



ICEES 2022



Bilateral International Conference

On Ecotoxicology & Environmental Sciences

Date:
19- 20 October, 2022

Venue:
Journalist Liakat Ali
Auditorium,
Acharya Jagadish Chandra
Bose Academic Building,
Khulna University, Khulna,
Bangladesh

Organized by
**INSTITUTE OF ECOTOXICOLOGY AND
ENVIRONMENTAL SCIENCES (IE&ES), INDIA**
and
**BANGLADESH ENVIRONMENT AND DEVELOPMENT
SOCIETY (BEDS), BANGLADESH**
in association with
KHULNA UNIVERSITY, KHULNA, BANGLADESH



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This conference has been partially supported by the **National Forum of “Building a multi-country, civil society partnership to increase the resilience of coastal populations in South Asia”** project.

**BILATERAL INTERNATIONAL CONFERENCE ON
ECOTOXICOLOGY & ENVIRONMENTAL SCIENCES
(ICEES-2022)**

Partially supported by

**National Forum of “Building a multi-country, civil society partnership to
increase the resilience of coastal populations in South Asia” project**

Health associate:

Peerless Hospital & B. K. Roy Research Centre, Kolkata, India

19-20th October, 2022

at

**Journalist Liakat Ali Auditorium,
Acharya Jagadish Chandra Bose Academic Building, Khulna University,
Khulna, Bangladesh**

ABSTRACT VOLUME

Organized by

**INSTITUTE OF ECOTOXICOLOGY AND ENVIRONMENTAL SCIENCES (IE&ES),
Y/7, XI, Purbachala, Salt Lake, Kolkata – 700097, West Bengal, India**

&

**BANGLADESH ENVIRONMENT AND DEVELOPMENT SOCIETY (BEDS),
House No. 6/3, Road No. 01, Prantika R/A, Nirala, Khulna – 9100, Bangladesh**

In Association With

**KHULNA UNIVERSITY,
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Message from the Honorable Vice – Chancellor



I feel nice as an abstract book is ready to get published for an international conference on 'Ecotoxicology and Environmental Science'. It's again an added pleasure to me that Khulna University hosts such a big event on October 19-20, 2022; when, i believe this burning issue will trigger a new wave of thoughts.

'Ecotoxicology and Environmental Science' is an amply discussed topic particularly over the last century. The challenges that have surfaced recently for the survival of nature and life, are largely dependent on the multi-dimensional aspects of these issues. At the same time, sustainability of environmental protection and the growing needs for adaption with the climate change has now become a great concern for human civilization. Numerous aspects like agricultural production and utility of soil and water are intrinsically related to Ecotoxicology and Environmental Science. A review of the situation along with few directions can carve out an exit plan. I think organizing such an International Conference on this issue carries a timely message for all of us.

In this connection, I heartily congratulate Indian Institute of Ecotoxicology and Environmental Science (IE&ES) and the Voluntary organization Bangladesh Environment and Development Society (BEDS) for jointly arranging this conference. At the same time, I would like to express my sincere thanks to the teachers of Agrotechnology Discipline of Khulna University, who are trying hard to make the International Conference a success. I stand grateful to the scientists, researchers and experts from home and abroad along with the representatives of government, autonomous institutions and private organizations who are likely to take part in this Conference.

I believe that the recommendations, data and guidance received from this International Conference on Ecotoxicology and Environmental Science will create new opportunities for working together in the related areas and will be helpful for even the policy makers at national, regional and international levels.

A handwritten signature in black ink, appearing to read 'Mahmood'.

(Prof. Mahmood Hossain, Ph.D)
Vice-chancellor
Khulna University

Message from the Honorable Pro-Vice Chancellor



I am happy to learn that a Book of Abstracts is going to be published on the occasion of a two-day long International Conference on 'Ecotoxicology and Environmental Science' on October 19-20, 2022 at Khulna University. 'Ecotoxicology and Environmental Science' is burning issue in the current global context. We know that Ecotoxicology is related every component of agriculture, soil, water and process food, as well as others field of our daily life. In this regards save the Earth and it's environment, diversity we needed to more research and future directions. I think organizing such an International Conference on this issue is a timely initiative.

I heartily congratulate Indian Institute of Ecotoxicology and Environmental Science (IE&ES) and voluntary organization Bangladesh Environment & Development Society (BEDS) for jointly arranging this conference. At the same time, I would like to express my sincere thanks to the teachers of Khulna University, who are trying hard to make the International Conference a success. My personal greetings to the scientists, researchers and experts from home and abroad and also the representatives of government and non-government organizations who will participate in this Conference.

I believe that the recommendations from this International Conference on Ecotoxicology and Environmental Science will guidance new opportunities for working in this related areas and policy making.

I wish the two-day long International Conference on Ecotoxicology and Environmental Science to be held at Khulna University Godspeed.

A handwritten signature in black ink, appearing to read 'Hosna'.

(Prof. Dr. Mosummath Hosna Ara)

Pro-Vice Chancellor

Khulna University

Message from the Dean of Life Science School



I am glad to know that a journal containing abstracts is being published on the occasion of a two-day international conference on 'Ecotoxicology and Environmental Science'. The venue of this conference is Khulna University's life Science School - it is my pleasure.

We know that Ecotoxicology and Environmental science are very important issues in the contemporary world. Due to Global Warming, use of harmful chemical solvents in agriculture and other activities, environmental pollution has reached an alarming level, which has become a threat to human civilization and the entire organism and world. Already we are noticing its negative and feeling its negative side. It has become necessary to bring forward the issue of Ecotoxicology and Environmental Science in the overall context and determine the future in this regard. Realizing that reality, India's Institute of Ecotoxicology and Environmental Science (IE&ES) and the voluntary organization BEDS jointly organized this conference, on behalf of the Life Science School, I express my sincere thanks to both institutions. Khulna University Honorable Vice-Chancellor Professor Dr. Mahmood Hossain expressed his sincere gratitude to organizing this conference and venue and agreeing to inauguration as the chief guest. I am congratulating to Agrotechnology Discipline teacher of this University Professor Dr. Sardar Shafiqul Islam for fulfilling his important duties as the focal point of the conference. Greetings in advance to the researchers, scientists and experts who are attending the conference from home and abroad.

I wish the success of the two-day international conference on Ecotoxicology and Environmental Science.

A handwritten signature in black ink, appearing to be 'Khan Golam Quddus', written in a cursive style.

Professor Khan Golam Quddus
Dean, Life Science School
Khulna University.

BILATERAL INTERNATIONAL CONFERENCE

ON ECOTOXICOLOGY & ENVIRONMENTAL SCIENCES (ICEES-2022)

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Message from the President, IE &ES and Chairperson, Organizing Committee, ICEES – 2022



Environmental Ecotoxicology is a multidisciplinary field of science concerned with the study of the harmful effects of various physical, chemical and biological agents on the environment as well as on living organisms at the population and ecosystem level. The sources of environmental contaminants are diverse and they are largely anthropogenic as waste product discharged in the form of solid, liquid and gas emitting from Industries, Agricultural products, Incinerators, sewage plants etc. Many of these contaminants devastate the ecosystem and adversely affect human health. The damaging effects may not only be temporary but may also have long-term effects. Institute of Ecotoxicology and Environmental Sciences regularly organize National and International Seminars, Workshops to disseminate awareness and knowledge among students, scholars, faculties, policy makers to improve the quality of environment and to maintain sustainable development. The present “Bilateral International Conference on Ecotoxicology and Environmental Sciences in collaboration with BEDS (Bangladesh Environment and Development Society) and in association with Life Science School and Chemistry Discipline of Khulna University” is one of such endeavor. I sincerely express my gratitude to our National and International Scientific Advisors and heartfelt gratitude to the organisers of BEDS (Bangladesh Environment and Development Society) providing helps in scientific activities and sincere thanks to Life Science School and Chemistry Discipline of Khulna University for helping in Scientific session as well as for Technical support and hospitalities. I express my sincere thanks to those who provided financial support to IE & ES for conducting this International Conference at Khulna University. Special thanks and gratitude to Vice-Chancellor, Dean of Science and other faculty members of Khulna University and the members of BEDS for their support to make this event successful. Our efforts are to improve the quality of Post-graduate teaching and research in India. Our efforts will be successful if the young scientists / researchers are benefited from the deliberations of resource persons.

