures' presence. The vultures were observed with 20X40 DPSI Olympus binocular and direct naked eye. The coordinates of the sightings were recorded using Garmin Montana 680 GPS. Photographic records were taken with Canon EOS 700D with 70-250 mm zoom lens. The species were identified using field guide (Grimmett et al., 2014) and a research paper by Alstrom (1997). ArcMap 10.4 was used to draw the study area map. To identify any possible threats to the vultures in the sanctuary, we carried out close-ended questionnaire surveys. 32 respondents were selected, comprising of 10 individuals of departmental officials and 12 individuals of field workers engaged in DEMWLS; and 10 individuals from fringe areas of the sanctuary.

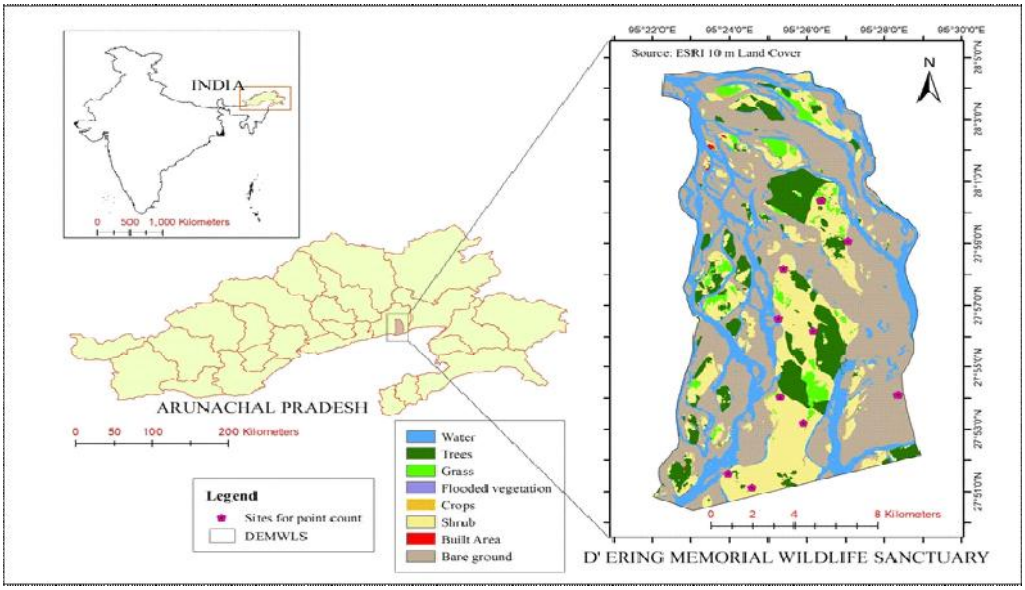

Fig.1. Map showing D'Ering memorial wildlife sanctuary

Results:

Population status of vultures in the sanctuary:

The continued surveys from 2016 to 2019 have resulted in sighting of total 334 individuals of vultures in the sanctuary. Presence of 4 vulture species have been confirmed and were recorded during the survey period and these areWRV, SBV, LBV, and HV (Table 1). Among the species, HV was the most abundant (n=174), followed by WRV (n=96), SBV (n=57), and LBV (n=7). Total of 28 individuals in 2016, 75 individuals in 2017, 202 individuals in 2018, and 29 individuals in 2019 were recorded (Table 2).

Table 1. Summary of vultures found in DEMWLS

Sl. no.	Species	IUCN Status	Habitat
1	White-rumped vulture	CR	R, O, A
2	Slender-billed vulture	CR	R, O, A
3	Long-billed vulture	CR	R, O, A
4	Himalayan vulture	NT	R, O, A

R= Riverine forest/vegetation

O= Open savanna with scattered tall trees and bushes

A= Aerial

Table 2. Population status of vultures in DEMWLS (2016-2019)

Sl. No.	Species	2016	2017	2018	2019	Total
1	White-rumped vulture	03	32	43	18	96
2	Slender-billed vulture	03	04	39	11	57
3	Long-billed vulture	03	-	04	-	07
4	Himalayan vulture	19	39	116	-	174
		28	75	202	29	334

Potential threats to the vulture populations in the sanctuary:

The questionnaire responses showed that the habitat degradation, food shortage and intentional hunting are the potential threats to the vultures in the sanctuary. All the 32 respondents believed that the habitat

degradation is the major potential threat (Fig. 2.). The questionnaires were distributed among 3 groups of individuals: local from the fringe areas (31%), forest officials (31%) and field workers (38 %).

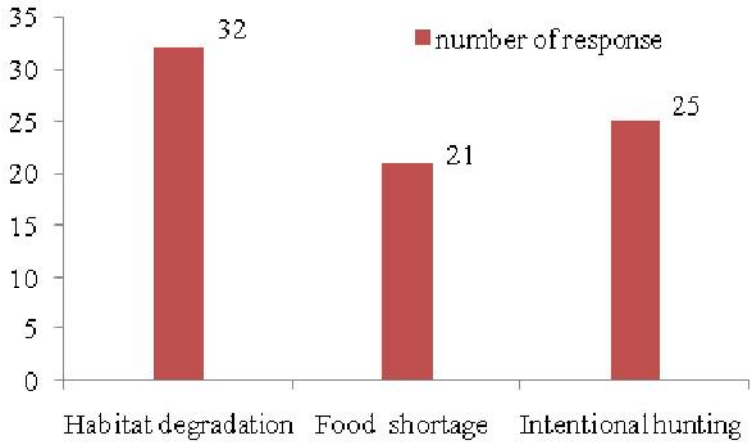

Fig. 2. Potential threats to vultures in DEMWLS

Discussions and Conclusion:

Population status of vultures in the sanctuary:

The continued survey from 2016 to 2019 to assess the population status of vultures in Arunachal Pradesh resulted in regular recording of vultures in D'Ering memorial wildlife sanctuary. Throughout the study period, cumulatively a total of 334 vulture individuals were recorded, with highest in 2018 (n=202). Such finding confirms that the sanctuary is a suitable habitat for the vultures. The suitability of the habitat in the sanctuary is further facilitated by the overall landscape, vegetation and food resource availability. The riverine vegetation and open savanna with few tall trees and bushes provide the vultures an easy access to the region for food and shelter. The availability of domestic ungulates (cattle, buffaloes, horses) in the fringe areas of the sanctuary fulfils their need of food. Only four species i.e., WRV, LBV, SBV and HV were recorded during the study period. The overall population of individual vultures in the sanctuary were good and slightly stable, except for LBV. HV were the most abundant, followed by WRV, and SBV. Drastic surge in individuals have been observed in 2018. Though the overall population are slightly stable, the numbers of individuals annually have shown large variation with 28 individuals in 2016, 75 individuals in 2017, 202 individuals in 2018, and 29 individuals in 2019. The limited field visits may be one of the reasons for recording of such variation. Other possible reason may be due to the non-synchronisation of the time of field visits and vulture's food search. Earlier reports suggested the recording of CV and EG from the sanctuary but, during our study period we have not recorded any

of them. These may suggest their abandonment of the winter site and if so, then it is a serious conservation concern which needs to be addressed.

Potential threats to the vulture populations in the sanctuary:

The habitat degradation, food shortage and intentional hunting were recorded as the potential threats to the vultures in the sanctuary. The overall landscape and habitats components in the sanctuary are affected and transformed by the flooding pattern of prevailing rivers, which surrounds and intersects the sanctuary. The habitat degradation is also due to the increasing anthropogenic pressure in terms of harvesting of fuel wood, and timber from the fringe areas of the sanctuary. Decreasing in the numbers of domestic ungulates from the fringe areas of the sanctuary is believed to be the reason of food shortage. Though, hunting is prohibited inside the sanctuary, such offensive act still persist and happen occasionally. The respondents suggested that the hunting of vulture is rare, but sometime they are being hunt just with playful intention of the hunter.

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Response of sparrows and associated urban birds on fine-scale habitat variables: a case study from a rapidly urbanizing tropical city of Asia

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Abstract

With increasing human population, the environment undergoes a number of physical changes, including increase in the ambient temperature; increasing levels of air and soil pollution; and changes in land use change, particularly an increase in paved areas at the disbursement of vegetation. Furthermore, increasing developmental activities leads to habitat fragmentation and isolation which in result affects the species congregation, particularly among higher trophic groups. Urbanization is the process of human settlement that steadily transforms uninhabited wildlands into lands including some degree of relatively permanent human existence. It is a continuous process that produces a range of settlement densities and patterns from widely spaced agricultural and recreational homesteads to the concrete and steel heart of a large metropolitan area. For a variety of social, economic, political, behavioral, and temporal reasons, much of this range in settlement patterns can often be found in proximity to large cities around the world. We studied habitat selection of sympatric sparrows and other associated urban avifauna at the micro scale, where the decision whether to use or not for life-history needs was possibly taken. The current study was conducted in Guwahati, the capital city of Assam, which is one of the most important cities in terms of population size, connectivity of transport and strategic location. We collected data between September 2013 to February 2014 and September 2014 to February 2015. The survey of both sparrow species and other mostly associated bird species viz., House Crow, Feral Pigeon, Spotted Dove, Common Myna, Jungle Myna, and Asian Pied Starling was carried out in different urban gradients covering almost all types of man-made habitat throughout Guwahati city. Assam type houses in the periphery of Guwahati city sampled in this study having high plant diversity (H2 =2.51 ± 0.19 & green cover (45.60 ± 7.77%) followed by residential apartment/buildings (30.06 ± 3.66%) and commercial/semi-commercial areas (4.76 ± 1.55%) in the city. A total of 101 species of plants recorded from the three different man-made habitats studied. Plant species richness and diversity was high for Assam type houses. House Sparrow, Feral Pigeon has fairly positive association with urbanization whereas Spotted Dove, Asian Pied Starling and Common Myna were found to be negatively associated with extent of urbanization and positively with greenness. In addition, Tree Sparrow negatively associated with housing structure. Therefore, to sustain the viable population of sparrow in the future the city requires- awareness campaign, educating public through training workshops, engagement of media and promotion of citizen science at different institutional level (school, colleges, universities and research institutes).

Key words: House Sparrow, Tree Sparrow, Guwahati city, Assam, Urbanization

Introduction:

In the developing countries human populations are increasing at exponential rates. Countries in which urban growth will occur so rapidly, local governments may struggle to provide adequate housing,

infrastructure, sanitation, public safety and other essential services. Consequently, the result will be an increased human impact on ecosystems. In general, emigrants tend to restructure themselves in a suburban or exurban pattern, causing cities to grow in area much faster than in population and resulting in strong gradients of human density. These gradients of urbanization become increasingly complex and multi-modal as suburbs take on increasingly urban characteristics (Alberti et al., 2001). These developments, collectively known as urbanization, had negative effect on native flora and fauna. Urbanization is likely to be the unique supreme-most driver of extinction in this century.

Habitat relationship is a persistent rather than categorical variable, as particular species reveal diverse stages of preference/avoidance of different habitats (Gregory and Gaston 2000). Organism's behavioural and physiological response to choice of space is a hierarchical process (Horne et al., 2008). Even, the lack of information on the habitat ecology and the spatial use of animals can hamper the management and conservation of both the species and the landscapes (Apps et al., 2001). To sustain any animal populations, it is necessary to have adequate quantities of usable resources. Hence, there is a need to identify resources used by animals and document the availability of those resources. Resources which are selected frequently than others are of specific interest as these provide fundamental information about the nature of animals and how they meet their requirements for survival. In general, it is assumed that species will select resources that are best able to satisfy its life requirements, and high-quality resources will be selected over low-quality ones. Resource selection is a two-step process (Svardson 1949), in which organisms use general features of the landscape to select broadly from different environments and then respond to choose where to live (Morrison et al., 2006).

Habitats selected by wildlife are often altered by human land uses influencing their population in positive or negative ways depending on focal taxa. However, in case any bird species, habitat preference is one of the key ecological traits as in most of the instances habitat suitability determines both breeding performance and survivability of adults. Habitat requirements also predict long-term population trends in many bird species, probably owing to habitat alteration resulting in changes in local abundance of bird's dependent on affected habitats.

In urbanized landscapes intense human activity leads to highly-complex mosaics of semi-natural and built-up areas (Blair 2004) which often increases total bird densities, although only a few species contribute to this increase. Cities comprise of mixtures of built-up habitats and green patches, and few species can adapt and flourish in most developed parts of the city where vegetation is almost absent. Thus, urbanization increases the abundance of feral pigeons, swallows, swifts, and a few other species including most successful House Sparrow and Eurasian Tree Sparrow. In the early Pleistocene, both House Sparrow and Tree Sparrow originated from a common ancestor, the Tree Sparrow in China and

the House Sparrow in the Middle East, and that subsequent expansions have led to extensive sympatry (Summers-Smith 1988), between which hybrids have regularly been reported. There is a potential competitive relationship between House Sparrow and Tree Sparrow as both species are generalist granivores. Vepsalainen et al., (2005) found that Tree Sparrow colonized places where House Sparrows were present without any competition, and human impact has positive effect on colonization. Many parts of India and within the distribution limit of House Sparrow around the world in recent years have witnessed a perplexing decline in the number of House Sparrow. Several hypotheses been put forwarded for such decline, which includes loss of tree cover, changing architecture of human habitation that has deprived nesting sites, lack of traditional groceries, excessive use of pesticides, excessive use of pesticides in agricultural field and home gardens, predation, diseases and electromagnetic radiation (Anderson 2006, Balmori and Hallberg 2007). Subsequently, some authors (Chamberlain et al. 2007) have supported a deeper understanding of the fine-scale variations in urban distribution, as a tool to gain greater insights into the causes of House Sparrow decline. In any urban landscapes spatial heterogeneity is one of the main features. Presently, ecologists are trying comprehending the drivers of urban bird community structure and population dynamics, the role of vegetation profile vs. predator-prey interactions, and interspecific competition for food and other resources. Therefore, application of habitat choice models is particularly valuable to guide conservation management of threatened but sparsely understood species.

Habitat choice is explored by functions that either model the population state (presence, index of use or density) with the putative factors, or compare used (occupied by the focal species) versus unused (unoccupied) or available (independent of occupancy status) resource units. Such statistical functions, which are proportional to the probability of use of a resource unit, are termed as *resource selection function* (or RSF, see Manly et al., 2002).

This study explored the habitat selection of sympatric sparrows and other associated urban avifauna at the micro scale, where the decision whether to use or not for life-history needs was possibly taken. we investigated the influence of fine scale habitat structure for daily activity including foraging, resting, roosting and nest site choices. Based on apriori, ecological understanding, we hypothesized that a) urban food resources and nest site choices (includes variables distance to nearest market, number of food shops, number of rolling shutters) b) greenness as cover, resting, roosting and insect prey (distance to nearest green patch, % green cover, % grass cover, plant diversity) c) housing structure as nest-site choice (single storied house, multistoried building, house/building with tin-roof & concrete-roof and d) open drains as a source of optional easily available mosquito larvae (protein source for the chicks during breeding season) are factors and their effects in combinations would influence the habitat use of sparrows.

Study area:

The current study was conducted in Guwahati, the capital city of Assam, which is one of the most important cities in terms of population size, connectivity of transport and strategic location (Figure 1). The landscape is characterized by river Brahmaputra and fragmented hill slopes. The city is the gateway to Northeast India and important being capital of the state Assam. With the new emerging socio-economic forces, the city is in the direction of more developed and among advanced ones, responding to diverse developments including both internal and external. The city Guwahati is located on the southern bank of river Brahmaputra extending from $26^{0}102$ north latitude and $92^{0}492$ east longitude. Guwahati is situated towards the south-eastern side of Kamrup district bounded by Nalbari district in the North, Darrang and Marigaon districts in the East, Meghalaya State in the south and Goalpara & Barpeta Districts in the West. The city is surrounded by hillocks on the southern and eastern sides on undulating plain with varying altitudes of 49.5 m to 55.5 m above mean sea level (MSL). The central part of the city has small hillocks namely Chunsali Hill (293 m), Nilachal Hill (193 m), Nabagraha Hill (217 m) and Sarania Hill (193 m).

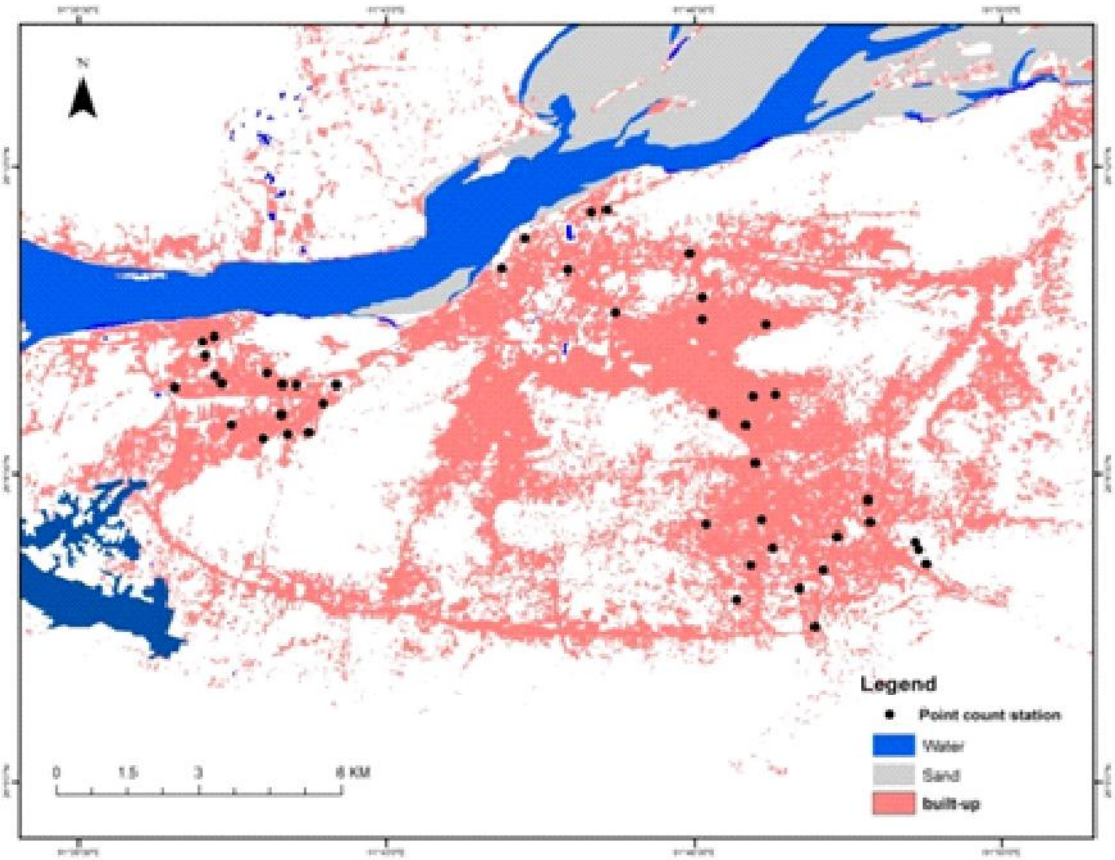


Figure 2. Map showing the temporal point count station in Guwahati City

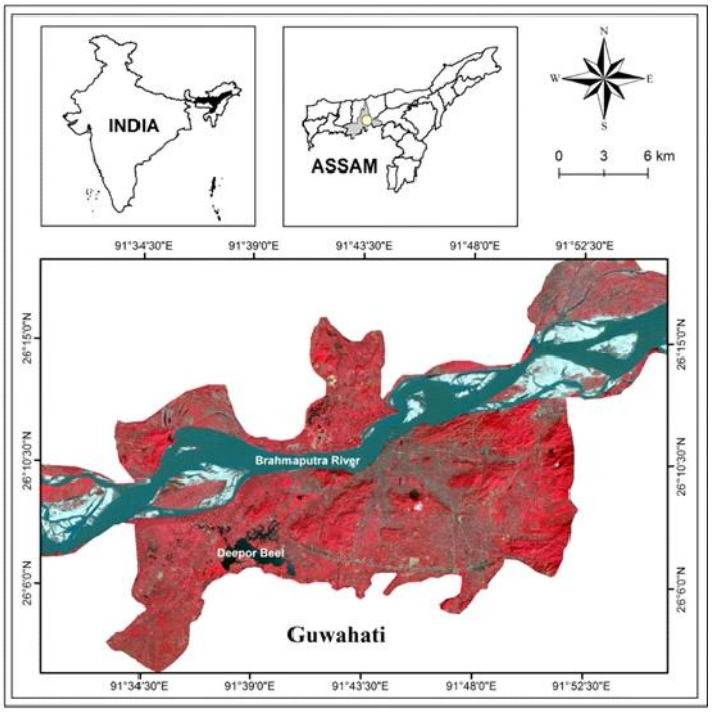


Figure1. Map showing the Study Area-Guwahati City, Assam, India

Methodology:

We collected data between September 2013 to February 2014 and September 2014 to February 2015. The survey of both sparrow species and other mostly associated bird species *viz.*, House Crow, Feral Pigeon, Spotted Dove, Common Myna, Jungle Myna, and Asian Pied Starling was carried out in different urban gradients covering almost all types of man-made habitat throughout Guwahati city: highly commercial/semi-commercial city centers, residential apartments/buildings and Assam type houses (Maligaon Railway quarters and Veterinary Department quarters at Chandmari). We placed a total 45-point count stations 15 each in the above mentioned urban gradients and counted birds with a fixed radius of 30 m for 5 minutes and we repeated each point count stations 10 times during above mentioned study period (Figure 2). Points were surveyed in the morning between 0600-0900 hrs. For the habitat use, we collected 12 ecologically meaningful fine scale habitat variables (Table 1). We performed Pearson Correlation test among ecological variables including House Sparrow and Eurasian Tree Sparrow. We conducted Principal Component Analysis using covariance matrix and varimax rotation that extracted orthogonal components representing similar ecological gradients. Before performing PCA analysis I had transformed all the variables into a Z-score.

We conducted CCA to show the association of most encountered urban bird species in response to three different ecological gradients extracted from PCA analysis at different sites. CCA allows a quick appraisal of how community composition varies with the different habitat variables. Constrained

ordination (such as Redundancy Analysis and CCA) explicitly puts into relationship between two matrices: one dependent matrix (in this case, the mean number of birds irrespective of species in a sampled plot) and one explanatory matrix (PCA extracted loadings which has ecological meaningful interpretation). CCA seeks the combinations of explanatory variables that best explain the variation of the dependent matrix. This constrained ordination analysis produces as many canonical axesas there are explanatory variables, but each of these axes is a linear combination (a multiple regression model) of all explanatory variables. Examination of the canonical coefficients (i.e., the regression coefficients of the models) of the explanatory variables on each axis helps to find out which variables are most important to explain the first, second or any other axis. Statistical significance of the canonical axes was tested with a Monte Carlo permutation test using 1000 permutations.

Table 1. Collection and processing of variables in 30 m radius for micro-scale analysis of sympatric sparrow habitat use in Guwahati city during 2013-2015.

Habitat features	Variables & method of collection	Data processing	Post processing
1. Greenness	1a. Distance to nearest green	We delineated the boundary of nearest suitable green patch (during field survey often sparrow took short foraging trips) with the help of Google Earth and measured the closest distance of the boundary of the green patch from the centre of the 30m radius circle.	We computed the principal component scores from variables 1a to 1d as covariate
	1b.Green cover	We digitized green cover (tree + grass cover) using high resolution image of Google Earth *V*.	
	1c.Grass cover	We used both Google Earth and hand held laser range finder to estimate the % grass cover in each 30 m radius sampled.	
	1d.Plant diversity	We count the number of individuals of plant species (trees and sapling) within the 30m radius. Subsequently diversity index Shannon H´ was calculated using Biodiversity Pro software.	
2.Degree of urbanization: urban food& nest-site source	2. a Distance to nearest Market	We generated the centre point of the open market places (open daily markets, congested areas with hotel restaurants, crowded places nearby bus-stops and railway station etc.) and measured the distance from the centre point of 30m radius circle.	We computed the principal component scores from variables 2a, 2b and 2c in *SPSS*toobtain the final covariate
	2 b. Food shops	We counted the number of hotels, restaurants, grocery shops with in the 30m radius.	
	2 c. Rolling shutter	We counted the number of rolling shutters people use for the front gate of shops and garage.	
3. Housing structure	3 a. Single storied house	We counted the number of single storied houses in the 30 m radius sampling plots.	The principle component scores yielded a final covariate
	3 b. Multi-storied building	We counted the number of multi-storied buildings in the 30 m radius sampling plots.	
	3 c. Tin-roof	We counted the number of houses having tin-roof.	
	3 d. Concrete roof	We counted the number of houses with concrete roof	
4. Open drain		We measured the area opening of drains using laser range finder and then converted the area into % by dividing the area of 30 m radius circle	% covers open drain used as covariate

Results:

Micro habitat characteristics:

General habitat characteristics of the point location sampled at 30 m radius as follows: Percent green cover, grass cover and plant diversity decreases with the increase in urbanization. Significant differences of almost habitat variables were found among three habitat types except for distance to green patch (Table 6.2). Assam type houses in the periphery of Guwahati city sampled in this study having high plant diversity (H2 =2.51 ± 0.19 & green cover (45.60 ± 7.77%) followed by residential apartment/buildings (30.06 ± 3.66%) and commercial/semi-commercial areas (4.76 ± 1.55%) in the city. Local open markets were scattered within the city. Rolling shutters usually were more in commercial areas as most of the shops used it as front gate, and in few instances we found it on the residential areas either on a grocery shop/garage. The housing structure in commercial areas of Guwahati varied from single storied buildings to multi-storied shopping malls. Buildings with concrete roof were observed in highly commercial areas and tin roofs were seen in open local markets. Residential areas were dominated by apartment and multistoried buildings with few Assam type houses in between with tin roofs; even in multistoried buildings peoples were found to cover the roof with tin sheets.

Vegetation structure:

A total of 101 species of plants recorded from the three different man-made habitats studied. Plant species richness and diversity was high for Assam type houses (68 species, H2 = 2.51 ± 0.19) followed by residential buildings/apartment (65 species), and commercial and semi-commercial area (12 species). Most abundant plant recorded in my study was *Areca catechu* (15.32%) followed by *Cocos nucifera* (7.05%), *Murraya paniculata* (6.33%), *Magnolia grandifloria* (5.82%), *Musa* sp. (4.98%), *Pinanga gracilis* (4.39%), *Polyalthia longifolia* (4.01%), *Populus deltoides* (3.75%) and *Citrus* sp. (3.55%).

Relationships among bird species mean abundance and ecological variables:

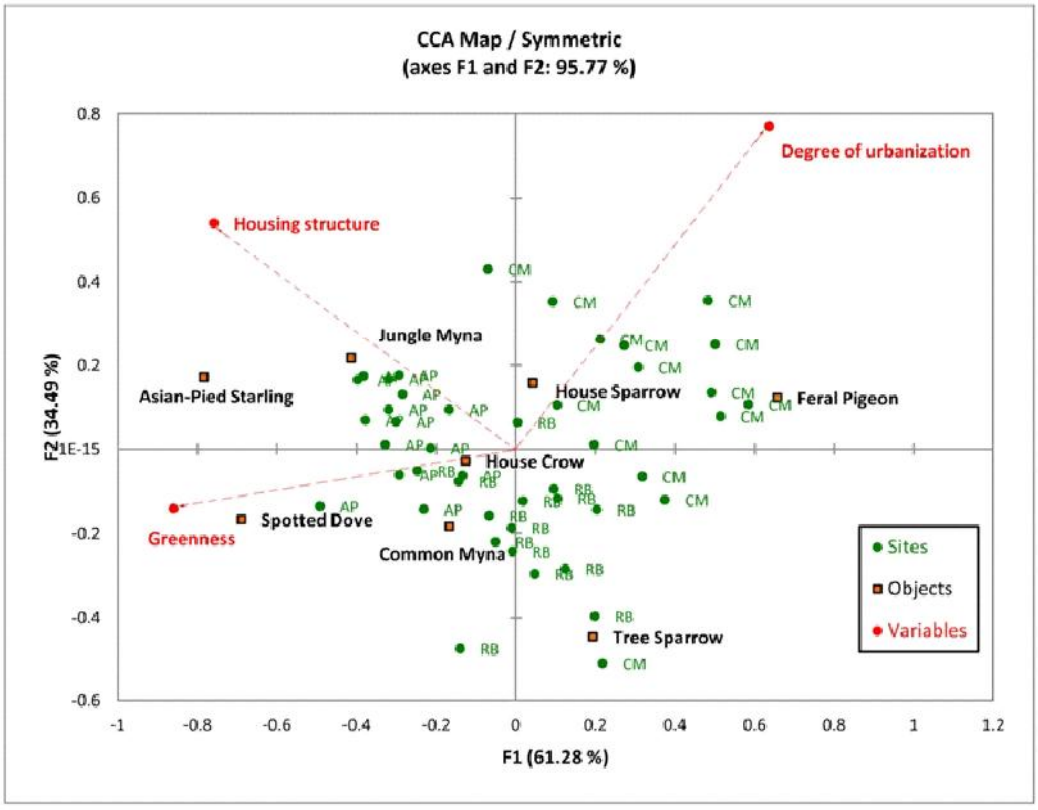
A canonical correspondence analysis was performed for the species with three identified independent variables such as degree of urbanization, greenness and housing structure. CCA Axis 1 (61.28%) and Axis 2 (34.49%) cumulatively explained 95.76% of the total variance (Table 2). Degree of urbanization formed the major variable of the F1 axis. A graphical representation of the contribution of ecological variable to the distribution of abundance of urban bird species and sites are given in figure 3. The biplot depicted the abundance of House Sparrow, Feral Pigeon has fairly positive association with urbanization whereas Spotted Dove, Asian Pied Starling and Common Myna were found to be

negatively associated with extent of urbanization and positively with greenness. Furthermore, Tree Sparrow negatively associated with housing structure.