With warm hearty welcome,

Dr. Sarmila Pal

Chairperson, ICEES -2022

&

President

Institute of Ecotoxicology and Environmental Sciences (IE&ES)

Y/7, XI, Purbachala, Salt Lake, Kolkata – 700097,

West Bengal, India

For more details visit: <http://www.ieesonline.in> / <http://www.bedsbd.org> / <https://ku.ac.bd>

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Message from the Vice-Chairperson of IEES-2022



I am delighted to acknowledge the “Bilateral International Conference on Ecotoxicology and Environmental Sciences (ICEES 2022)” organized by the Institute of Ecotoxicology and Environmental Sciences (IE&ES), India and Bangladesh Environment and Development Society (BEDS) in association with Khulna University, Bangladesh.

I'm appreciative to the organizing committee for hosting a fruitful conference and disseminating fresh insights and academic findings. I send them my best wishes as they work to educate people about various environmental challenges, including biodiversity and ecological destruction, particularly in the Sundarbans coastal areas. I think that the conference's outcomes will have a significant impact on how policies are developed to stop future environmental degradation and ensure the sustainable development of coastal ecosystems.

Bangladesh Environment and Development Society (BEDS) is a non-governmental and non-profit organization working since 2010 to maintain harmony between humans and nature. The impact of climate change and its mitigation are the top global issues to save the planet; therefore, the BEDS family is delighted to be a part of such an important conference.

I am very grateful to the Institute of Ecotoxicology and Environmental Sciences (IE&ES), India and Khulna University, Bangladesh for their substantial cooperation and support in organizing the conference.

Finally, I would like to express my gratitude to the BEDS members and all others who are contributing to make the event a success.

Md. Maksudur Rahman
Vice-Chairperson, IEES-2022
&
Chief-Executive
Bangladesh Environment and Development Society (BEDS)
House No. 6/3, Road No. 01
Prantika R/A, Nirala, Khulna-9100, Bangladesh
www.bedsbd.org

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Khulna, Bangladesh

Message from the Convener (Bangladesh Chapter), ICEES – 2022



Dear Esteemed Participants,

I am delighted to welcome all participants to the Bilateral International Conference on Ecotoxicology and Environmental Sciences (ICEES 2022) jointly organized by Institute of Ecotoxicology and Environmental Sciences (IE&ES), India, Bangladesh Environment and Development Society (BEDS) and Khulna University, Bangladesh. The main aim of organizing the conference is to share and increase the knowledge of each individual about climate change, global environmental pollution, loss of biodiversity and possible measures to tackle these issues. In addition to oral and poster presentations, the conference plans to organize workshops relevant to the above-mentioned topics. I believe this conference will benefit the global participants and I am proud that Khulna University is the venue for this event. The success of the conference depends on the active participation of researchers and the cooperation of those working to organize the event. The keynote paper will be presented by renowned scientist and honorable vice-chancellor Professor Dr. Mahmood Hossain which will add a new dimension to the conference.

I would like to express my deep gratitude to the authors whose technical contributions have been presented in this abstract books. It is because of their wonderful contribution and hard work that we have been able to produce these books. The significance of the research presented at this conference represents another step towards environmental issues.

I would like to thank everyone for making this international conference possible. I acknowledge our university administration, Honorable Vice-Chancellor Professor Dr. Mahmood Hossain and Professor Khan Golam Quddus, Dean of School of Life Sciences, Khulna University, Bangladesh for their continuous support.

My special thanks and gratitude to the Discipline Heads of Life Sciences School of Khulna University for their valuable suggestions and cooperation in making the event success.

Professor Dr. Sarder Safiqul Islam

Convener of IEES-2022 (Bangladesh Chapter) and
Professor of Agrotechnology Discipline,
Khulna University, Khulna, Bangladesh

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Khulna, Bangladesh

Message from the Secretary, IE &ES and Convener (India Chapter), ICEES - 2022



My heartfelt welcome to all dear participants in the Bilateral International Conference on Ecotoxicology & Environmental Sciences (ICEES-2022) at Journalist Liakat Ali Auditorium, Khulna University, Bangladesh on 19th&20th October, 2022. It is a great opportunity for all concerned to share their scientific thoughts, ideas, theories associated with the global environmental problems and policies. For the last two years it was not possible to arrange such conference due to the deadly COVID pandemic which was prevailed as the curse on human civilization. Man can fight against all adversities with proper planning and genuine endeavour. The conference will provide discussions regarding the prevailing common environmental problems and will furnish the novel researches in the field of environmental sciences.

India and Bangladesh - the two neighbouring countries share common climatic, physical and geographical conditions and definitely with some similar environmental problems. I hope that this bilateral conference will help to generate some ideas which will be helpful for the policy makers to create important implementations.

I am pleased to announce that as per the resolution of the Governing Council of IE&ES, first time the society is going to announce two prestigious awards for the outstanding contribution in the field of environmental sciences or other branches of science & technology — "IE&ES YOUNG SCIENTIST AWARD" and "IE&ES DISTINGUISHED SCIENTIST AWARD".

My sincere thanks to Md. Maksudur Rahman, Chief Executive of BEDS for accepting the proposal of this bilateral conference and my heartfelt gratitude to respected Vice-chancellor, Khulna University for supporting enormously to realise the conference. I do admire Dean, Life Science School, Khulna University and Dr. Sardar Safiqul Islam, Convener (Bangladesh Chapter) for their continuous support and guidance. I would like to thank all co-sponsors for making this international conference possible.

I hope that the main motto to organize this conference will be achieved. The participants especially the students and researchers will be benefitted and this will be the success of the conference.

Thank you all

With regards

Dr. Debabrata Mukherjee

Convener (India Chapter), ICEES -2022

Secretary, Institute of Ecotoxicology and Environmental Sciences (IE&ES)

Y/7, XI, Purbachala, Salt Lake, Kolkata – 700097, West Bengal, India

**BILATAERAL INTERNATIONAL CONFERENCE ON ECOTOXICOLOGY AND
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PROGRAMME

Note: 15 minutes are allotted for each Plenary lectures and 10 minutes are allotted for each Contributed paper. Presenters are urged to abide by this time restriction strictly. Session Chairpersons are requested to announce the time limit at the beginning of each session.

Wednesday 19th October, 2022

Kit Distribution & Spot Registration for Listeners: 8.30 - 9.30 A.M

Inaugural Session: 9.30-10.30 A.M

09.30 A.M: National Anthem of Bangladesh

National Anthem of India

National Anthem of other participating countries

09.40 A.M: Presenting Flower bouquet to the guests

09.45 A.M: Opening Song

09.50 A.M: Welcome Address by the Convener (Bangladesh Chapter), ICEES-2022

10.00 A.M: Address by the Vice-chairperson of ICEES-2022

10.05 A.M: Address by the Special Guests

10.15 A.M: Address by Chief Guest

10.20 A.M: Address by Chairperson of ICEES-2022

10.25 A.M: Vote of Thanks by the Convener (India chapter), ICEES-2022

TEA BREAK: 10.30 - 10.40 A.M

Keynote Speech: 10.40 - 10.55 A.M

Is the Sundarbans of Bangladesh in a state of pollution?