Eigenvalues and percentages of inertia (CCA):			
		Axis	
	F1	F2	F3
Eigenvalue	0.076	0.043	0.005
Constrained inertia (%)	61.277	34.489	4.234
Cumulative %	61.277	95.766	100.000
Total inertia	13.250	7.458	0.916
Cumulative % (%)	13.250	20.708	21.624

Regression coefficients:			
	F1	F2	F3
Greenness	-0.438	0.300	1.358
Deg. of urbanization	0.312	1.002	0.836
House structure	-0.559	0.501	-0.837

Table 2. Axis summary statistics for CCA between ecological variable matrix and mean abundance of urban bird species in Guwahati City



*CM = Commercial; RB = Residential building; AP = Assam Pattern house

Figure 3. CCA biplot representing the relationship among urban bird species and habitat features in Guwahati City.

Discussion:

Urban landscapes are heterogeneous, multiple commercial as well as social groupings and a patchwork of built and vegetation covers. Since urban landscapes are highly managed (Dow 2000), it

follows that the patchwork of cities should reflect the possessions, efforts, and influences of their managers, including homeowners. Like all other urban landscape green cover and plant diversity in Guwahati too, are uneven and patterns are linked with social characteristics of house owners. Results indicate that comparatively both plant diversity and percent green cover were low in the city centers and more in the city outskirt areas. Maligaon Railway quarters and Veterinary quarters Assam type houses were old compared to other recent built-up structure present in many parts of the city. Almost all Assam type house especially quarters had the similar pattern having green lawn and well-maintained garden. The newly built building/apartment near to city centers had less in plant diversity having high population pressure and less amount of open space to grow tree species with canopy. Hence most of the house owners might preferred to plant a tree with a minimum number of branches or completely devoid of it, such as betlenut and coconut tree which adds ornamental value to their gardens too.

As mentioned, nestling of both House Sparrow & Tree Sparrow require invertebrate food to be available throughout a long breeding season and are likely to be dependent on several invertebrate taxa, higher plant diversity will have greater insect diversity. Furthermore, a recent study on Virudhunagar District of Southern Tamil Nadu reported that in urban sites, the insect preys of House Sparrow were Mantidae, Spiders, Eumastacoidea, Lepidoptera, Aphid, Coleoptera, Carabidae, Psyllidae and Homoptera (Balaji et al., 2014). Insects belong to Lepidopteran family directly associated with the host plant. From my personal observation, literature available and other researchers working in the field of plant-insect interaction we found that 62 species of butterflies hosted on the 41 species of plants out of 101 species we recorded within my sampling plots (Balaji et al., 2014 found that in urban areas 11% of the chick diet of House Sparrow comprises of Lepidopteran larvae). It is possible that more or less similar pattern also could be found for the other insect family as well. Therefore, vegetation structure within the Guwahati city plays a major role in the survival of chicks of sparrow. Additional research into the patterns of microhabitat use of House Sparrows in parks and gardens (e.g. Wilkinson 2006) and into the value of garden floras for invertebrate prey is needed.

CCA provided a very quick appraisal about the association of different urban species in relation to microhabitat variables (though microhabitat variables were specifically selected by looking at daily needs of sparrow but greenness and degree of urbanization directly or indirectly was associated with other species included in CCA analysis). As anticipated, House Crow had not shown any specific habitat association among the three different habitats studied whereas Feral Pigeon and House Sparrow were found to be more associated with degree of urbanization. On the other hand, Tree Sparrow showed fine preference towards residential buildings/apartment. However, we have not come across any negative interaction between both the sparrow species. The lack of notable competition between the two sparrow species is also suggested by Väisänen et al., (1998). However, Cordero and Senar (1990) reported interspecific competition between the two sparrow species for nest-boxes in nest-box

colonies. In Guwahati City, House Sparrow predominantly found to construct nest in the commercial places whereas Tree Sparrows found to avoid commercially crowded zones. Only in the residential building/apartment areas species may compete with each other for nesting as in the residential building areas both species often encountered together. Furthermore, there was no strong either positive or negative association found with other most frequently encountered urban birds species with sparrows. In Western Europe, competition with Feral Pigeons *Columba livia* suggested as one of the causes for the sharp decline in urban population in sparrows (Summer-Smith 1999). Because both species regularly feed on human refuse in urban areas, food would be principal candidate for a limiting resource that could be mediating a competitive interaction between the two species. However, there is virtually no concurred evidence to support the suggestion that competition between the two species resulted in the decline, although presence of pigeons remains conspicuous in many urban areas where the House Sparrow has declined (Anderson 2006). Kheera et al., (2009) reported that House Sparrow exhibited a significant negative relationship with the Common Myna and House Crow. However, in Guwahati neither Crows nor Mynas had any negative impact on sparrows. Although, Crow's ability to exploit anthropogenic food resources and habit of preying on other species' eggs and young suggest that their success may be partly responsible for many other species' failure to thrive in urban areas (Marzluff and Balda 1992). However, studies also found that there is very poor or weak comparison between crow population size and nesting success of other birds (Marzluff and Restani 1999).

. Therefore, to sustain the viable population of sparrow in the future the city requires- Awareness campaign, educating public through training workshops, engagement of media and promotion of citizen science at different institutional level (school, colleges, universities and research institutes). Engaging and informing agencies and policy makers at the local as well as state levels for sustainable development approach. Imploring to gain protections for urban birds and habitat through the creation, enhancement and preservation of green spaces (gardens and parks) in urban area.

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Ethnomedicinal study of plants used in villages around Dulung Forest Reserve, Lakhimpur district, Assam, India.

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Abstract

The primary objective of this study is to present a database on Indigenous knowledge of medicinal plants used for the treatment of various diseases among the tribal communities living in villages in and around Dulung forest reserve. The study was carried out during the period July 2019- September 2020 and information regarding different types of plants used, mode of administration, parts used were recorded from 11 villages around Dulung forest reserve. A total of 56 species belonging to 38 families were recorded. Highest numbers of plants are used from Poaceae family followed by Rubiaceae, Cucurbitaceae, and Asteraceae. The most frequently utilized medicinal plant parts were roots, leaves followed by whole plant, fruit, and seeds. Majority of medicinal plant species of about 80% were collected from the wild compared to only 20% from cultivated land. The study also revealed that the tribal communities of the villages are well versed with nature and natural resources in the reserve forest, with the wild habitat being the most important reservoir for the majority of the plants. Awareness programmes on sustainable utilization and active involvement of community conservation programmes are necessary.

Keywords: Ethnomedicinal, Indigenous Knowledge, Dulung Forest, Conservation.

Introduction:

The Dulung Reserve forest is situated near the interstate boundary between Assam and Arunachal Pradesh, in Kadam of Lakhimpur district, Assam. The total geographical area of Dulung Forest Reserve is 9900.03 hecters. Dulung Forest Reserve came into being in the year 1913 and comes under the control of North Lakhimpur Range Office. The forest type is tropical evergreen forest. According to the census 2011, there are about 81 household with total population of 469 people in the fringe villages. The reserve forest houses many invaluable species of medicinal plants, timber trees and rare species of orchid. *Mesua assamica(King & Prain)* Kostermlocally known as "Siya Nahar" is found only in Dulung Reserve Forest. Due to various unsustainable development, anthropogenic activities and illegal encroachment from the border areas has resulted into depletion of forest cover of Dulung Reserve Forest (Saikia and Saikia;2020). The primary challenge to mankind is change in climate, reduction in biodiversity and dependence on external resources without giving importance to our rich natural resources. Therefore, there is need for exploration and documentation of the indigenous knowledge base for ecological, economic and environmental sustainability (Reddy et al., 2012). The World Health Organization estimates that about 80% of the world's population in developing countries is dependent on locally available plant resources for their primary healthcare. The Indigenous communities generally

depend on the nearby forest for fuel wood, timber and medicine. Especially people living near forest fringe areas are dependent on the forest for livelihoods Medicinal plants therefore have immense role in the primary healthcare system of local communities as the main source of medicines in the rural population as well as it forms an important socio-economic base (Hamayun et al., 2003). Moreover traditional medicine forms a valuable resource for the development of new pharmaceuticals (Iwu et al., 1994). The traditional knowledge about the plants is very essential to be used in the near future (Narzary et al., 2013). Fringe areas of Dolung Reserve Forest are inhabited by many ethnic groups like Mising, Bodo, Sonowal Kachari, Hajong. The present aim of the study is to document Indigenous knowledge and practice of the communities living in the villages around Dulung reserve forest.

Materials and methods:

Study Area:

The study was undertaken from July 2019 to September 2020 after verbal consent of community elders was obtained in accordance with the ethics of ethnobiological research (ISE 2006). It is approximately 20 km away from North Lakhimpur town. The present study was carried out in the forest fringe villages of Dulung Forest Reserve . It was conducted in the following villages: Bhurbandha, No 1 Ghagarmukh, Pamagoan, No 2 Ghagarmukh, Darga Gaon, Joying Gaon, Dirpai, Maguri Pathar, Rajgarh, No. 2 Rajgarh Nepali, Koilamari. The communities adjacent to the reserve forest areas have access right over the forest to an extent as stipulated in the village forest management plans.

Data Collection:

The study design included interview, participation, observation; field interview, forest and village walk with key informants and local market survey. Local traditional healers were interviewed to document the folk healing practices in local languages. Gender specific ethnomedicinal knowledge was also documented accordingly interview of focus group, women was arranged. Ethnomedicinal interviews on medicinal plants used to treat common illness were conducted with the traditional medicinal practitioners using open- ended semi- structured questionnaires. Disease treated, methods of preparation, use and habitat of medicinal plants were recorded. The plant specimens were mounted on herbarium and were identified with the herbarium specimen of Department of Botany, Gauhati University. Nomenclatures of Plants were compared with the online database *The Plant List* (www.theplantlist.org). Some of the plants collected during the field study were also identified with the help of Hooker (1875-1897).

Result and Discussion:

The study recorded a total of 56 medicinal plants species belonging to 38 families (Table 1), The most commonly used plant families recorded during the study were found to be Poaceae followed by Rubiacea,

Cucurbitaceae, Astereaceae. A total of 10 plant parts (root, leaves, whole plant, fruit, stem, bark, seed, flower, rhizome and shoot) were recorded for the preparation of traditional medicine. The most frequently used medicinal plant parts were roots (21%), leaves (18%), whole plant and fruit (16% each) followed by shoot and seed (7% each), stem (5%), flower (4%), bark and rhizome (3% each). Reproductive ailments in females were the condition treated with the highest percentage of medicinal plants species followed by stomach, dysentery, fever, diarrhea, and cough. In the study, it is found that the herbal healers prescribedthe traditional medicine mostly through the oral route of administration (73%), followed by cutaneous(16%), inhalation (5%) and buccal, ocular and sublingual (2% each), Majority of medicinal plants species were collected from the wild (80%) compared to only about 20% are from cultivated land. The study also revealed that the indigenous communities are well versed with the uses of medicinal plants

Table. 1-Ethnomedicinal Plants recorded around the villages of Dulung Forest Reserve

Mis-Mising,**Ass**-Assamese

Sl. No	Botanical name	Vernacular Name	Family	Parts used	Route of Administration	Human Ailments
1	*Abroma augusta L.*	Ui-sipak(Mis)	Malvaceae	Roots	Oral	Uterine tonic
2	*Amaranthus spinosus*	Genak (mis) Hatikhutura (Ass)	Amaranthaceae	Roots	Oral	Menorrhagia, Stomach pain
3	*Asparagus racemose* Wild,	Satmul (Ass, Mis)	Lilaceae	Tuberous root	Oral	Fertility enhancers
4	*Ageratum conyzoids*	Namyeyin(Mis) Gondhuabon(Ass)	Compositae	Leaves	Cutaneous	Wound
5	*Alpinia allughos Roxb.*	Tora paat(Ass)	Zingiberaceae	Rhizome	Oral	Jaundice
6	*Antidesma ghaesembilla*	Somkong(Mis)	Phyllanthaceae	Fruit	Oral	Headache, Menstrual flow
7	*Azadirachta indica*	Mahaneem(Mis)	Meliaceae	Leaves	Cutaneous	Skin diseases
8	*Baccaurea ramiflora*	Buri aye(Mis)	Phyllanthaceae	Stem, bark	Sublingual Ocular Oral	Mouth Ulcer

Sl. No	Botanical name	Vernacular Name	Family	Parts used	Route of Administration	Human Ailments
9	*Bambusa tulda* Roxb.	Jati bah(Ass)	Poaceae	Shoot	Oral	Menstrual Pain
10	*Chromolaena odorata* L. Voigt	Bakbon(Mis) Jermanibon(Ass)	Asteraceae	shoots	Cutaneous	Cuts and Wounds
11	*Colocasia esculent L.*	Saru Kachu (Ass)	Araceae	Leaves	Oral	To recover from post-delivery problem
12	*Centella asiatica L. Urban syn. Hydrocotyle asiatica L*	Bor Manimuni(Ass)	Apiaceae	Whole plant	Oral	Post-delivery problem
13	*Chenopodium album*	Jhilmil(Ass)	Amaranthaceae	Roots	Oral	Stomach problems
14	*Coccinia grandis*	Kunduli(Ass)	Cucurbitaceae	Roots	Oral Cutaneous	Diabetes, Arthritis
15	*Cassia fistula*	Sonaru(Ass)	Fabaceae	Fruit pulp	Oral	Cough
16	*Coix lucryma jobi* L	Kaurimoni(Ass)	Poaceae	Roots	Cutaneous	Pain
17	*Clerodendrum colebrookianum Walp.*	Pakkom (Mis) Nephaphu (Ass)	Verbenaceae	Leaves	Oral	Intestinal worms
18	*Commelina benghalensis*	Konahimolu (Ass)	Commelinaceae	shoots	Oral	Irregular Mensuration
19	*Benincasa hispida*	Sal Kumura(Ass)	Cucurbitacea	Fruit	Oral	Maintains Blood Pressure
20	*Cissus quadrangularis*	Harhjura lota (Ass)	Vitaceae	Stem	Cutaneous	Bone fracture
21	*Caesalpinia bonduc*	Letai guti(Ass)	Fabaceae	Seeds	Oral	Pneumonia
22	*Costus specious*	Jomlakhuti(Ass)	Zingiberaceae	Rhizome	Oral	Diabetes, Jaundice, Reduces blood pressure

Sl. No	Botanical name	Vernacular Name	Family	Parts used	Route of Administration	Human Ailments
23	*Curcurbita moschata*	Ronga lau(Ass)	Cucurbitacea	Seeds	Oral	Male fertility
24	*Carica papaya*	Amita (Ass)	Caricaceae	Seeds	Oral	Abortion
25	*Citrus limon*	*Gol Nemu*(Ass)	Rutaceae	Fruit	Oral	Dysentery
26	*Cyanodon dactylon* L	Dubori(Ass)	Poaceae	Whole Plant	Oral	Delayed puberty Enhance fertility
27	*Cyclosorus extensus*	Rukji(Mis)	Thelpteridaceae	Tender leaves	Oral	Increase in lactation
28	*Cuscuta reflexa Roxb.*	Aakashilota(Ass)	Convolvulaceae	root	Oral	Jaundice
29	*Dillenia indica*	Sompa(Mis) Outenga(Ass)	Dilleniaceae	Fruit (Calyx)	Oral	Diabetes
30	*Drymaria cordata* Willd	Laijabori(Ass)	Caryophyllaceae	Whole plant	Steam Inhalation	Sinusitis
31	*Emblica officinalies Gaertn*	Amlakhi(Ass)	Euphorbiaceae	root,	Oral	Diabetes
32	*Ficus racemose* L.	Tagik(Mis) Dimaru gos (Ass)	Moracea	Leaf, bark	Oral	Blood diseases
33	*Garcinia pedunculata* Roxb.	Bor thekera(Ass)	Clusiaceae	Fruits	Oral	Haemorrhoids
34	*Hydrocotlye rotundifolia* Rox.ex DC.	Soru manimuni(Ass)	Apiaceae	Whole plant	Oral	Brain tonic
35	*Kalanchoe pinnnata (Lamk) Pers.*	Pategoja	Crassulaceae	Leaves	Oral	Digestive, stone
36	*Lawsonia inermis* L.	Jetuka(Ass)	Lythracea	Leaf	Oral	Blood pressure
37	*Leucas aspera*	Durun bon(Ass)	Labiatae	Whole plant	Steam Inhalation	Sinusitis
38	*Oxalis corniculate Linn.*	Soru tengesi(Ass)	Oxalidaceae	Whole plant	Oral	Stomach Problem, dysentery

Sl. No	Botanical name	Vernacular Name	Family	Parts used	Route of Administration	Human Ailments
39	*Orzya sativa*	Dhan(Ass)	Poaceae	Husked rice	Oral	Pin worm infection
40	*Ocimum gratissimum Linn*	Bon tulosi(Ass)	Labiatea	Whole plant	Oral	Cough, Fever
41	*Oldenlandia corymbose Linn*	Bon jaluk.(Ass)	Rubiacea	Whole plant	Oral	Jaundice
42	*Paederia scandens*	Bhedialota(Ass)	Rubiaceae	Leaves	Oral	Menstrual disorder.
43	*Phlogocanthus thrysiflorus*	Titaphul(Ass)	Acanthaceae	Flower	Oral	Anemia
44	*Psidium guajava L.*	Mudori aam(Ass)	Myrtaceae	Fruit	Oral	Dysentery, Diarrhea
45	*Paederia foetida L.*	Bhedailota, (Ass) Bungkirepuk (Mis)	Rubiacae	roots	Cutaneous	Menorrhagia Abortive
46	*Piper nigrum,*	Jaluk(Ass)	Piperaceae	Fruit	Oral	Dysmenorrhea
47	*Spilanthes acmella Lin.*	Marsang (Mis)	Asteraceae	Flower, Inflorescence	Cutaneous Oral	Mouth ulcer,Toothache
48	*Solanum indicum Roxb.*	Donam Bangko (Mis)	Solanaceae	berries	Oral,Buccal	Cough Asthma Teeth disorders
49	*Saccharum officinarum* L	Kuhiyar(Ass)	Poaceae	Stem	Oral	Urinary Problems
50	*Sarcochlamys pulcherima*	Ombe, Notke (Mis) Adumbra (Bodo)	Urticaceae	Shoot	Oral	Dysentery, diarhhoea
51	*Terminalia bellarica*	Bhumura(Ass)	Combretaceae	Fruit	Oral	Stomach ache
52	*Terminalia chebula*	Silikha(Ass)	Combretaceae	Fruit, Bark	Oral	Digestive Stomach ache
53	*Tinospora cordifolia*	Sogonilota(Ass)	Menispermaceae	Roots	Oral	Fertility
54	*Ricinus communis* Linn.	Era paat(Ass)	Euphorbiacea e	roots	Cutaneous	Urinary trouble, piles
55	*Vitex negundo*	Pochotiya (Ass)	Lamiaceae	Whole plant	Oral, Inhalation	Antibacterial Stomach trouble
56	*Zanthoxylum nitidum*	Rikkum (Mis)	Rutaceae	Leaves	Oral	Pneumonia

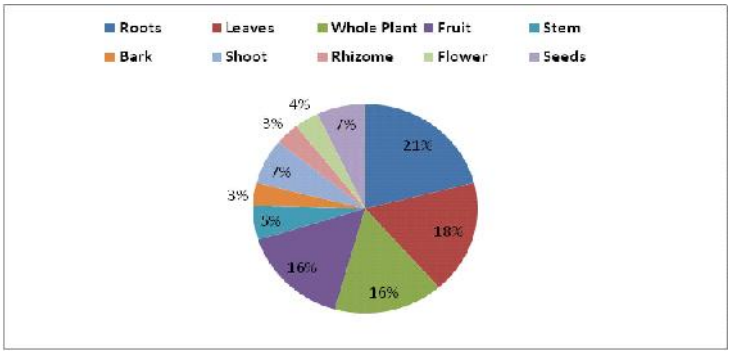

Fig. 2:Percentage composition of plant parts used for preparation of ethnomedicines.

Fig.3: Photographic representation of some medicinal plant species recorded from the study area. From left to right (a.Solanum indicum,b.Paederia foetida c. Asparagus racemose d. Piper longum, e. Oldenlandia corymboseLinnf. Zanthoxylum nitidum)

Conclusion:

A rich diversity of medicinal plants species are used for the treatment of different diseases in villages around Dulung forest reserve, with the wild habitat being the most important reservoir for the majority of the plants. It is found that majority of the ethnic communities living in villages around the Dulung Forest Reserve are dependent on the reserve forest and collect and use different plant species for medicinal purposes and food. Therefore, conservation of the reserve forest is the need of the hour since reserve forest are the remnants of forest, rich in plant diversity with economic values and its socio-culturally linked with the indigenous communities. Thus, awareness programmes on sustainable utilization, proper management and active involvement of community in conservation programmes are needed.

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Environmental issues from coal mining activities in Assam: a case study in Ledo colliery

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Abstract

Coal is the most important fuel resource all over the world. It is known as the primary source of energy which contributes largely in the economic growth of a country. It forms from decay of plants and animals over millions of years. Coal consists of a large number of elements because during its formation different biological, chemical as well as physical processes occur. Among these elements some elements are potentially hazardous although they are present in trace amount in coal. These elements can expose into environment through chemical and physical processes like weathering in the form of Acid Mine Drainage (AMD) during coal mining activities. Ledo colliery in Assam imparts some environmental effects due to formation of AMD during mining and post mining. Since coal mining in Ledo colliery is an active open cast mining, so it has more impact on environment than underground mining. High sulphur content in Ledo coal is responsible for formation of highly acidic AMD. Dumping of the overburden (OB) also produce a large amount of AMD which dissolves various hazardous elements like Pb, Hg, As, Cd etc. that can contaminate the nearby water resources and soil. The minerals present in Ledo coal contain enormous amount of calcium and magnesium leading to the hardness of water which is found to be a major problem in the region. The soil around the mining area is highly affected by mining activities because the presence of large amount of Ca, Mg, Fe etc. can alter the soil quality. Thus, the AMD formation due to coal mining activities is the major contributing factor for environmental degradation in Assam. The present study aims to assessment study of the hazardous effect of AMD formed due to open cast mining in Ledo colliery towards its mitigation.

Introduction:

Coal is one of the world's most plentiful energy resources, and its use is likely to quadruple by 2020 (Coal Mining and Production). Although the economic development is the key criteria in the development of an area, but the other factors like healthy environment in reference of soil, water and air is equally essential for the development. Since open cast Mining has a number of affects including deforestation, soil pollution, pollution of water resources etc. In Assam, both mining processes namely open cast and underground mining processes are adopted. Literature[1,2,3] showed that the nature faces more scars from open cast mining than underground mining. Ledo open cast coal mining is the biggest mining process in Assam. It is found that the underground mining is very expensive and because of the soil condition of Assam, open cast mining has been adopted as the main method for coal mining over underground method. But the open cast coal mining destroys the environment, leaving large scars instead of fertile paddy fields and forests. Neighboring areas are also polluted with large quantities

of overburden (OB). These are dumped on low-lying arable lands or on the hill slopes. The OB gets washed away by rains water, joins streams and drains and ends up at the large water resources like river causing severe water pollution. The OB and other mine wastes are responsible for the formation of Acid Mine Drainage (AMD) which is the main source of environmental pollution due to open cast coal mining activity in Ledo colliery. The biochemical process of AMD formation has been established by a number of researchers like [4,5,6,7].

The formation of AMD is caused by the oxidation of pyrite (FeS2) minerals by either oxygen (O2) or ferric iron (Fe^{+3}). According to Sato [8] and Nordstrom [4], the initial oxidation of pyrite is described by the following equation:

$$FeS_2 + O_2 + 2H^+ \longrightarrow Fe^{2+} + S_2^0 + H_2O_2 \quad (1)$$

Equation (1) shows the consumption of hydrogen ions (H^+), but the further oxidation of Fe^{2+} causes a net increase in H^+ according to:

$$Fe^{+2} + 5/2\ H_2O + 1/4\ O_2 \longrightarrow Fe(OH)_3 + 2H^+ \quad (2)$$

$$S_2^0 + 3O_2 + 2H_2O \longrightarrow 2SO_4^{2-} + 4H^+ \quad (3)$$

However, pyrite oxidation can also be carried out by ferric iron in the absence of oxygen according to the following equation:

$$FeS_2 + 14Fe^{3+} + 8H_2O \longrightarrow 15\ Fe^{2+} + 2SO_4^{2-} + 16H^+ \quad (4)$$

Although the equation (4) does not require O2 directly, it requires large concentrations of dissolved Fe^{3+} ion. This ion can be present in water only when the pH is less than 4.5 and when Fe^{3+} ion is being rapidly replenished by the acidophilic bacteria named as Thiobacillus Ferrooxidans. According to Nordstrom [4], the pyrite oxidation in equation (4) is faster than equation (1) in low pH and in presence of Thiobacillus Ferrooxidans. This mine water is highly acidic which may have pH range within the range (2 - 4.5) and this property of mine water is responsible for dissolution of large number of potentially hazardous elements (PHEs). The AMD water can flow with the rain water to the nearby water resources by contaminating them making unfit the water for human being as well as for animals and aquatic plants and animals. Also, it may impart a long-lasting effect on nearby land by destroying its fertility. Our present study tries to assess the environmental effect of coal mining activity in Ledo colliery on nearby water bodied and land.

Study area:

The Makum coalfields expands from Naga Pataki hills ranges from Sibsagar in Assam to Noa Dihing in Arunachal Pradesh in a distance of about 250 Km. and lies between Latitude 27°15' and 27° 24'N and Longitude 95°40' and 95° 59'E (Approx). The general strike of the seam is along NE-SW. Coal seams are in the form of asymmetrical syncline known as Namdang syncline located between Margherita thrust in North and Haflong-Disang thrust in the south. The southern limb of Namdang syncline is steeply inclined (55-90 degree). The anticlinal zone is covered by Tirap and Ledo and is popularly known as Ledo anticline. Northern limb of Ledo anticline has undergone a small synclinal folding leading to high geological disturbances. In Makum coalfields, 20 feet and 60 feet seams are found which are persistent and are being worked. These coals are characterized by low moisture (2-5%), low ash (3-10%) and highly volatile matter (>40%) and high sulphur content (2-6%). Different sample sites are given in Fig.1

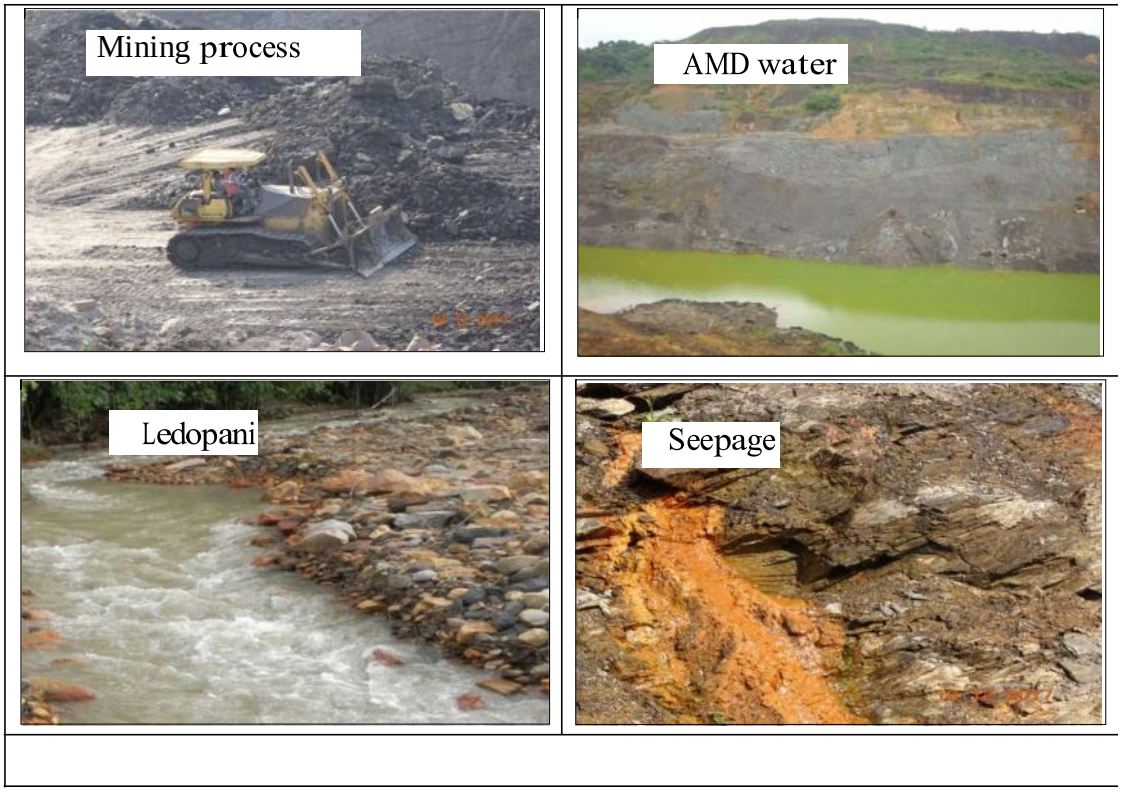

Fig.1: Sampling points of study area (Ledo Colliery)

Methods and materials:

Sampling process:

The water, soil, and sediment samples of study area was collected by using ASTM method. The samples were collected from neighboring area and within the 5 km radius from the Ledo coal mine. The soil and sediment samples (LS-1, LS-2, LSE-1, LSE-2) were air dried and crushed into 36 and 72 BS (British Standard) and stored in plastic bottles for further analyses. The water samples were collected from two streams namely LW-1 (Ledopani, near coal mine) and LW-2 (Kachanalla, 5 km from Ledo Colliery) and LW-3 (tube-well, 5 km from Ledo coal mine). The samples were preserved by adding nitric acid in 1:3 ratio and used for further analytical processes.