Prof. Dr. Mahmood Hossain

Vice-chancellor, Khulna University

Professor, Forestry and Wood Technology Discipline, Khulna University, Bangladesh

Scientific Session I: Environmental Pollution: Source & Monitoring

Chair: Prof. Pasquale Avino

Co-Chair: Dr. Sarmila Pal

Plenary Lecture I: 10.55-11.10 A.M

Heavy Metals and Metalloids In The Environment: Human Toxicity And treatment Strategies

Prof. Okechukwu Jonathan Okonkwo,

Faculty of Science, Tshwane University of Technology, Arcadia Pretoria, South Africa,

Plenary Lecture II: 11.10- 11.25 A.M

Pollen /spore allergy and allergen biology in India

Prof. Swati Gupta Bhattacharya,
Ex-Professor, Division of Plant Biology,
Main Campus, Bose Institute, Kolkata, West Bengal, India

Contributed Papers: 11.25-12.40 P.M

CP_AP-07, CP_AP-09, CP_AP-12, CP_AP-14, CP_RS-11, CP_ST-01, CP_ST-11, CP_ST-21

Scientific Session II: Biodiversity and Conservation: Threats & Mitigation

Chair: Prof. Kashinath Bhattacharya Co-Chair: Dr. Santasmita Das Bhattacharya

Plenary Lecture: 12.40-12.55 P.M

A successful endeavor of ecological restoration/conservation of degraded mangroves outside the protected areas of Indian Sundarbans

Dr. Krishna Ray
West Bengal State University, Kolkata,
West Bengal, India

Contributed Papers: 12.55- 1.45 P.M

CP_AP-04, CP_AP-10, CP_RS-05, CP_RS-06, CP_RS-07, CP_ST-20

LUNCH: 1.45-2.45 P.M

Scientific Session III: GIS, Remote Sensing and Instrumentation

Chair: Prof. Swati Gupta Bhattacharya Co-Chair: Dr. Md. Aminur Rahman

Plenary Lecture: 2.45-3.00 P.M

Evaluating the appropriate technique for mapping and modeling the Soil Salinity using remote sensing technique in Gosaba, West Bengal, India

Dr. Santasmita Das Bhattacharya
Associate Professor
Amity University Kolkata Campus,
New Town, Kolkata, India

Plenary Lecture II: 3.00-3.15 P.M (Online mode)

Remote sensing and GIS techniques in earth's feature identification and ground water prospecting

Dr. Pinaki Roy
Assistant Professor, Durgapur Government College,
Jawaharlal Nehru Avenue, Durgapur,
West Bengal, India

Contributed Papers: 3.15-3.40 P.M

CP_AP-01, CP_AP-03

Scientific Session IV: Nanotechnology and Molecular approaches to Environmental Sciences

Chair: Prof. Okechukwu Jonathan Okonkwo Co-Chair: Prof. Dr. Sheikh Julfikar Hossain

Plenary Lecture: 3.40-3.55 P.M

Nanotechnology and environment: A molecular insight under current agricultural scenario

Dr. Biplab Sarkar,

Principal Scientist (Nanobiotechnology), IIAB, (Indian Council of Agricultural Research)

Ranchi, Jharkhand, India

Contributed Papers: 3.55-4.05 P.M

CP_AP-15

TEA BREAK: 4.05-4.15 P.M

• Special Presentation (Recorded) : 4:15 – 4:30 PM

Microplastic Pollution in Mangroves in Malaysia: A Pioneer Investigation

Prof. Dr. P. Agamuthu

Professor and Associate DEAN, Sunway University, Malaysia

Foreign Expert, Ministry of Science and Technology, China

• Presentation for Selection of ‘IE&ES Young Scientist Award 2022’: 4.30 -5.00 P.M

Scientific Session V: Production of Bio-mass and Implications

Chair: Prof. Dr. Sarder Safiqul Islam

Co-Chair: Prof. Samir Kumar Sandhu

Plenary Lecture: 5.00-5.15 P.M

Production of Bio-mass and Implications

Dr. Md. Azharul Islam,

Professor, Forestry and Wood Technology Discipline,

Executive Editor, Khulna University Studies, Khulna University, Bangladesh.

Contributed Papers: 5.15-6.00 P.M

CP_RS-10, CP_RS-13, CP_RS-14, CP_ST-13, CP_ST-19

Selection of Poster Presentation and Workshop/Demonstration: 6.00 – 7.00 PM

CULTURAL PROGRAMME: 7.00-8.00 P.M

DINNER AT 8.00 PM

Thursday 20th October, 2022

Scientific Session VI: Toxicology of Metals and Metalloids: Impact on Environment and Human Health

Chair: Prof. Okechukwu Jonathan Okonkwo

Co-Chair: Prof. Dr. Md. Saifuzzaman

Plenary Lecture I: 9.30-9.45 A.M

Impact of Heavy Metals and Metalloids on the Environment and Public Health

Prof. Pasquale Avino,

Department of Agricultural, Environmental and Food Sciences,

University of Molise, Via De Sanctiss.n.c., I-86100 Campobasso, Italy

Plenary Lecture II: 9.45-10.00 A.M

Metals and metalloids in aquatic ecosystems and its toxic effect on human health

Dr. Md. Golam Sarower,
Professor and Head, Fisheries and Marine Resources Technology Discipline,
Khulna University, Bangladesh.

Contributed Papers: 10.00-11.20 A.M

CP_AP-02, CP_AP-11, CP_AP-13, CP_RS-02, CP_ST-12, CP_ST-14, CP_ST-15, CP_ST-16

TEA BREAK: 11.20-11.30 A.M

Scientific Session VII: Microbial interaction operating in nature - Biomarkers & bio-indicators

Chair: Dr. Md. Golam Sarower

Co-Chair: Sk. Mustafizur Rahman

Plenary Lecture: 11.30-11.45 A.M

Low-cost mitigation of arsenic from rice rhizosphere

Dr. Arup Kumar Mitra,
Associate Professor & Founder Head, Post Graduate Department of Microbiology,
St. Xavier's College (Autonomous), Kolkata, India

Plenary Lecture II: 11.45-12.00 A.M (Online Mode)

Microbial biocomplexity in coastal Bay of Bengal- molecular perspectives on biogeochemical cycling

Prof. Punyasloke Bhadury Professor,
Dept. of Biological Sciences (DBS)
Indian Institute of Science Education And Research Kolkata Mohanpur,
West Bengal, India

Contributed Papers: 12.00-1.30 P.M

CP_AP-05, CP_AP-06, CP_AP-08, CP_RS-08, CP_RS-12, CP_ST-02, CP_ST-08, CP_ST-09, CP_ST-10

Scientific Session VIII: Waste Management

Chair: Prof. Dr. Abdullah Harun Chowdhury

Co-Chair: Dr. Arup Kumar Mitra

Plenary Lecture: 1.30-1.45 P.M

Recycling and Waste Management for Sustainable Economy, Health and Environment

Prof. Dr. M. Aminur Rahman
Department of Fisheries and Marine Bioscience,
Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore
7408, Bangladesh

Contributed Papers: 1.45-2.05 P.M

CP_RS-09, CP_ST-06

LUNCH: 2.05-3.00 P.M

Scientific Session IX: Climate Change: Impact & Mitigation

Chair: Dr. Biplab Sarkar

Co-Chair: Dr. Debabrata Mukherjee

Plenary Lecture: 3.00-3.15 P.M

Impact of Climate Change on Biodiversity

Prof. Kashinath Bhattacharya,
Ex-Professor, Department of Botany, Siksha Bhavana, Visva- Bharati,
Santiniketan, West Bengal, India

Contributed Papers: 3.15-3.55 P.M

CP_RS-01, CP_ST-04, CP_ST-05, CP_ST-17

TEA BREAK: 3.55-4.10 P.M

Scientific Session X: Environmental Management and Control

Chair: Prof. Dr. Shamim Ahmed Kamal Uddin Khan

Co-Chair: Dr. Krishna Ray

Plenary Lecture: 4.10-4.25 P.M

Environmental Management And Control: A Case Study On The St. Martin's Island - An Ecologically Critical Area

Dr. Abdullah Harun Chowdhury,
Professor and Head, Environmental Science Discipline,
Khulna University, Bangladesh.