Physicochemical analysis of water samples:

The collected water samples were subjected to pH, TDS (Total Dissolved Solid), EC (Electrical Conductivity) analyses by using EUTECH PC700 pH/EC/TDS meter. The hardness of the mine water samples was determined by using EDTA through standard ASTM method. The temperature of sampling site was recorded by using the same apparatus.

Ion- Chromatographic analysis of mine -affected water:

Ion-chromatographic analyses of mine water samples have done to determine the concentrations of metal ions like Na +, K +, Ca 2+, Mg 2+, Li + and NH 4+ and anions including F -, Cl -, Br -, SO_4 2- present in the samples. Before starting the analysis, the mine samples were filtered by using 0.22 mm Millipore filter paper. For this analytical method the pH of the samples was adjusted so that it should be more than 3.5 - 4. The anions were analyzed using 4 mm 9 250 mm Metrosep A Supp 5 analytical column with the chemical suppression sulfuric acid and Metrosep RP2 3.5 guard column. Similarly, the cations were analyzed using a 4 mm 9 150 mm Metrosep C-4 analytical column and Metrosep RP 2 3.5 guard column.

Atomic Absorption Spectroscopic (AAS) analyses of soil and sediments:

AAS analyses of soil and sediment samples have been done in CSIR-NEIST, Jorhat, India by digesting the samples in microwave digestor. An amount of 0.21 g of the samples were mixed with 3ml HCl, 3ml HF, and 9 ml HNO^3 and subjected for digestion. After digestion the samples were diluted to 25 ml and used for analysis.

XRD analysis of soils and sediments:

The minerals in the samples were identified by X-ray diffraction (XRD) technique. The analysis was carried out by X-ray diffractometer (Rigako, ULTIMA IV) and the diffraction data

of the samples were obtained with starting angle set as 2.00 and the stopping angle at 75.00 with a stepin angle 0.05, with a scanning rate of 1 per minute and the target used was a Cu-K α (λ 1.7902A) target.

Results and discussions:

Physicochemical analysis of waters samples:

The physicochemical analyses of water samples include pH, TDS, EC and hardness have done to study the impact of coal mining on water resources. The pH of the water samples namely LW-1, LW-2 and LW-3 were found to be within the range of 4.4 - 6.0. This is an indication of acidic nature of the water resources because according to EPA, the normal range of pH for drinking water is 6.5 - 8.5. Thus, the coal wastes mainly the AMD produced in mining process contaminates the water sources up to 5 km distance. Electrical conductivity gives an indication of the amount of total dissolved substitution in water [9]. The EC values of same samples were found to be within the range 223-1100 µm cm^{-1}. According to Indian drinking water specification (2012), the maximum permissible limit of EC for drinking water is 1400 µm cm^{-1}. Thus, the recorded value is just below the maximum permissible limit. The TDS of surface water (streams) and ground water (tube - well) have the values in the range of 100-668 ppm which is higher than the permissible limit recommended by WHO and APHA (500 ppm). The total hard ness of water samples was determined by using standard ASTM method. From analysis the values of hardness were recorded as 600, 480 and 400 ppm respectively. WHO recommendation for hardness of drinking water is 500 ppm. Thus, our analytical values have just higher values than standard value. The overall values of all physicochemical parameters reveal that the coal mining activity affects the water bodies even at a distance of 5 km.

Ion- Chromatographic (IC) analysis of mine-affected water:

IC analysis of mine affected water samples have done to determine the cationic (Na^+, K^+, Ca^{2+}, Mg^{2+}, and $NH4^+$) and anionic (F^-, Cl^-, Br^-, and $SO4^{2-}$) concentrations present in the samples. The Table1 shows different cationic (cations and anions) concentration in samples. From this analysis it was found that there is no indication of $NH4^+$ water samples, this may be due to the oxidation of ammonium ions into nitrite by aerobic bacteria. The absence of $NH4^+$ ion confirms the low pH of water bodies near the mining area. Mg^+ above the normal range (the normal range is 20 - 30 ppm). Very high concentration of Br^{--} occurs in water samples LW-2 which was collected from Kachanallah stream at a distance of 5 km from the mine source. The high level of Br^- ion is responsible for bromism which is harmful to the nervous system, skin, glandular secretions and gastrointestinal tract [10]. This is an indication of contamination of water bodies even at a longer distance from the source.

AAS analyses of soil and sediments:

AAS analyses of soil and sediment samples have been done in CSIR-NEIST, Jorhat to determine the presence of some toxic elements present in soil and sediments which are contaminated by mine-water.

Table 1: cationic and anionic concentrations of ions in water

Cations	LW-1	LW-2	Anions	LW-1	LW-2
Na^{+}	0.53	0.72	F^{-}	-	0.86
K^{+}	0.35	2.13	Cl^{-}	0.49	8.84
Mg^{+2}	35.01	60.78	Br^{-}	78.34	227.17
$NH4^{+}$	-	-	$SO4^{-2}$	3.90	15.40

Table 2: Concentrations of elements in soil and sediments

Elements	Concentration (in ppm)			
	LS-1	LS-2	LSE-1	LSE-2
Cd	0.04	0.04	BDL	BDL
Cr	2.2	1.3	1.1	1.2
Zn	1.75	1.83	0.66	0.71
Cu	0.18	0.26	0.21	0.21
Fe	109	182	208	167
Co	0.40	0.45	0.30	0.20
Hg	0.31	2.63	0.02	0.12
As	0.90	1.10	0.32	0.28
Mn	2.8	4.1	1.8	4.7
Ni	1.3	1.1	0.60	0.70

From our investigation it was found that some of these elements are present in the samples in a higher concentration than the desirable limit recommended by WHO, and APHA [11]. The Table 2 gives information about the elemental concentrations in water. AAS analysis of the soil and sediment samples showed high concentrations of some PHEs including Fe, Cr, Hg, and As.

These elements were present at a concentration higher than the permissible limit set up by WHO guidelines.

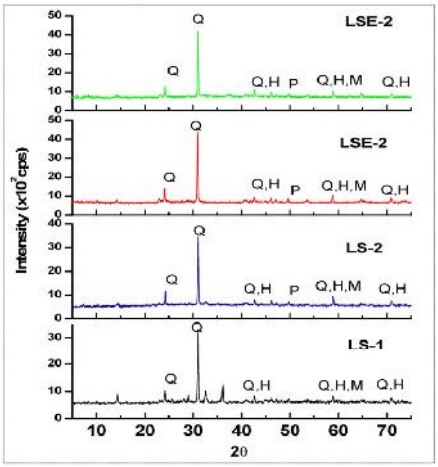

Fig. 2: XRD analysis of soil and sediment samples of Ledo colliery XRD analysis of soil and sediment:

X-ray diffraction analyses of soil and sediment samples were carried out to determine the mineral types and crystallinity of the samples. Fig. 2 shows the XRD-mineralogy of soil and sediment distinctly. The assessment of the XRD mineralogical peaks for the presence of minerals in the samples was carried out with the help of the literature available [12,13,14]. Quartz is the common mineral present in all the samples and the most prominent peak in all coal samples are due to quartz. The other minerals present are hematite, pyrite, and marcasite. A prominent peak of quartz is due to its high stability. The presence of pyrite [FeS_2], hematite [$Fe2O_3$], marcasite [FeS_2] minerals are responsible for the high iron content in nearby soils which is revealed by the AAS analysis of soil samples. If the agricultural soil is associated with too much iron, then plants will absorb it and finally suffer from the counting effect. According to some researchers [15], soils become dangerous because of high iron content at a level of 100 mg or more.

Conclusions:

The results found from different analyses including pH, TDS, EC, Hardness and IC of water samples and AAS and XRD analyses of soil and sediment samples collected from different points near Ledo colliery show that the coal mining activity in Ledo affects directly in the neighboring areas. The AMD water generated in mining process contaminates the ground and surface water bodies as well as the soil system through rain water as it is associated with a large number of PHEs like Cd, Hg, Cr, Fe, As. etc. The elements are harmful for human being as well as for other life systems when they are present in excess amount. The present study tries to highlight the environmental effect of coal mining activity in Ledo colliery.

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Mammalian Diversity of Kakoi Reserved Forest: Their Conservation Status and Threats

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Abstract

The present study was organized to study the mammalian diversity of Kakoi Reserve Forest. Kakoi Reserve forest is located in the northern part of the Lakhimpur District. This area is very less documented and is largely ignored. It is at the fringe of the Assam-Arunachal border and close to many tea gardens. The Kakoi river runs through this reserve forest making the sandy beaches perfect for spotting various mammals coming for a drink as well as getting pugmarks and footprints as evidence of the presence of various mammals. The study explores the diversity in the reserved forest in terms of mammals. The presence of mammals is a clear indicator of the health of a biome. Various mammalian species have been recorded which were observed during the field visits and also a few others that were not seen but the secondary data was collected from the questionnaires which were handed out to the nearby villagers and the forest officials. There is also an account of the various threats the Reserve forest faces, both artificial and natural. An attempt was made to give an idea about the location, climate and ecology of Kakoi Reserve Forest along with various problems faced by this reserve forest. Further, there is also a mention about the amazing forest management system followed by the locals of that area as a measure to conserve the diversity and beauty of the forest they adore.

Key words: Assam, Community, Diversity, Kakoi Reserve Forest, Mammals, North Lakhimpur Threats.

Introduction:

Out of the eight North-eastern states of India, Assam occupies second place in terms of size which comprises a 7.84-million-hectare geographical area [22]. The biogeography of Assam and its neighbours is remarkable. The Pre-Tertiary Tethys Sea had its eliminated from this very region resulting in the formation of a soil link between the Indian Peninsula Asia. This region thus functioned as a highway through which the Oriental and Palaearctic fauna made their way into the country [5]. This region is at the confluence of the Eastern Himalaya and Indo-Myanmar Biodiversity Hotspots. This blend of two major hotspots results in a very rich diversity just next to the African Subcontinent, which has the highest diversity on this planet. In India, the inflow of faunal species was considered to be through two main gateways- the North-eastern and the North-western parts of the country. This might have been because the faunal species were able to circumnavigate the lofty Himalayas. The inflow of so many species coupled with the presence of a wide spectrum of floral diversity has led to the scholars describing the north-eastern states as a "Biological Gateway" [2].

Mammals form a crucial role in forest communities as well as whichever ecosystem they live in. Their importance is paramount to maintain a balanced ecosystem which can be achieved by addressing the services and operations involved in sustaining the balance such as seed dispersal, predator-prey interactions etc. They further contribute to the food web in a forest ecosystem as different species from various food chains by occupying various trophic levels, which later intertwine to give rise to an extensive food web.

The class Mammalia comprises about 4800 extant species [3]. There are 2059 species in the order Rodentia and 977 species in the order Chiroptera [6]. Mammals are 48 families [20,18] of which the Northeast Indian Region holds roughly 54% of the threatened mammals found in India. The mammalian diversity of Assam tallies at 193 species which is 60% of the whole country's share [15]. In Kakoi Reserve Forest, among the herbivores are Asiatic elephant, Sambhar deer, Wild boar, Capped Langur, Barking Deer, Giant Squirrel, Assam Macaque, and the carnivores are Fishing Cat, Leopard cat, Jungle cat, Binturong (Jahamal). Herbivores such as rabbits and deer are the primary consumers that feed on plant material and are prey to numerous omnivores and carnivores. Omnivores, on the other hand, have a wider food palate. Their ability to consume both plant and animal material makes them eligible to hold the posts of both prey and predator in the ecosystem. Carnivorous mammals such as leopards and other felines feed on other animals and can be fundamental to controlling the population of other mammals. Scavengers, like the Dholes, prefer to prey upon the weak, old, injured or diseased animals, which helps in maintaining a healthy prey population.

Kakoi Reserve Forest is one of the most unique Reserve Forests in this biodiversity-rich region. It is rich in endemic flora and fauna of this locality. Trekking is easier because of the presence of small roads inside the forest leading to every nook and corner of that area. It is at a suitable distance from the city, because of which there was no need to set up camp. The reserve is surrounded by small villages and the villagers were a source of secondary data. The forest officers and management of that area are quite efficient and keep records up to date. Consequently, this leads to selecting this specific study area.

Materials And Methods:

Study Area :

Regular visits were made to the reserved forest during the span of a year (June 2018 to July 2019). Kakoi reserve forest is located towards the east of the state of Assam between 27 Ú 13´23´´ N to 27 Ú 20´00´´ E and 94 Ú 11´00´´ E to 94 Ú 72´13´´ E. It spans on the upper bank of the Brahmaputra. KRF is located in the Northern Part of the Lakhimpur District. The reserve forest covers an area of 4,415.03 hectares [14]. It is about 25 km from north Lakhimpur town. It was declared a reserve forest in the year 1927. The forest comes under the Lakhimpur range. The reserve constitutes

two beats- Kakoi and Johying and two camps- Bokanala and Dirgha. The reserve borders Arunachal Pradesh in the north, Lakhimpur district in the south, Boginadi on the east, and Ranganadi to the west. The reserve consists of both hilly and plain areas. The hills that constitute this Reserve are Bokanala, Bhongapahar, Gumnodi, Himolubari and Jutulinola. The Kakoi river is the most significant river to pass through this Reserve forest and Bokanala, Dirgha, Hukannola, and Gumnodi. A naturally formed lake named Kasobeel is also present here. Fig 1 is a Hand-Drawn Map of the Kakoi Reserve Forest and Fig 2 is a Map of the Kakoi Reserve Forest with adjoining areas

The habitat of the reserve forest ranges from tropical semi-evergreen to tropical moist deciduous and hilly streams. This highly diverse area of the eastern Himalayas still largely remains an unexplored biological wonderland. The exclusive biogeographic position, climate, and physio-geography have laid the ground work for the propagation of a variety of habitats that harbour a diverse biota with a high level of endemism. The "tropical monsoon rainforest climate" is prevalent here; in the summers, the temperatures reach a maximum of 32. 1ÚC with high humidity and intermittent rainfall, and in winter, a minimum of 9.3 Ú C [16]. The climate is characterized by heavy monsoon downpours, reducing the summer temperatures and affecting foggy mornings and nights. Spring (Mar-Apr) and autumn (Sept-Oct) are usually pleasant with moderate rainfall and temperature. Animals generally prefer a habitat with less extreme temperature variations, and thus Kakoi is quite suitable for sustaining a healthy population of wild animals. This comfortable temperature of Kakoi is mainly due to the network of rivers and tiny streams flowing through it.

Kakoi Reserve Forest is very humid throughout the year. Rainfall is abundant in the monsoon months; the maximum humidity almost reaches 90% (around August) because of the presence of many rivers and streams and a lot of evergreen vegetation. The lowest was 75% around February and March. The relative humidity remains around 84% throughout the year [25].

The rainfall in this area is very high, especially during the monsoon months, but in the winter months, it reduces greatly and becomes quite dry. The highest average rainfall recorded between June 2018 to July 2019 was found to be 3166.1 mm annually [13]. This high rainfall is mainly because of its location, which is at the foothills of the outer Himalayas. Thus the rain-laden clouds from the Indian Ocean directly precipitate in this area and which results in its high rainfall.