Contributed Papers: 4.25- 5.05P.M

CP_RS-03, CP_RS-04, CP_ST-03, CP_ST-18

SPECIAL PRESENTATION BY CONFERENCE PARTNERS: 5.05-5.30 P.M

Contributed Paper:

CP_AP-02, CP_AP-16

Vote of Thanks by the Convener (India Chapter) - ICEES-2022: 5.50 P.M

VALEDICTORY SESSION: 6.00-7.50 P.M

Concluding Speech: Convener (Bangladesh Chapter), ICEES-2022

DINNER AT 8.00 P.M

END OF CONFERENCE

- ❖ **There will be two Parallel sessions each for Poster presentation (CPP-01 to CPP-19) and Workshop/Demonstration (CPW-01 to CPW-03) on 19th & 20th October, 2022**
- ❖ **Please note the Abbreviations stands for:**
 - IP: Invited Papers
 - CP_SA: Young Scientist Award
 - CP_DS: Distinguished Scientist Award
 - CP_AP: Contributed Papers by Academicians/Professionals
 - CP_RS: Contributed Papers by Research Scholars
 - CP_ST: Contributed Papers by Students (PG/UG)
 - CPP: Contributed Papers for Poster Presentation
 - CPW: Contributed Papers for Workshop

Friday 21st October, 2022:

**POST CONFERENCE TOUR
VISIT TO SUNDARBAN, BANGLADESH**

Please note: Programme schedule may change due to unavoidable circumstances

Help Line: +8801894627716, +8801712546305, +917908690714, +918777085274

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IS THE SUNDARBANS OF BANGLADESH IN A STATE OF POLLUTION?

Mahmood Hossain^{1*}, Chameli Saha¹, H. M. Nurul Islam², Mushfiq Ahmed², Tanvir Ahmed²,
Abdul Halim², Farhad Sikder², Md. Mutasim Billah²

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Abstract

The Sundarbans is the world's most extensive natural mangrove forest and home to various natural resources. The population in the vicinity of the Sundarbans has increased, causing more dependency on the resources of the Sundarbans. In recent years, the development of industrialization, urbanization, aquaculture, intensive agricultural practices, seaports, tourism facilities, and so on in the peripheral areas of the Sundarbans have made significant changes in the surrounding and upstream land uses of the Sundarbans. Thus, the components of the ecosystem (air, water, soil, and biodiversity) of the Sundarbans has introduced wastage from various sources, which may significantly influence the pristine ecosystem. Several issues and concerns (habitat degradation, habitat isolation, increased salinity, tourism, increased navigation of sea-going vessels, industrial pollution, agrochemical, heavy metal pollution, oil pollution, etc.) have been identified related to the sustainable management of the ecosystem of the Sundarbans. It is highly demanding to produce a piece of baseline information or data on different sources of pollution and their present status in the various components of the Sundarbans. This initiative synthesizes the available information and data to identify the sources of pollution, pollutants and their current situation, and possible impacts on the Sundarbans. These initiatives can be an effective tool to monitor the soil and water quality of the Sundarbans, may portray the present scenario of the ecosystem, and provide an idea of the further contamination.

Key words: Ecosystem, Mangroves, Monitoring, Pollution, Sundarbans

HEAVY METALS AND METALLOIDS IN THE ENVIRONMENT: HUMAN TOXICITY AND TREATMENT STRATEGIES

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Abstract

Heavy metals are a group of metals and metalloids that have relatively high densities. Some of the heavy metals and metalloids include, but not limited to, antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), palladium (Pd), thallium (Tl), tin (Sn) and zinc (Zn). Among the heavy metals and metalloids, Cu, Co, Fe, Mg and Zn and others have functional roles that are essential for various diverse biochemical activities in the body. However, when taken in large doses, they can be harmful to the body; whereas others such as Cd, Hg, Pb, and As even at low concentrations are well-known environmental pollutants due to their toxicity, persistence in the environment, and bioaccumulative nature. Their natural sources include, weathering of metal-bearing rocks and volcanic eruptions, forest fires, while anthropogenic sources include mining and various industrial and agricultural activities. As persistent pollutants, heavy metals accumulate in the environment and consequently contaminate the food chains, thus causing a potential health threat to their consumers. Their induced toxicity and carcinogenicity involves many mechanistic aspects, some of which are still not well understood. However, each metal has unique features that govern its specific toxicological mechanisms of action. This review provides an analysis of their environmental occurrence, uses, routes of human exposure, and molecular mechanisms of toxicity. Additionally, natural and nanotechnology detoxification strategies for heavy metal toxicity are discussed.

Keywords: heavy metal, toxicity, anthropogenic pollutants, human health.

POLLEN/SPORE ALLERGY AND ALLERGEN BIOLOGY IN INDIA

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Abstract

Respiratory allergy and asthma have become a major health problem worldwide with India being no exception. Currently, about 20-25% of the total Indian population is sensitized with various types of allergens originating from pollen grains, fungal spores, foods, insects and house dust mites. Based on hospitalization data from different parts of our country there are sharp increase in the prevalence IgE-mediated atopic diseases in the last few decades. India, being a land of diverse climates, vegetations, and food habits, has been reported to have a broad range of such allergens. The basic principle of allergen research is to identify the exact causative factor (protein/glycoprotein) of allergen. So the identification and characterization of allergenic protein or glycoprotein are found to be very important for (a) evaluating the significance of an allergic sensitization, (b) prescribing adequate medication, and (c) judging the consistency of an allergen eliminating programme (management). We have several reports on prevalent allergens from various parts of our country mostly based on preliminary detection and identification of the allergens. But a few of such allergen molecules have been characterized by molecular techniques such as recombinant technology and structural biology. The present paper illustrates the inclusive reports on the biochemical, immunological and molecular information on the various allergens vis-a-vis allergen specific immunotherapy testified from India.

Keywords: Allergy, Allergen, Molecular characterization, Immunotherapy, India

**A SUCCESSFUL ENDEAVOR OF ECOLOGICAL
RESTORATION/CONSERVATION OF DEGRADED MANGROVES OUTSIDE THE
PROTECTED AREAS OF INDIAN SUNDARBANS**

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Abstract

To date, degraded mangrove ecosystem restoration accomplished worldwide primarily belong in the continuum of ecological restoration to rehabilitation with monotypic plantations, being the most followed one. This study from Indian Sundarbans addresses such an integrative restoration framework experimented in a small ~3.16 ha degraded fringe mangrove forest outside the protected area with a unified final goal of full recovery of functionality of the ecosystem supporting human well-being as well. The site-specific strategies/ key activities followed were based on novel scientific/ ecological rationales, under-exploited in mangrove restoration. This restoration approach uniquely exploits intrinsic eco-physiological resilience of mangrove species as a predictor of degradation and accordingly adopted novel strategies, which were site-specific but globally pertinent. The strategies included: (1) initial stabilization of erosion-prone site by planting native salt tolerant grasses; (2) an on-site nursery with ~30 species, facilitating multispecies, self-sustaining ecosystem, stimulating epifaunal diversity, resilience to sea level rise; (3) sapling transplantations based on physiological continuum of salinity tolerance. Both conventional and unique metrics were used to evaluate the restoration success having worldwide applicability such as (1) edaphic factors/nutrient status; (2) colony-forming units/genomic abundance of nutrient-cyclers; (3) osmolyte status; (4) reproductive potential/plant–pollinator mutualisms; (5) species composition/diversity; (6) forest structure; (7) epi-faunal diversity and fish/crab species availability providing livelihood to local communities; (8) resilience to cyclones. All the results indicate gradual return of functional independence of the experimental site. We critically appraise this comprehensive restoration framework as a model for ecological restoration of degraded mangrove forest ecosystems.