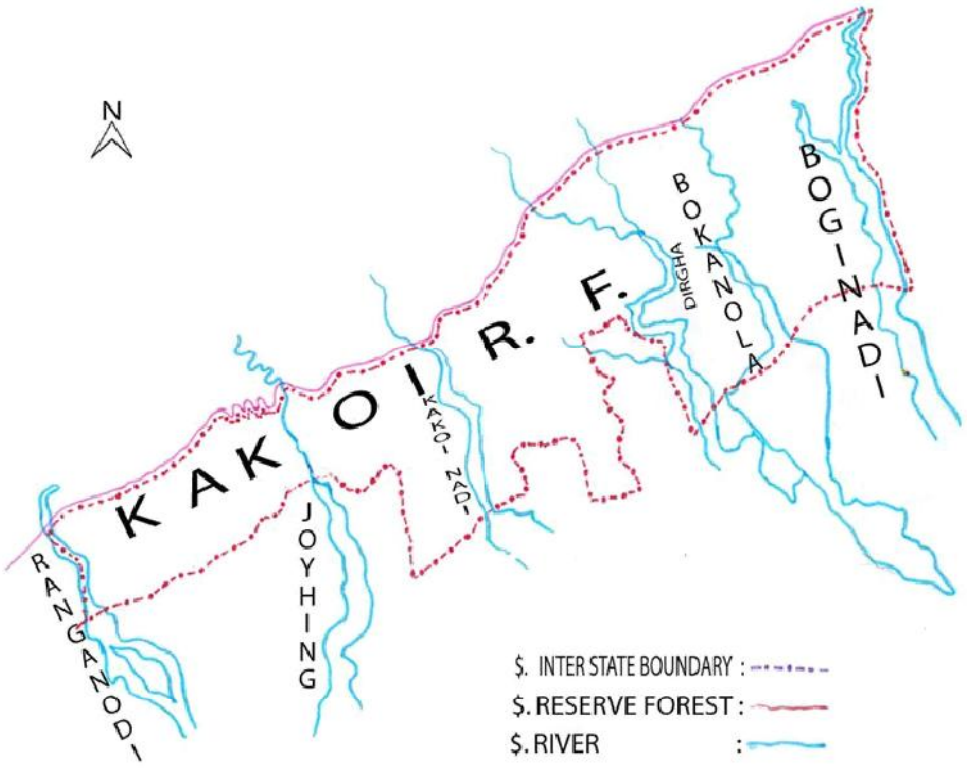

Fig 1: Hand –Drawn Map of Kakoi Reserve Forest

Fig 2: Map of the Study Area with adjoining areas

Types of forest found in KRF:

Assam constitutes the Indo-Burma mega biodiversity hotspot [11]. The forest types that can be found in the reserve forest are tropical wet evergreen, tropical semi-evergreen, and tropical moist deciduous [10, 4].

Tropical wet evergreen forest:

It is found in a narrow stretch in the Lakhimpur district along the foothills. Holong, the tallest tree of Assam (Also the state tree), is the predominant species of these forests. The associated species are Jatinahor, Dhuna tree, Borpat, Sewa dam, Banderdima, etc. one can even witness ornamental orchids, ferns, and other creepers indicating that the forest is a healthy one. *Mesua assamica*, a tree endemic to this region, has been bestowed with several uses, including anti-cancerous pharmaceutical properties [24] and other traditional uses [1].

Tropical semi-evergreen forest:

These forests have mostly medium-sized trees. Shrubs climber's orchids and ferns grow copiously. At the fringe areas, bamboo and cane occupy the space. *Amblyanthopsis bhotanica* is present in a single location in the Kakoi reserve forest of Assam, with about 50 matured individuals distributing in an area of about 100 m^2 [23].

Deciduous forest:

It consists of Sal forest and a Mixed Deciduous Forest where deciduous trees are the most common, with evergreen ones in between. These forests have a diversity of shrubby and herbaceous ground vegetation. *Capricornis sumatraensis* is a deciduous species found in this reserve forest [29].

Survey methodology:

Searches are conducted throughout a study area to identify all potential habitat resources. These searches necessitate the use of specific survey methods to yield satisfactory results. There are several types of methodology used in the search and survey of mammals.

Direct observation:

Diurnal or daytime searches for active fauna

For species that are active during the day, such as at dawn or dusk, diurnal or daytime surveys are appropriate. Diurnal overviews are done to recognize fauna when they are dynamic rummaging, drinking, resting, or relaxing in the sun. The survey method involves looking for fauna and can be done on foot, in a vehicle, or from a hide. Fig 6 is a direct sighting of *Trachypithecus pileatus*, Fig 8: shows a captured *Petaurista philippensis*, Fig 9: shows the sighting of *Nycticebus bengalensis*, Fig 11 is a sighting of a captured *Prionailurus bengalensis* and Fig 12 is a Sighting of *Macaca mulatta*

Indirect observations:

Finding signs of fauna activity is considered indirect evidence of a species' presence at a location. This includes searching the subject site during the day for signs of mammal activity such as scats, scratches on trees, sap-feeding scars on tree trunks, diggings in the ground, nests, remains, tracks, and burrows.

Scats:

Scats provide indirect evidence that a species exists in a particular location. Scat searches are applicable to all species, regardless of size; however, scats produced by large mammals are easier to detect than those produced by smaller species. The presence of seeds, hairs, and other plant parts indicates that the animal is herbivorous or carnivorous. [7]. Fig 4: shows the Dung of *Elephus maximus* and Fig 5: shows the Scat of *Prionailurus viverrinus*

Tracks:

Tracks are another indicator of faunal activity that indirectly indicates the presence of a species. Tracks made by similar species are frequently indistinguishable [9], necessitating direct survey methods to determine which species is present. Additional direct survey methods are used to confirm the presence of species in areas where tracks are detected. Fig 3: shows the Pugmarks of *Sus scrofa* and Fig 7: shows the Pugmarks of *Muntiacus muntjac*

Shelter sites – Burrows:

Burrow structure varies greatly between species [16, 17], and it also varies within a species based on the duration of occupation of the burrow or the age of the occupant [17]. Intra-specific differentiations in burrow measurements are likewise thought to be identified with soil physical properties [24]. Fig 10 is a burrow of *Euroscaptor micrura.*

Burrows provide indirect evidence of a species' presence, and searching for these features is an important part of detection surveys for all known burrowing species. Those made by larger species are more obvious and thus simpler to detect than those made by smaller species. Signs of activity, such as footprints and scats, distinguish active burrows of all species.

Call detection:

Many forest mammals have evolved to rely on acoustic displays to communicate with conspecifics [19]. Cue counting is a technique in which an action that represents the presence of an organism is recorded at a central location [26,12, 8] Call identification can be used to identify species that make loud and distinct vocal sounds. Call detection surveys are conducted by passively listening for calls in the appropriate habitat.

Community consultation:

Community consultation can be helpful in collecting historical information and anecdotal observations, especially for large and noticeable mammals that are frequently observed by the

local community. Interviews, publicity methods such as newspaper articles, pamphlets, and interpretive initiatives, by contacting people in a local area and asking them to fill out a questionnaire or contact a number with information can all be used to gather information from local communities.

Results:

Mammalian species found:

During the visits to Kakoi Reserve Forest, many mammalian species were observed and also the clues left behind by them indicated their presence in that area. A list of all the mammalian species can be found in Table 1.

Sl. No.	Common Name	Local name	Scientific name	Order	Source	IUCN Status	Abundance
1	Elephant	Hathi	*Elephas maximus*	Proboscidea	D.S./P.M.	Endangered	Abundant
2	Barking deer	Khutiaphu	*Muntiacus vaginalis*	Artiodactyla	Call	Least concern	Common
3	Indian fox	Shiyal	*Vulpes bengalensis*	Carnivora	Qu	Least concern	Common
4	Bintorang	Johamal	*Arctictis binturong*	Carnivora	Qu.	Vulnerable	Rare
5	Common palm civet	Johamal	*Paradoxurus hermaphroditus*	Carnivora	Qu	Least concern	Common
6	Rhesus monkey	Molua Bandar	*Macaca mulatta*	Primates	D.S.	Least Concern	Abundant
7	Hog deer	Hugaripahu	*Axis porcinus*	Artiodactyla	D.S.	Endangered	Rare
8	Wild pig	Bonoriagah ori	*Sus scrofa*	Artiodactyla	D.S.	Least Concern	Abundant
9	Short-tailed Mole	Utonua/ ukmuk	*Euroscaptormic rura*	Eulipotyphl a	Burrow	Least Concern	Abundant
10	Large Indian civet	Johamal	*Viverrazibetha*	Carnivora	Qu	Least Concern	Rare
11	Hispid hare	Khagorikota Hoha	*Caprolagushisp idus*	Lagomorpha	D.S.	Least Concern	Rare
12	Indian giant flying squirrel	Ram shor	*Petauristaphilip pensis*	Rodentia	D.S. (Captured)	Least Concern	Rare
13	Slow loris	Lajukibando r	*Nycticebus bengalensis*	Primates	D.S.	Endangered	Rare
14	Dhole/wild dog	Rang kukur	*Cuonalpinus*	Carnivora	Qu	Endangered	Occasional
15	Jungle cat	Bonoriamek uri	*Felis chaus*	Carnivora	Qu	Least Concern	Common

Sl. No.	Common Name	Local name	Scientific name	Order	Source	IUCN Status	Abundance
16	Himalayan crestless porcupine	Ketelapohu	*Hystrixbrachyura*	Rodentia	D.S.	Least Concern	Rare
17	Capped langur	Tupimuriab andor	*Trachypithecus pileatus*	Primates	Qu	Vulnerable	Rare
18	Leopard Cat	Nahorphutu kimekuri	*Prionailurus bengalensis*	Carnivora	Qu	Least Concern	Common
19	Fishing cat	Masuwoime kuri	*Prionailurusviverrinus*	Carnivora	Scat	Vulnerable	Rare

D.S. – Direct Sighting, Qu – Questionnaire, Fd- Forest department (reports), P.M. - Pugmark

Fig 3: Pug marks of *Sus scrofa*

Fig 4: Dung of *Elephus maximus*

Fig 5: Scat of *Prionailurusviverrinus*

Fig 6: Direct Sighting of *Trachypithecuspileatus*

Fig 7: Pug mark of *Muntiacus muntjac*

Fig 8: A captured *Petauristaphilippensis*

Fig 9: Sighting of *Nycticebus bengalensis*

Fig 10: Burrow of *Euroscaptormicrura*

Fig 11: Sighting of a captured *Prionailurus bengalensis*

Fig 12: Sighting of *Macaca mulatta*

Threats:

Poaching: This is a significant problem in this region. Although it has decreased over time, there still continues to be an occasional killing of animals like wild boar for their meat.

Deforestation: The exponential growth of the human population, cattle grazing, and cultivation exert tremendous stress on the vegetation and results in habitat destruction of a region [21]. In Kakoi, it used to be very severe, but in recent years it has decreased. Fig 13 shows the illegal logging practices.

Timber wood collection: Kakoi has a considerable reserve of rare species of timber which is exploited illegally.

Firewood collection: The locals regularly collect firewood from the forest for their domestic use. This action results in a disturbance in the natural living environment of the animals. Fig 14 shows the illegal collection of firewood

Thatch grass collection: People also regularly collect grass and other thatching material from the forest by slashing down large areas of grassland and trees

Fodder collection: Fodder collection from the forest results in lesser availability of fodder for the wild animals leading to starvation and death in a few cases. Fig 15 shows the illegal collection of fodder and Fig 16 shows the illegal collection of edible herbs.

Cattle grazing: The cattle from the nearby villages are occasionally grazed in the forest, leading to overexploitation of the fodder, leaving less food for the wild herbivores.

Illegal encroachment: Illegal encroachment is still prevalent in Kakoi Reserve Forest as and there is very little control over this. The forest lands are encroached by dishonest people who illegally build homes and claim the land as their own.

Fig 13: Illegal Logging

Fig 14: Illegal collection of firewood

Fig 15: Illegal Fodder collection

Fig 16: Edible herbs collection

Discussion:

This data consists of direct sightings and indirect methods like scat, burrows, calls and tracks. A few mammals like the wild pig dig up the ground at specific clearings to look for food; others like the elephant leave a distinctive type of dung that is very easy to spot. The data puts forward the diversity of mammals found in this reserved forest. Among these 4 are Endangered, 3 are Vulnerable, and 12 are of

Least Concern (According to the IUCN). This degree of variation and diversity is not common. Among these 19 mammals, we have 3 species of Artiodactyla, 8 species of Carnivora, 1 species of Eulipotyphla, 1 species of Lagomorpha, 3 species of Primates, and 1 species of Proboscidea and 2 species of Rodentia.

Mammalian diversity is a significant factor in the health of an ecosystem. Mammals are the largest animals and are capable of a massive impact on the environment they live in. Fragmentation of the habitat is considered the most significant threat to mammals' survival, particularly the primates in Northeast India [27]. Many instances of Human-Animal conflict have been observed in this area as it shares borders with the nearby tea gardens. Rhesus monkeys and Elephants are the most common mammals which are frequently involved. But this condition seems to be improving as the elephants have been taking alternate routes through the nearby connected reserved forests. Reduction in the logging and deforestation practices has brought about more area for the monkeys to reside, reducing the human-monkey conflict. Hence the reserved forest is on the way to rejuvenation, and if this trend continues, more and more species might be expected to show up in the near future. Hence it can be said that this region holds a gargantuan opportunity for further study and research.

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Comparative analysis of radon and its progeny in some specific places of Assam

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Abstract

The study of radon has been recognized globally as it has a life threating impact on the dwellings in the particular area. So, we have taken up a study to compare the radon datas with respect to our present study. Institutions like EPA (The Environmental Protection Agency),WHO (World Health Organisation), ICRP(International Commission on Radiological Protection) and many more world recognized organizations have taken up the study of radon and its importance. The element emanates naturally from the ground, and some building materials, all over the world, wherever traces of uranium or thorium can be found, and particularly in regions with soils containing granite or shale, which have a higher concentration of uranium. Because radon has a similar pressure and temperature curve as propane, and oil refineries separate petrochemicals based on their boiling points, the piping carrying freshly separated propane in oil refineries can become partially radioactive due to radon decay particles. Residues from the petroleum and natural gas industry often contain radium and its daughters.The availability of radon in indoor mainly depends on its source in the building materials, the soil beneath the building, the quantity and types of ceramic and the ventilation of rooms. Fifty locations within state were investigated during the period July 2010 to February 2011. The results showed that radon concentration varies between 70.8 and 291.7 Bq/m^3 with a mean value of (154 ± 3.8) Bq/m^3. The received dose (effective dose) due to inhalation of radon gas has been found to be varied from 0.42mSv/y to 0.91mSv/y. The values are within the safe limit recommended by ICRP, 2011 & ICRP ,1993).