Keywords: Ecological restoration, Indian Sundarbans, eco-physiological resilience

**EVALUATING THE APPROPRIATE TECHNIQUE FOR MAPPING AND
MODELING THE SOIL SALINITY USING REMOTE SENSING TECHNIQUE IN
GOSABA, WEST BENGAL, INDIA**

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Abstract

Soil salinity is a common process for the degradation of land. Soil salinity is caused by either natural or human activities. In 2009, cyclone 'Aila' hit the Indian Sundarban region, which was inundated by saline waters from the Bay of Bengal. It increased the salinity of agricultural land. An integrated approach has been used for mapping the soil salinity in these areas. Remote sensing techniques with statistical methods have been used for developing the soil salinity models. Different soil salinity indices have used for this analysis. Soil salinity indices were calculated from bands of Landsat images. After analyzing all, statistical correlations have been established between field-based electrical conductivity (EC_e) and remote sensing-based salinity indices. Among all the salinity indices salinity index (SI) is yielded the best result for mapping the soil salinity. SI showed the highest coefficient of determination ($R^2 = 0.70$). It signified a strong linear relationship with EC_e and its p-values also indicated a strong correlation with EC_e . Thus, the remote sensing technique with statistical methods is very efficient to model and map the soil salinity.

Keywords: Landsat data; Electrical Conductivity, Soil salinity indices; Statistical model

**REMOTE SENSING AND GIS TECHNIQUES IN EARTH'S FEATURE
IDENTIFICATION AND GROUND WATER PROSPECTING**

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Abstract

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on-site observation. Remote sensing is used in numerous fields, including geography, land surveying and most Earth Science disciplines and oceanography, and many other socioeconomic applications. GIS can refer to several different technologies, processes, and methods. It is attached to many operations and has many applications related to engineering, planning, management, transport, insurance etc. Though acquisition and processing of remotely sensed data, more popularly known as satellite imagery are involving complex soft-skill oriented methods; interpretation of satellite images are exclusively specialised job that needs conjugate use of both art and science. Spectral reflectance curve plays a vital role in distinguishing different earth's object specifically vegetation, soil, and aquatic environment.

Remote sensing and GIS methods permit rapid and cost-effective natural resource survey and management. Moreover, remotely sensed data serve as vital tool in groundwater prospecting. The remote sensing data helps in fairly accurate hydrogeomorphological analysis and identification and delineation of land features. With sufficient ground data, hydrological characteristics of geomorphological features can be deciphered. Rapid advances in the development of Geographical information system which provides spatial data integration and tools for natural resource management have enabled integrating the data in an environment which has been proved to be an efficient and successful tool for groundwater studies. In recent years, extensive use of satellite data along with conventional maps and rectified ground truth data has made it easier to establish the base line information for groundwater potential zones. To understand groundwater prospects of an area, integration of different thematic layers is required. The use of remote sensing and GIS tools to extract detailed features of Drainage, Slope, Geomorphic, Piezometric levels to demarcate the groundwater potential zones.

Keywords: Remote sensing, hydrogeomorphology, soft-skill oriented methods, groundwater potential zones.

NANOTECHNOLOGY AND ENVIRONMENT: A MOLECULAR INSIGHT UNDER CURRENT AGRICULTURAL SCENARIO

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Abstract

Nanotechnology applies innovative tools of delivering agricultural inputs in minimal quantity with maximum efficiency to drive a sustainable agricultural system. Agricultural deliverables like pesticide, fertilizer, medicines, feed, fodder, biocontrol agents add productivity in terrestrial as well as aqua based farming systems but also create havoc to environment. In this scenario, nanoparticle induced delivery of agri-input appears efficacious and environmentally safe. Our research initiatives depicted that plant tissue derived green silver nanoparticle inferred low cytotoxicity to zebrafish (*Danio rerio*) in comparison to chemically synthesized nanosilver. Solid waste like fish residual tissues can be used for synthesizing silver nanoparticles having propensity to heal non-specific bacterial infections in fish. Low doses of nanosilver stimulated larval growth in zebrafish which was deciphered through oct-4 expression profiling whereas nanosilver delivered through hydrogel nanocomposite showed healing at incision wounds in fish. Nano lime applied in place of routine lime for counteracting soil acidity in chickpea (*Cicer arietinum*) cultivation appeared safe to rhizosphere microbes, exhibited higher biodistribution as well as biological activities at 1/50 to 1/100th doses when analyzed through metagenomics sequencing, ICP-MS profiling as well as transcriptomics analysis respectively. Semiconductor nanoparticle degraded methylene blue in water through photocatalysis property which denoted an alternative safe method of nano-remediation. Hence, nanotechnology derived formulations and products can be useful and safe to environment due to its minimal application dose and higher efficacy as observed in fish and crop systems.

Keywords: Nanotechnology, environment, molecular tool, toxicity, fish and crop

PRODUCTION OF BIO-MASS AND IMPLICATIONS

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Abstract

Biomass is a broad term pertinent to all plant and animal derived resources that are currently living. The biomass originated from plants is used to produce food and fodder, bio-based materials, chemicals and bioenergy. The United Nations Food and Agriculture Organization revealed over 9.4 billion tonnes of crops produced in 2021 and the contribution of forest biomass to the global economy has been raised to 17%. Other than food and fodder, plant biomass triggered a big contribution to global climate change issues. Moreover, biomass commercialization is a key challenge as it has been linked with the economic and environmental implications. The demand for biomass as well as biomass waste is increasing but without proper management it will be difficult to satisfy the demand. Agro-industrial and forestry residues are the key byproducts for the production of energy fuel and chemicals. Thus, executing effective reuse and recycling strategies for the products made from the biomass should be ensured. Therefore, this article will deal with the challenges and opportunities of sustainable biomass production using advanced technology and establishment of a prosperous bio based economy considering the implications of food, animal feed, energy and other biomass-based products. Besides, present status of biomass production in Bangladesh and their potential markets associated with geographical region, problems to expansion, future research and development will also be considered.

Keywords: Biomass, biomass production, bioenergy, bio economy, supply and consumption

**IMPACT OF HEAVY METALS AND METALLOIDS ON THE ENVIRONMENT
AND PUBLIC HEALTH**

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Abstract

The release of heavy metals and metalloids into the environment has been a problem of concern for years. Industries, mines, pesticide, fertilizers and electronic waste are the main activities responsible for the emission of heavy metals and metalloids into the environment with a significant increase in their rates of mobilization and transport since the 1940s. Research-based evidence seem to confirm the harmful impact on the environment and, consequently, on human health. Heavy metals and metalloids remain present, in fact, in form harmful for the human body, affecting its normal functions. It has been proved that an acute exposure to heavy metals and metalloids may damage the central nervous function as well as the cardiovascular and gastro intestinal systems may be seriously compromised. As humans, animals can be affected by these contaminants. For example, some aquatic species have been seriously affected by heavy metals and metalloids, that contributed to declines in their populations. Organisms get exposed to heavy metals and metalloids through inhalation, dermal contact by crossing the skin barrier and digestive tract and, for some heavy metals (e.g., Cd, Pb, Hg) and metalloids (e.g., As) trace quantities are sufficient to be toxics for humans and wildlife, representing a serious issue with environmental and ecological implications. For these reasons, monitoring and analysis of heavy metals and metalloids concentrations are necessary for environmental pollution assessment. Principal sources of these contaminants should be controlled and monitored to assess the levels of contamination of water, soil, sediment of a specific area as well as the impact on humans and wildlife.

Keywords: Heavy metals, fertilizers, electronic waste, human health, wildlife.

**METALS AND METALLOIDS IN AQUATIC ECOSYSTEMS AND ITS TOXIC
EFFECT ON HUMAN HEALTH**

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Abstract

Heavy metals and metalloids are constantly released in aquatic systems from natural and anthropic sources such as industrial and domestic sewage discharges, mining, farming, electronic waste, anthropic accidents, navigation traffic as well as climate change events like floods. Metals are easily dissolved in water and are subsequently absorbed by aquatic organisms such as fish and invertebrates inducing a wide range of biological effects, from being essential for living organisms to being lethal. Some metals are essential at low concentrations for living organisms but at higher concentrations, they could induce toxic effects disturbing organisms' growth, metabolism, or reproduction with consequences to the entire trophic chain, including on humans. The nonessential heavy metals enhance the overall toxic effect on organisms even at very low concentrations. High levels of metals in the environment could be a hazard for functions of natural ecosystems and human health, due to their toxic effects, long persistence, bioaccumulative properties, and biomagnification in the food chain. Due to desorption and remobilization processes of metals, the sediments constitute a longterm source of contamination to the food chain that result in bioaccumulate in aquatic ecosystems and in turn, may cause human health problems. The bioavailability of metals depends on the organism biology, metal geochemistry, physical and chemical factors. The free hydrated metallic ion, suitable organic ligands-metal complexes and organic binders is the most bioavailable form for some heavy metals that facilitate the diffusion of the hydrophobic compound in the lipid membrane. Metal speciation, the presence of organic or inorganic complexes, variable environmental factors could modulate metal toxicity on mitochondria and differential gene expression that finally turn out to be a cell apoptosis. The toxic metals are the most frequently detected pollutants in the aquatic environmental, and their effects identification are essential to protect the ecosystems integrity as well as human health.

Keywords: Toxic effect, metal speciation, bioavailability, mitochondria, gene expression

LOW- COST MITIGATION OF ARSENIC FROM RICE RHIZOSPHERE.

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Abstract

The rice plant growing in the districts of 24 Parganas (S) and Nadia usually gets contaminated with arsenic because of the high concentration of arsenic in the ground water. Thus it results in wide spread toxicity in the people consuming this toxic rice. In this investigation, a low cost mitigation is suggested using the Azolla and the rhizosphere bacteria. Thus a unique consortium is developed where two bacterial association is developed along with the Azolla plant. These bacteria can grow along with Azolla without modifying it's association with *Anabaena azollae*. The mitigation of arsenic is also brought about by Azolla but the presence of bacteria increases its efficacy since they have immense PGP activities. The testing is also carried out in vivo condition but a substantial reduction in the arsenic occurs in the water thus minimising the uptake by rice plant.

Key words: Arsenic mitigation, Azolla, rhizosphere, bacteria , PGP.

MICROBIAL BIOCOMPLEXITY IN COASTAL BAY OF BENGAL- MOLECULAR PERSPECTIVES ON BIOGEOCHEMICAL CYCLING

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Abstract

The coastal Bay of Bengal is home to variety of biotopes with rich biodiversity, influences regional climatic patterns and supports the livelihood of millions of communities. Sundarbans, the world's largest contiguous mangrove ecosystem, an UNESCO World Heritage Site and a RAMSAR site, located along the north east coast of the Bay of Bengal and shared between India and Bangladesh, is home to unique biodiversity and abundant marine bioresources. However, there is a limited understanding of the microbial biocomplexity that is shaped by prevailing environmental gradients of Sundarbans which could have huge consequences on understanding many key ecosystems level processes including biogeochemical cycling of carbon. Understanding fluxes and rates of carbon cycling influenced by microbes or vice versa can have far reaching consequences towards improved estimation of regional carbon fluxes, in particular budget of carbon in coastal oceans. Using a series of combinatorial approaches including through the establishment of a decade old time series- Sundarbans Biological Observatory Times (SBOTS) and high-throughput genomics using environmental DNA (eDNA), we are investigating how structure and function of microbial communities including functional complexities behave along temporal and spatial scales in this unique mangrove ecosystem. We have undertaken robust field mesocosm experiments to disentangle the functional significance of microbial complexity towards breakdown of complex forms of organic matter such as mangrove litterfall in Sundarbans. We have also initiated environmental surveillance of freshwater to coastal connectivity to get a better understanding of prevalence of antibiotic resistance genes (ARGs) and metal resistance genes (MRGs) and possible implications in terms of changes in functional attributes of microbial communities for Sundarbans. Our ongoing studies show that unique microbial communities in the waterscapes of Sundarbans have adapted to prevailing environmental gradients and are key players in processes such as coastal carbon cycling. The information on microbial complexity offers avenues for tackling complex issues including climate change as well as ecological restoration of mangroves. Most importantly based on functional microbial community mapping and deciphering key roles in ecosystem processes are key to maintaining ecological health of Sundarbans, coastal blue economy bioresources such as rich fisheries of the Bay of Bengal and across South Asia.

Keywords: Sundarban, RAMSAR, biogeochemical cycle, SBOTS, eDNA, ARGs, MRGs

IMPACT OF CLIMATE CHANGE ON BIODIVERSITY

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Abstract

Biodiversity is the variety of life in all its forms, levels and combinations. The variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part. So far, about 1.5 - 1.75 million species have been identified. Scientists estimate that there may be between 10 to 13 million species. Biodiversity is not distributed evenly across the planet. Species diversity for most taxa is lowest near the poles, and increases toward the tropics, reaching a peak in tropical rain forests. The period since the emergence of humans has displayed an ongoing biodiversity reduction and an accompanying loss of genetic diversity. The huge gene pools of various wild and indigenous breeds have collapsed causing widespread genetic erosion and genetic pollution.

The climate change is one of the prime factors for loss of biodiversity. Over the centuries surface temperature raised by $0.6 \pm 0.2^{\circ}\text{C}$ and it is predicted that it would be raised by 1.4 – 5.8 $^{\circ}\text{C}$ by 2100 AD. Changing climatic conditions and dramatic increases in carbon dioxide will put our ecosystems to the test, threatening supplies of fresh water, clean air, fuel and energy resources, food, medicine and other matters. Species loss and endangerment are rising along with global temperatures. As many as 30 percent of plant and animal species alive today risk extinction by 2050 if average temperatures rise more than 1.1^o to 6.4^oC. In a recent review, analyzing the distributions of 1103 species of animals and plants from various parts of the world, the authors showed that 15-37 percent are likely to go extinct based on the best projections of future climate change. Climate change has started affecting bear populations. Coral reefs - which are biodiversity hotspots will be lost in 20 to 40 years if global warming continues at the current trend.

Dramatic increases in greenhouse gases will put our ecosystems to the test, threatening supplies of fresh water, clean air, fuel and energy resources, food, medicine and other matters.. As the climate warms, experts estimate drought conditions may increase by at least 66 %. Experts use climate models to project the impact rising global temperatures will have on precipitation. In just 30 years the occurrence of the strongest hurricanes - categories 4 and 5 - has nearly doubled.

Agenda 21 is a non-binding action plan proposed in Rio Earth summit (1992) with regard to sustainable development. The Convention on Biological Diversity (CBD) is a multilayered treaty. Under the Paris Agreement, each country must determine, plan, and regularly report on the contribution that it undertakes to mitigate global warming.