Key-words: Indoor radon, Progeny, LR-115, Effective Inhalation Dose

Introduction:

Radon is produced in the soil due to the presence of ^{238}U and is transported to atmosphere by turbulent diffusion (J.E.Tanner). Once formed by the decay of the parent ^{226}Ra, the ^{222}Rn atoms are free to diffuse through the interstices between mineral or soil particles where they become a minor constituent of soil. The processes effective in transporting ^{222}Rn from soil to the surface are related directly to the size and configuration of the space occupied by the soil gas. Radon concentrations in soil pores (J.Porstendorfer) at depth are dependent directly upon the radium content of the soil, emanating power for radium and soil moisture content. Exhalation of ^{222} Rn, a radioactive inert gas, is associated with the presence of ^{226} Ra and its ultimate precursor uranium in the earth crust. Although these elements occur in virtually all types of rocks and soils, their concentration varies with specific sites and geological formation of materials.

The rate at which radon escapes or emanates from solid into the surrounding air is known as radon

exhalation rate of the solid. This may be measured by either per unit mass or per unit surface area of the solid. Measurement of radon exhalation rate of soils and rocks are helpful to study radon health hazards. Radon exhalation is the amount of radon (radon activity) as obtained from a given layer (geological material on the surface/surface exposure) mainly the outer thinner part of the crust. In the deeper material (within a geological strata), due to the attenuation of alpha particles from the uranium rich rock and/or thorium (another isotope of radium) it decreases. It is primarily due to diffusion, advection and convection as modes of radon transport. The presence of fractures, shearing, deformations, tectonic lineaments and faulting aids in the upward migration of radon. On the other hand Radon emanation is dependent on permeability of the rock, other lithological properties like rock alteration, erosion, diagenetic changes, to name a few. It also dependents on the nature of uranium and/or thorium. Radon enters into buildings through the soil or building materials. So radon exhalation rate from the soil or building material is an important parameter for estimating local environmental radon level. So, a qualitative analysis and comparison is highly essential in context to world concern. Radon is a decay product of uranium, which is relatively common in the Earth's crust, but generally concentrated in ore-bearing rocks scattered around the world. Radon mostly appears with the decay chain of the radium and uranium series (222Rn), and marginally with the thorium series (220Rn).

Materials and Methods:

The track density ρ (tracks.cm^{-2}) so obtained was converted into the units of (Bq m^{-3}) of radon concentration C_{Rn} using the following equation (F. Saad, H.A. Hend, & N.A. Hussein; M.A. Ayman & A. Ali; I.Tayseer & M.A. Ayman):

$$C_{Rn} = \rho / kt \qquad \text{.....(1)}$$

where t is the exposure time of distributed LR-115 detector in (days) and k is the calibration factor tracks of CR-39 in (tracks.cm^{-2}. day^{-1}/Bqm^{-3}) (F. Saad; M. A. Ayman & A. Ali; I.Tayseer & M. A. Ayman) The effective radium content C_{Ra} (Bq/Kg) can be calculated from the relation

$$C_{Ra} = \rho hA / kT M \qquad \text{..... (2)}$$

where ρ.is the counted track density (tracks.cm^{-2}), h is the distance between the detector and the top of the sample (m), A is the area of cross section of the can (m^2), K is the calibration factor of the detector, M is the mass of the sample (Kg) and Te is The effective exposure time (in hour) which can be determined using the following equation.

$$T_e = T - 1\text{-}\iota^{w\nu Rn\eta} / \lambda \text{.....} \qquad (3)$$

where T is the exposure time, and λ_{Rn} the decay constant for radon. The radon exhalation rate in terms of area, E_A (mBqm^{-2} h^{-1}) can be calculated from the (F. Saad, M.A. Ayman & A. Ali; I.Tayseer & M.A. Ayman):

$$E_A = C_{Rn} V\lambda / A[T + 1/\lambda (e^{-\lambda T} - 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where A, V, λ and T are the area of the can in (m^2), the effective volume of the can in (m^3), decay constant for radon in (h^{-1}), and the exposure time in hours, respectively. The radon exhalation rates in terms of mass, E_M (mBqm^{-2} h^{-1}) can be calculated by the following formula

$$E_M = C_{Rn} V\lambda / M[T + 1/\lambda (e^{-\lambda T} - 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where M is the mass of the sample (250 gm)

The risk of lung cancer from domestic exposure due to radon and its daughters can be computed directly from the equivalent effective dose. The annual effective dose, D (mSvy^{-1}) was computed from the integrated radon concentration using the following formula (Gupta, Mahur, Sonkawade, & Verma, 2010):

$$D = C_{Rn} \ 0.4 \times 3.88 \times 7000 / 170\ 3700 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where D and C_{Rn} are the annual effective dose in (mSvy^{-1}) and the integrated radon concentration in (Bq.m^{-3}) respectively. The equilibrium factor and the ICRP conversion factor (ICRP, 1993) are 0.4 and 3.88 mSv.WLM, respectively. 7000 is the number of hours per year, and 170 is the number of hours per working month.

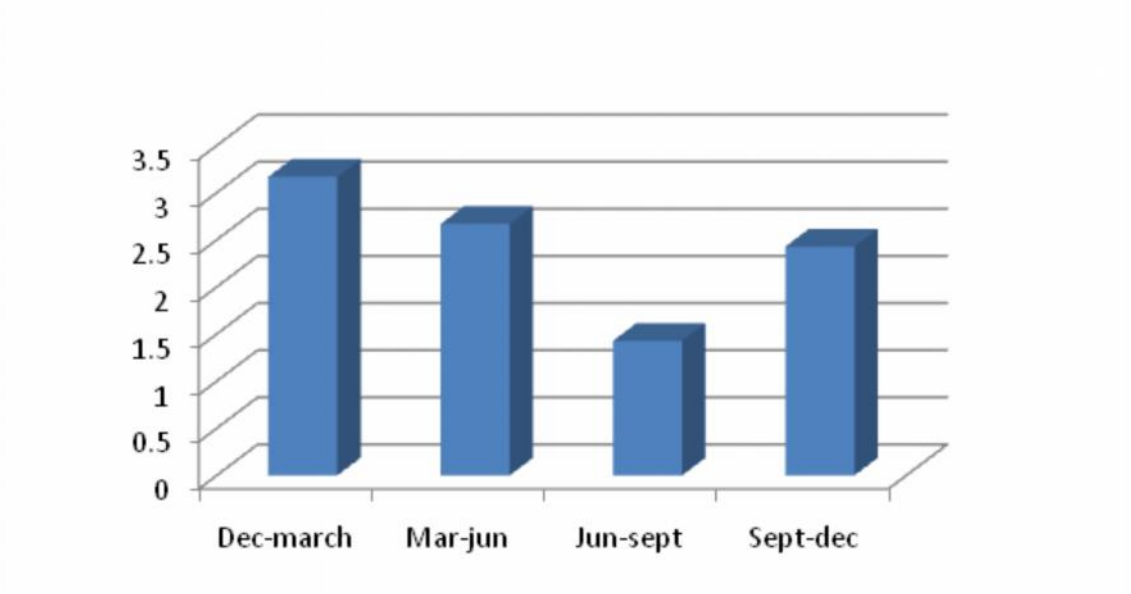
Results and Discussion:

Table 1 represents the activity concentrations of indoor Radon-222, effective Radium content (Bq/kg) and radon exhalation rate (mBqm^{-2} h^{-1}) were measured at different locations in oil field areas of Digboi, Assam. The soil samples are collected from different locations near oil industry within the range 2 – 4 Kms. The values of radium content at Digboi varies from 1.33 Bq/Kg to 1.6 Bq/Kg and radon exhalation rate varies from 29.37mBqm^{-2}h^{-1} to 31.18 mBqm^{-2}h^{-1}. From these data, a good positive correlation have been observed between radium content and radon exhalation rate in soil samples. The results show that there is a variation in radon exhalation rate from one location to other which depends on the geological formation. The variation in values of radon exhalation rate may be due to the differences in radium content (T.V. Ramachandran and M.C.Subba Ramu) and porosity (M. Folkerts) of the soil. The values of effective radium content are less than the permissible value of 370 Bq kg^{-1} as recommended by Organization for Economic Cooperation and Development (OECD 1979).

Hence, the result shows that these study areas are safe as far as the health hazards of radium are concerned.

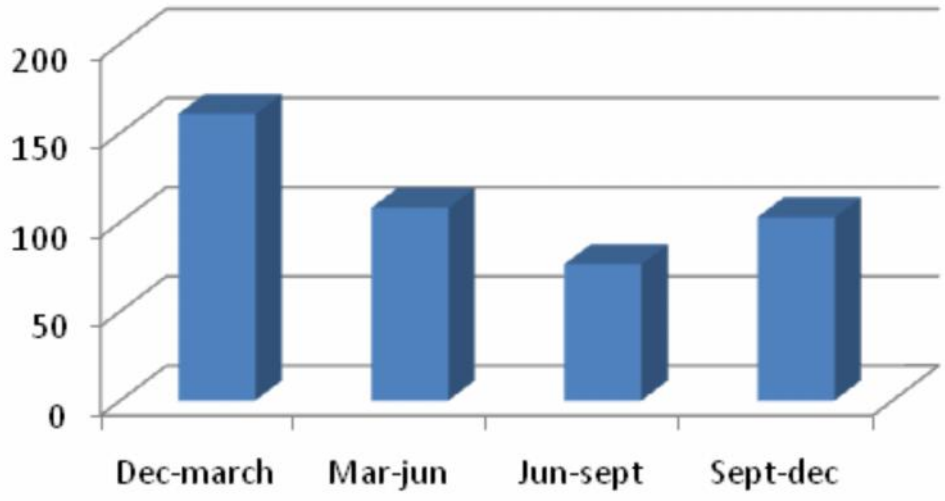
Indoor Radon progeny level(mWL) in RCC houses

Sl.No	locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	23.52	15.40	10.08	16.65
2	Guwahati hilly region	6.60	0.89	0.83	2.84
3	Namrup	0.83	0.60	0.47	0.66
4	Bongaigaon	0.97	0.61	0.53	0.59
5	Mangaldoi	0.66	0.47	0.36	0.43
6	Nalbari	0.49	0.35	0.28	0.38
7	Noonmati	0.42	0.33	0.45	0.54
8	Numaligarh	0.34	0.29	0.31	0.36
9	pathsala	0.23	0.20	0.21	0.36



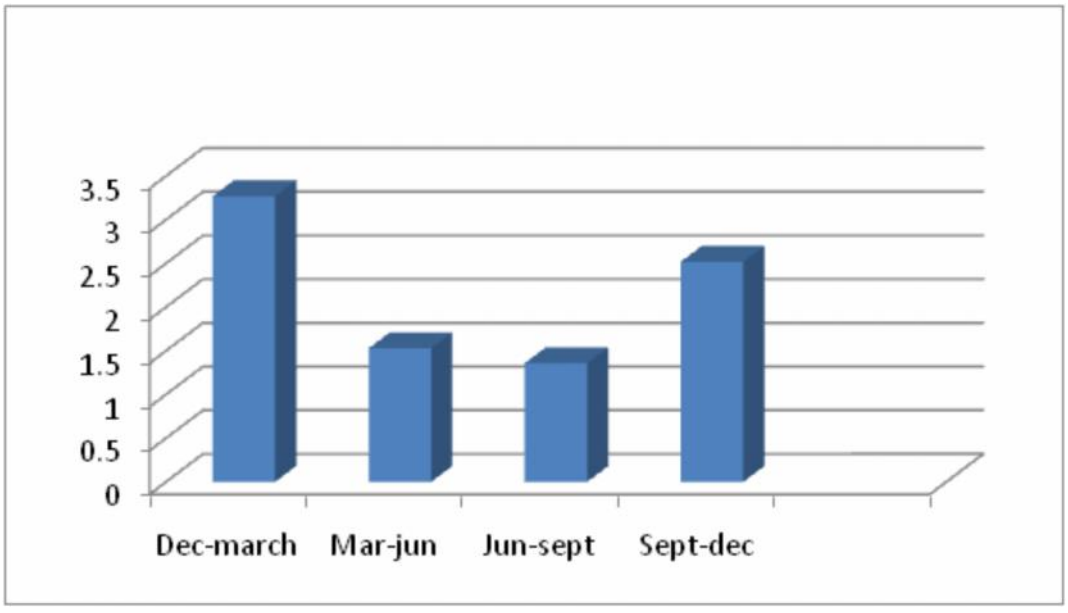
Indoor Radon concentration (Bqm^{-3}) in RCC houses

Sl.No	locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	88.55	59.38	38.84	62.26
2	Guwahati hilly region	244.68	153.46	160.12	177.7
3	Namrup	243.4	166.1	0.47	0.66
4	Bongaigaon	250.7	162.65	137.5	156.7
5	Mangaldoi	110.82	76.7	68.14	85.6
6	Nalbari	138.3	85.2	76.1	92.4
7	Noonmati	106.3	85.80	100.39	139.25
8	Numaligarh	160.7	96.3	101.5	109.1
9	Duliajan	103.6	87.01	94.73	101.1



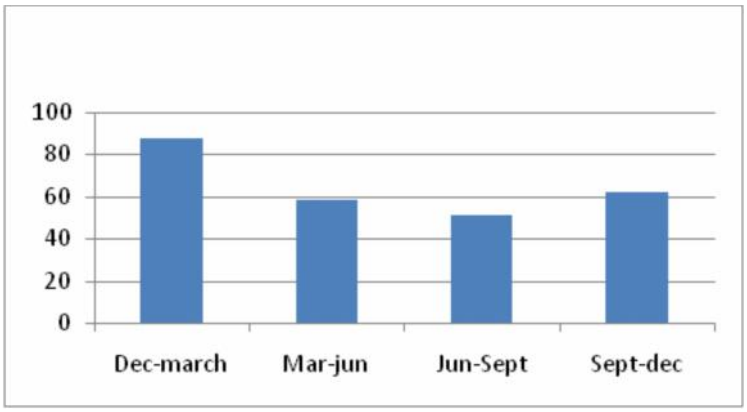
Radon progeny level(mWL) in AT houses

Sl.No	locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	24.32	12.40	10.08	20.25
2	Guwahati hilly region	2.80	0.54	0.81	1.33
3	Namrup	0.73	0.50	0.43	0.59
4	Bongaigaon	0.62	0.45	0.37	0.46
5	Mangaldoi	0.32	0.20	0.16	0.26
6	Nalbari	0.38	0.26	0.21	0.36
7	Noonmati	0.32	0.25	0.28	0.31
8	Numaligarh	0.28	0.22	0.18	0.27
9	Pathsala	0.27	0.17	0.20	0.29



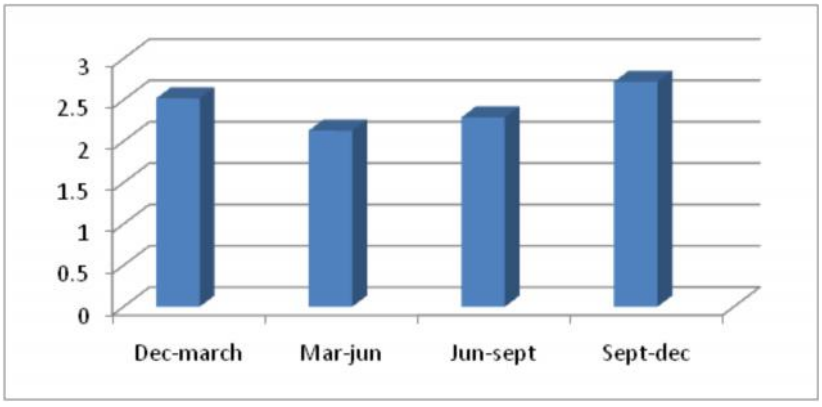
Radon concentration (Bqm^{-3}) in AT houses