Keywords: Biodiversity, concept, global scenario, Biodiversity loss with regard to climate change

**ENVIRONMENTAL MANAGEMENT AND CONTROL: A CASE STUDY ON
THEST. MARTIN'S ISLAND - AN ECOLOGICALLY CRITICAL AREA**

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Abstract

Environmental management always depending on the sustainable management of the different environmental components i.e. to confirm and improve the provision for the human demands and necessity by maintaining the physical, biological, technological, social, cultural, economical and political limitations to ensure minimum damage to natural habitats and ecosystems. Worldwide most of the people are directly and indirectly depending on the various ecosystem services like - their livelihoods, tourism, resources extractions, etc. Environmental management and control is a tool/ technique depending on the continuous research findings, knowledge of wise use and conservation of natural resources, habitats protection, hazards and pollution control, etc. Research are closely depending on academic knowledge of biology, chemistry, ecology, climatology, forest and fisheries sciences, environmental law, geo and information sciences, environmental engineering, economics and business, toxicology, public health, social affairs, etc. A detailed information on the status of any ecological area must be find out through a research for the application of environmental management and tool. In Bangladesh, St. Martin's is an ecologically critical area and only coral rich island, which is important hotspots for its exceptional biodiversity i.e. different species of corals, marine algae, molluscs, fishes, turtles, crabs, shrimp, mammals, wild animals, trees etc. The ecological conditions, habit and habitat of algae and other biodiversity of this island have been studied to develop a sustainable conservation technique of the biodiversity. Some environmental threats on biodiversity have been identified for future conservation and management. To mitigate the threats on the biodiversity different environmental management tools and technique must be applied like some areas and lagoons to be classified as habitat of different biodiversity and all kinds of activities should be prohibited inside the classified areas. Awareness rising to be continued among the tourists and islanders about the ecological and economical importance of biodiversity as well as sustainable environmental management and control.

Keywords: Environmental management, control, St. Martin's Island, Ecologically critical area

RECYCLING AND WASTE MANAGEMENT FOR SUSTAINABLE ECONOMY, HEALTH AND ENVIRONMENT

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Abstract

Waste is defined as any unavoidable materials resulting from domestic activity or industrial operation for which there is no economic demand and which must be disposed of waste (wastes) is unwanted or unusable materials. The amount of waste has been increasing along with expanding population and rising human activities. Waste management refers to the activities and actions that handle waste materials. It includes collection, transportation, processing, and disposal of waste. However, the discharge of wastes reflects the life styles and social activities of the peoples to a greater extent. Garbage is generated from daily life and social activities and therefore, the region-wise differences may result from industrial structure, physical distribution and people's consciousness about garbage. In general, the amount of wastes is larger in cities than rural areas. Generation of municipal solid waste will continue in increasing unless reduction of its source starts. On the other hand, it is possible to designate "waste" as any kind of material that the owner does not want anymore. This means that there might be some wastes which is useful for others. This gives the idea of "reuse", before the process of "recycle", that will be explained in this paper. There is a recognized trend as "3R"; as Reduce, Reuse and Recycle. The first step should be Reducing the amount waste, and then, reuse and recycle processes starts. However, in the recent years, this trend has already turned to "4R" with the inclusion of "recovery" as energy regain. For that reason, the process is reducing, reusing and then recycling the resting part, nowadays by the technological improvements; regaining energy becomes possible with lower costs that make a system feasible. Waste prevention, recycling, reuse, and recovery are important waste management strategies that eases the burden on landfills, conserves natural resources, and saves energy. Sustainability can only be executed only if the waste allows getting beneficial revenue. By separating and processing the wastes accordingly, will give great advantage in solving the waste problem and also derive profit. The health and economic of waste recycling are greatly felt on both local and national scale. Waste recycling is one of those climate change mitigation strategies which involves the reduce, reuse, and recycling of waste materials to ensure that our environment is a cleaner, healthier and greener place to live in. The study seeks to draw the attention of policymakers in government, non-government organizations and passionate individuals to the need to search for innovative ways of educating communities about waste recycling for sustainable development. This further explores the effective methods of bridging the communications gaps through the efficient information dissemination, intensive awareness outreach and the use of educational blogs to help ensure that the communities are well-concerned, adequately educated, and efficient in their task of waste recycling and management. This paper vividly explores the green entrepreneurial opportunities in waste recycling for sustainable economic growth and development.

Key words: Waste, Waste management, Recycling, Mitigation, Health, Environment

CONVERGENCE OF ALIENATED MICROFLORA WITH TEA PGPR TOWARDS INCREASED TEA PRODUCTION

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Abstract

Tea or *Camellia sinensis*, a quintessential beverage is the second most popular drink across the globe right after water. The importance of this beverage both commercially and therapeutically is immense, necessitating the need for a wholesome solution to improve the incessant depletion in the production, along with upgrading the quality parameters. Instances of using PGPR for targeted improvement of macro nutrient availability or nutrient solubilization has been attempted previously in tea cultivars, however, holistic attempt is still lacking. A probable reason for this can be attributed to the special soil and climatic conditions of tea growing regions. Keeping this background in mind, an attempt was taken to design a novel bacterial consortia consisting of strains from tea rhizosphere *Bacillus vallismortis* TR01K [NCBI Genbank Accession Number MT672714] and alien strains were isolated from regular commercial biofertilizer *Bacillus paramycoides* strain DBBA_P1 (NCBI acc: MZ227489), *Bacillus paramycoides* strain DBBA_K1 (MZ227495), *Bacillus luti* strain DBBA_BT1 (MZ229975), *Bacillus wiedmannii* bv. *thuringiensis* strain BDBA_BM1 (MZ229894), *Bacillus paramycoides* strain BDBA_SXCM4 (MW917244). The strains were then elaborately tested for their plant growth promoting and biocontrol abilities. Based on promising results from the aforementioned experiments along with results from inter-strains interaction studies treatment combinations were designed. The trial was conducted in vivo on tea cultivars in actual tea growing regions and data obtained thus were analyzed both statistically and by deep learning to understand the convergence of regular microflora with a flora from special conditions and also the in vivo impact of this convergence on tea cultivars in actual tea growing regions.

Keywords: tea rhizosphere, PGPR, biocontrol, consortia

HIMALAYAS: THE ABODE OF MULTIFACETED POLYEXTREMOPHILES.

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Abstract

Extremophiles are well-known to flourish in hostile extreme habitats. For instance, extremes of temperatures, acidic or alkaline environments, heavy metals etc. While extremophiles can survive in an individual extreme, polyextremophiles can survive in combinations of such extreme environmental niches. Polyextremophily mainly exists in two dimensional matrices of extreme conditions such as temperature and pH, temperature and salinity etc. Microbial biofilm, which is an assemblage of microbes in extracellular polymeric substances, secreted by the microbes themselves not only play a huge role in microbial colonization, nutrient sequestration and quorum sensing but also protects the microbes from the aforementioned array of environmental hostilities.

This investigation deals with, 5 novel polyextremophilic strains of *Bacilli* isolated from the waters of Ganges, at Gangotri and Suryakund, at Yamunotri situated in Uttarakhand, at an altitude of 3,415 meters from sea level, on the Greater Himalayan range. The strain *Bacillus* isolated from these waters were found to be tolerant to a huge plethora of extreme conditions ranging from temperature (from 20°C to 110°C), ultraviolet radiation (79200 $\mu\text{Ws}/\text{cm}^2$), pH (1-12), pressure (110 Lbs.), salinity (4%) to heavy metal concentrations (arsenic, silver, iron etc.). On further investigation, the strains were found to produce enormous amounts of biofilm and a control laboratory strain of *Bacillus* sp. which did not produce biofilm was also found to be sensitive to the array of extreme conditions the novel strains survived. Thus, providing a conclusive proof about the role played by microbial biofilm formation as one of the survival strategies for inhabiting such extreme niches. Further exploration of the properties of these strains revealed their potential as plant growth promoters, and producers of industrially and pharmaceutically important metabolites which were also then studied in detail.

Keywords: Extremophiles, polyextremophiles, extreme niche, environmental hostilities, microbial biofilm, *Bacillus*.