Sl.No	Locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	87.04	56.98	37.56	61.60
2	Guwahati hilly region	160.9	109.9	116.7	119.3
3	Namrup	187.7	138.3	119.9	155.8
4	Bongaigaon	150.1	109.1	91.9	111.5
5	Mangaldoi	63.1	47.6	36.66	48.01
6	Nalbari	26.0	18.1	16.5	19.2
7	Noonmati	16	12	11	13
8	Numaligarh	31	25	21	19
9	Pathsala	14	11	10	12



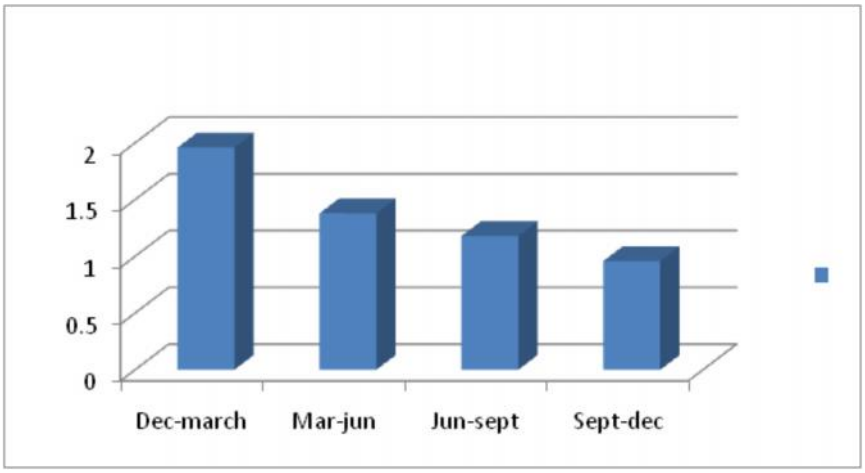
Thoron progeny level(mWL) in RCC houses

Sl.No	Locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	0.26	0.14	0.22	0.24
2	Guwahati hilly region	0.53	0.13	0.14	0.29
3	Namrup	0.08	0.04	0.03	0.05
4	Bongaigaon	0.08	0.06	0.04	0.07
5	Mangaldoi	0.08	0.05	0.04	0.06
6	Nalbari	0.06	0.04	0.02	0.04
7	Noonmati	0.11	0.06	0.10	0.12
8	Numaligarh	21.5	18.6	19.9	23.5
9	Pathsala	0.10	0.08	0.08	0.15



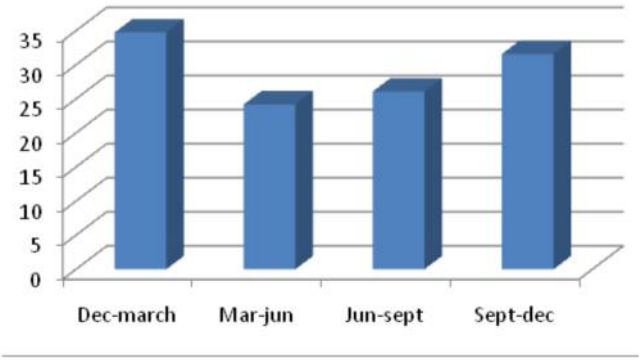
Thoron progeny level(mWL) in AT houses

Sl. No	Locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	0.16	0.04	0.03	0.08
2	Guwahati hilly region	0.33	0.08	0.07	0.15
3	Namrup	0.04	0.02	0.01	0.03
4	Bongaigaon	0.05	0.04	0.03	0.02
5	Mangaldoi	0.04	0.03	0.02	0.03
6	Nalbari	0.04	0.02	0.02	0.03
7	Noonmati	0.03	0.03	0.02	0.02
8	Numaligarh	18.78	12.34	8.98	6.76
9	Duliajan	0.16	0.12	0.08	0.10



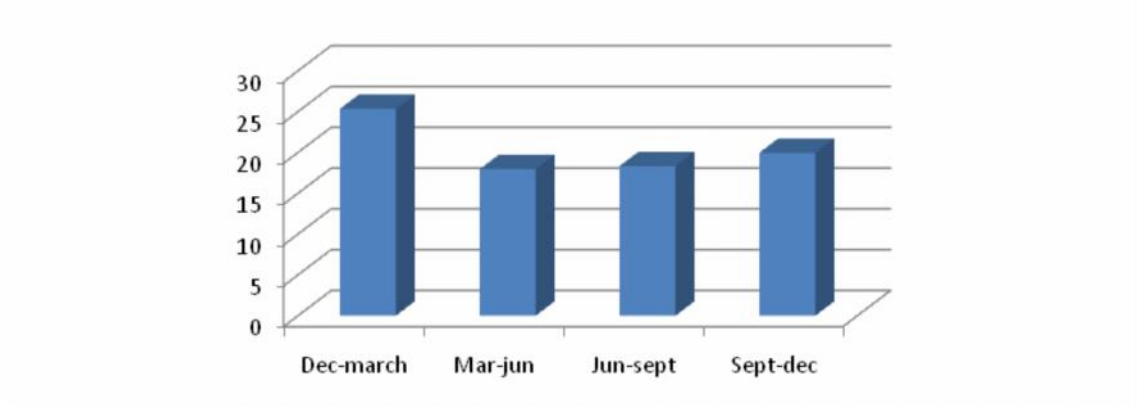
Thoron concentration (Bqm^{-3}) in RCC houses

Sl. No	Locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	60.5	41.9	49.8	52.8
2	Guwahati hilly region	46.38	31.38	32.36	34.86
3	Namrup	26.9	18.1	15.6	23.7
4	Bongaigaon	35.6	23.2	16.7	21.3
5	Mangaldoi	15.8	9.6	9.1	11.8
6	Nalbari	20.5	11.9	9.8	12.8
7	Noonmati	41.2	26.1	46.9	49.2
8	Numaligarh	23.45	19.67	17.44	18.66
9	Pathsala	46.38	36.11	38.61	59.44



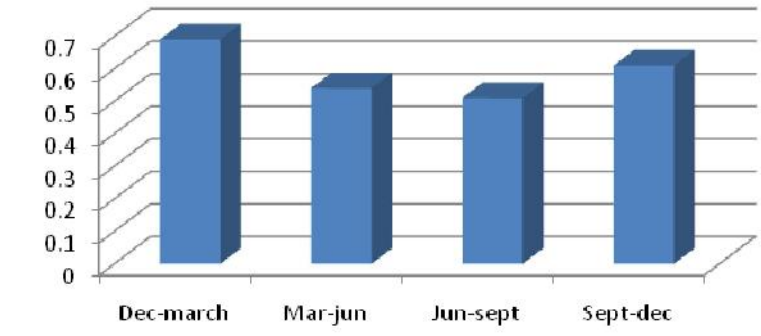
Thoron concentration (Bqm^{-3}) in AT houses

Sl. No	Locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	34.7	21.3	20.4	28.9
2	Guwahati hilly region	29.14	19.16	19.16	21.48
3	Namrup	19.6	14.0	12.5	15.4
4	Bongaigaon	16.8	12.8	10.7	13.0
5	Mangaldoi	15.3	9.6	8.0	11.6
6	Nalbari	16.0	8.1	6.5	9.2
7	Noonmati	45.9	28.1	42.7	33.2
8	Numaligarh	26.4	19.3	18.9	22.4
9	Duliajan	32.5	30.1	27.5	26.7



Total inhalation dose (μ $Sv.h^{-1}$)

Sl.No	Locations	Dec-march	Mar-jun	Jun-sept	Sept-dec
1	North kamrup areas	0.91	0.72	0.71	0.83
2	Guwahati hilly region	0.86	0.71	0.69	0.78
3	Namrup	0.89	0.62	0.49	0.67
4	Bongaigaon	0.83	0.56	0.46	0.52
5	Mangaldoi	0.42	0.24	0.23	0.35
6	Nalbari	0.47	0.32	0.28	0.34
7	Noonmati	0.58	0.43	0.61	0.69
8	Numaligarh	0.79	0.54	0.71	0.63
9	Pathsala	0.53	0.44	0.49	0.64



Conclusion:

Based on the results obtained in this study the following concluding observations may be drawn asfollows:

1. With increase of radium content of soil samples the radon exhalation rate also increases in the studied locations.

2. The average values of effective radium content at the locations of the studied area are lower than the OECD recommended value.

Acknowledgment:

A special thanks to the Assam Down Town University, Gandhinagar, Panikhaiti and Department of Physics for supporting this work. A special thanks to Dr. Nayan Talukdar, Down town university, Assam, and Dr. Ranjan Kr. Kakati, Director, Student's Welfare, Gauhati University, Assam for guiding me.

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Schedule of the International Conference on "Impacts & Consequences of Environmental Degradation on Animal Health and Human Wellbeing"

Date	Inaugural Session	1st Session	2nd Session	3rd Session	
	10.00AM - 12.00Noon	12.30 PM-2.30 PM	3.00 PM -5.00 PM	7.00 PM –9.00 PM	
2-9-2021		**Chairperson:** **Prof. Ramesh 'Zimbo' Boonratana,** Mahidol University International College, Bangkok, Thailand **Plenary Lecture: I** **Speaker:Prof. Krishna GopalBhattacharyya,** Retd. Professor & Head, Dept. of Chemistry, Gauhati University **Title: Heavy Metals in the Environment and their Ecological Impacts** **Paper Presentation of Participants- 5 nos.**	**Chairperson:** **Prof. Krishna Gopal Bhattacharyya,** Retd. Professor & Head, Dept. of Chemistry, Gauhati University **Plenary Lecture: II** **Speaker: Prof. Stuart R. Milligan,** Visiting Professor of King's College London **Title: Biological Dysfunction in a Fog of Man-Made Chemicals: "Endocrine Disruption" in Humans and Wildlife** **Paper Presentation of Participants: 5 nos.**	**Chairperson:** **Prof. Jogen Chandra Kalita,** Head, Dept. of Zoology, Gauhati University **Plenary Lecture-III** **Speaker: Prof. Achintya N. Bezbaruah,** North Dakota State University, NDSU, USA **Title: Nano, Micro and Macro Interventions to Minimize Anthropogenic Environmental Degradation** **Paper Presentation of Participants: 5 nos.**	
3-9-2021	----	9.00 AM-11.00 AM	11.30 AM-2.00 PM	3.00 PM-5.00 PM	
		Chairperson: **Prof. Aparajita Borkotoki,** Retd. Professor and Head of Zoology Dept. and Dean, Faculty of Science, Gauhati University **Plenary Lecture: IV** **Speaker:** Dr. Bibhuti Prasad Lahkar, Scientist E, Head, Elephant Research and Conservation Division (ERCD), Aranayak, Guwahati, Assam, India **Title: "Restoration ofgrasslands in Manas National Park to create habitat for threatened fauna and wellbeing of local communities"** **Paper Presentation of Participants: 5 nos.**	**Chairperson:** **Dr Hadida Yasmin,** Associate Professor, Cooch Behar Panchanan Barma University **Plenary Lecture: V** **Speaker:** **Prof. Prakash Lohar,** Head, Dept of Zoology & Biotechnology MGSM's ASC College, Chopda Chairman, BoS in Zoology, KBC North Maharashtra University, Jalgaon **Title: Plight of the Pollution in River Patalganga and It's Impact on Animal Life** **Paper Presentation of Participants: 8 nos.**	**Chairperson:** **Prof. Soumen Bhattacharjee,** University of North Bengal **Plenary Lecture: VI** **Speaker:** **Dr. Diganta Bhusan Das,** Department of Chemical Engineering, School of AACME, Loughborough University, UK **Title: Two Phase Flow in the Context of CO_2 Sequestration, Storage and Monitoring** **Paper Presentation of Participants: 7 nos**	
4-9-2021		10.00 AM-11.30 AM	12.00 Noon-2.30 PM	3.00 PM-4.30 PM	4.30 PM-5.30 PM
		Chairperson: **Dr Rezina Ahmed,** Associate Professor, Cotton University **Plenary Lecture: VII** **Speaker: Dr.Bidyut Bikash Goswami,** Research Professor, Irreversible Climate Change Research Centre (IRCC) Yonsei University, Seoul, South Korea **Title:Indian Ocean Warming and It's Impact on the Indian Summer Monsoon** **Paper Presentation of Participants: 5 nos.**	**Chairperson:** **Prof. Parthankar Choudhury,** Assam University, Silchar, Assam **Plenary Lecture: VIII** **Speaker: Prof. Arun S. Kharat,** Professor, School of Life Sciences, Jawaharlal Nehru University, New Delhi **Title:Antibiotic: An Environmental Burden** **Paper Presentation of Participants: 7 nos**	**Chairperson:** **Prof. Prakash Lohar,** Head, Dept of Zoology & Biotechnology MGSM's ASC College, Chopda Chairman, BoS in Zoology, KBC North Maharashtra University, Jalgaon **Plenary Lecture: VIII** **Speaker: Prof. Hilloljyoti Singha,** Professor & Head, Dept. of Zoology, Bodoland University **Title:People's participation in Wildlife Conservation: Opportunities and Challenges** **Paper Presentation of Participants: 7 nos**	**Valedictory Session**

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About Abhayapuri College:

Abhayapuri College, affiliated to Gauhati University,came into its existence as an Arts college on 13th August, 1955 at Abhayapuri, the administrative headquarters of the erstwhile Bijni Raj estate, presently the headquarters of North Salmara Subdivision under Bongaigaon district of Assam (India), as a result of untiring efforts of some luminaries of this locality under the able leadership of late Govinda Ch. Dev. Sarma. The Arts stream was brought under deficit system of Government of Assam in 1962. Realizing the need for science education for all-round development of the feeder areas, the science stream was introduced in 1979 and this stream was taken over by the state Government in its deficit grant- in-aid system in 1986.

The academic dimension of the college was further expanded by introducing a vocational component in 2015-16 comprising UGC sponsored B.Voc. programme in TTM, IT, RMIT and UGC's community College scheme in BFSI. Moreover, the college has been offering PGDCA (Regular) under G.U, a number of computer courses in self-financing mode and also functioning as a contact centre of Krishna Kanta Handiqui State Open University.

So far, the college has been accredited by NAAC twice; under 1st cycle it was accredited 'B' Grade by NAAC in 2004. The 2nd cycle of Assessment was conducted in 2015 and the college acquired 'B' Grade with CGPA 2.50 w.e.f. January, 2016. At present, the preparation for 3rd cycle of assessment is under way.

It is a matter of pride and immense pleasure to mention that in a study conducted by the India Today group in 2021 to assess the quality of education in the HEIs of the country, Abhayapuri college has been ranked 152nd and 158th with respect to the quality of its education under Science and Arts stream respectively. (www.abhayapuricollege.in).

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