**NOVEL HALOPHILIC PATHOGEN FROM SOUTH BENGAL AREA OF INDIA
AND ITS HOLISTIC MANAGEMENT**

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Abstract

In a search of prevalent fungal phytopathogens in urban and adjacent croplands of Kolkata, the busy metrocity of India we came across few common ones. In the investigation two different kind of leaf spot diseases were observed on cucumber and ladies finger or bhindi leaves samples. The infected leaf samples collected from cucumber field in Baruipur (Latitude: N 22° 22.262', Longitude: E 88° 24.5086') and Bhindi field in Howrah were processed through sequential steps of Koch's postulate and disease index proved the severity of the disease. The isolated fungi were identified using Sanger dideoxy sequencing method and sequence were submitted in NCBI. The fungi infecting Cucumber and Bhindi were identified as *Exserohilum rostratum* (MN337265) and *Alternaria aungustiovoidea* (MZ723051) respectively. As because there was no such record, this was the first time the host pathogen combinations were separated in India. Further experiments revealed different degrees of salt tolerance of the pathogen. To combat this potent threat of urban and semi-urban croplands we trusted on *in situ* bacterial population. Bacteria isolated from the fields and compost used in those fields were selected on the basis of their plant growth promoting and antifungal activities. Total 6 bacteria were identified by 16S rRNA sequencing and submitted in NCBI. *In vitro* and *in vivo* field application of microbial consortium showed promising result when applied with vermicompost base. The bacterial exudates were further analysed by Gas Chromatography and Mass Spectroscopy (GCMS) to identify the antifungal compound secreted by the bacteria. It is often debated that the major disadvantage of bio-control include its variable efficacy and delayed response, but this study has been proved to challenge this notion.

Keywords- Fungal Pathogen, Urban cropland, Bio-control agents, PGPR, GCMS, Antifungal agents.

UNDERSTANDING THE MOLECULAR MECHANISM OF HYPERTHERMAL ACCLIMATION OF FISH FOR DEVISING AMELIORATIVE STRATEGIES

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Abstract

Increase or decrease in environmental temperature from its optimal value can alter various homeostatic mechanisms. The impact of high temperature is found to be severe in poikilothermic animal like fish and leads to retardation of their growth, reproduction and may even cause death: all such factors are likely to affect the overall loss of aquaculture production. QStudies were conducted taking *Puntius sophore* as a model organism to understand the molecular mechanism of hyperthermal acclimation. *Puntius sophore* were collected where the water temperature remains 36-38 °C through out the year; fish collected from aquaculture ponds served as control. Expression analysis of *heat shock protein* genes was carried out which showed the up-regulation of *hsp90* and *hsp47*. To find out, which proteins might be in cross talk with the Hsps, global protein expression signature in the liver of *C. striatus* exposed to high temperature under 2-D gel based proteomics platform was carried out. This study showed that, in response to short-term temperature stress led to increased synthesis of several proteins. Further, pathway analysis using Ingenuity Pathway Analysis (IPA) software showed that the transcription factor Nrf-2 (nuclear factor erythroid 2-related factor-2) induced the expression both the antioxidative enzymes and molecular chaperones. Therefore, it was hypothesized that potential Nrf-2 inducers can augment heat stress tolerance in fish and to test this hypothesis, a feeding trial study with diets supplemented with Curcumin (0.5%, 1%, 1.5%) (a potential Nrf-2 inducer) was carried out in *Puntius*. Significant increase in the CTmax and simultaneous increase in expression of Nrf-2, antioxidative enzyme genes *sod*, *catalase* and *gpx* and *hsp* genes *hsp60*, *hsp70*, *hsp90* and *hsp110* was observed in the 1.5% curcumin supplemented fish. In order to find out the impact on reproductive physiology of fish, expression analysis of *hsp* genes and genes associated with gonadal integrity like *sox-2*, *oct-4*, *nanog*, *vtg* was carried out in *Puntius* exposed to high temperature (36 °C) for 7/60 days. Expression of *hsps*; *hsp90*, *hsp70*, *hsf1* and *vtg* genes similarly pluripotency marker genes *sox-2*, *oct-4* and *nanog* were down regulated in both ovary and testis of heat stressed fish indicating that high temperature stress could result in decline in the quality of gametes.

Keywords: Climate change, High temperature, *nrf-2*, *hsp*, *Puntius sophore*, Gonadal integrity

**EVALUATION OF ZINC OXIDE NANOPARTICLES INDUCED DYE
DEGRADATION IN WATER INFERRING CELLULAR CYTOTOXICITY AND
PHAS ACCUMULATION IN BACTERIAL SYSTEM**

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Abstract

Synthetic dyes are treated as potential pollutant in aquatic ecosystem and very few remediation protocols are enumerated for its degradation. The current investigation explores the photocatalytic degradation of methylene blue dye when exposed to zinc oxide (ZnO) nanoparticles under open sunlight with positive and negative control. ZnO nanoparticles are gaining attention in science due to their distinctive features, which include semiconducting, piezoelectric, optical, antibacterial, antifungal, and wound-healing abilities, as well as strong catalytic and photochemical activity. Among all inorganic photocatalytic materials, ZnO has the highest photocatalytic effectiveness. It also responds strongly to UV light, which considerably increases its ability to interact with synthetic dye. Zinc oxide nanoparticles were synthesized using chemical precipitation method and characterized through UV-Visible spectroscopy, XRD, FTIR and FE-SEM. The dye solution is exposed to different concentrations of ZnO nanoparticles and analysed using conventional spectroscopic approaches like UV-Visible Spectroscopy. A bacteriological screening was performed using PHAs (Poly hydroxyalkanoates) synthesizing bacteria, i.e., *Bacillus megaterium* Ouat 016 and reported that degraded dye water elicited low PHAs accumulation as confirmed through confocal microscopic imaging. Photocatalytic degradation efficacy of ZnO nanoparticles was further confirmed and validated assaying cytotoxicity of degraded dye solutions. Proposed confirmatory method can be applied to evaluate other colour based pollutants immensely present and pervaded in aquatic bodies.

Keywords: Methylene Blue Dye; Zinc oxide nanoparticles; Photocatalytic degradation; Cell cytotoxicity; PHAs

COAL DUST EXPOSURE AND SPECTRUM OF LUNG DISORDERS IN WEST BENGAL COAL MINERS

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Abstract

Coal miners of India are exposed to a spectrum of metal dust especially silicon, cadmium, nickel, iron, chromium, copper etc. These heavy metals are of great concern to the pulmonary function of individuals after inhalation.

A cross sectional study over 3 closed (underground mines) was conducted accounting to a total population of 375 males (244 miners and 131 control). Radiology of lung of suspected individual with reduced FVC, FEV₁, predicted FVC, FVC/VC ratio and spirometry flow volume loop nature (Gestalt method) was recommended. Induced Sputum was collected in miners with pulmonary radiological changes Coal dust was collected by miners using a G95 filter. Metal concentration of the dust was measured by using Atomic Absorption Spectroscopy. Kruskal-Wallis H test and Wilcoxon signed rank test, Pearson's correlation coefficient statistics were performed for testing of hypothesis. $P < 0.05$ was considered a biological significance level.

The results showed that coal dust exposure is responsible for decline of pulmonary flow volume parameters in underground miners. 23% had developed lung diseases as evidenced by spirometry, radiology and sputum examination. Coal dust trace metal concentration, specifically silicon, nickel and chromium were highly correlated with respiratory morbidity in miners. The pattern of development of obstructive disorders was noticed in population of miners exposed to coal dust for a minimum of 15 years followed by increase in prevalence of COPD in miners up to >25 years of exposure. Restrictive disorders were noticed in miners exposed for a minimum of 15 years with an increase in number of nodular lung and fibrotic changes up to >25 years of exposure. Mixed pattern of disorders including interstitial lung disorders, fibrotic emphysema, pneumothorax developed in individuals exposed for 20 years and more. The most prevalent disorders were chronic bronchitis and bronchial asthma were observed as the key patterns of Coal Mine Workers Pneumoconiosis (CWP). A significant correlation of lung pathological findings with oxidative stress was also revealed.

It may be concluded that environmental dust in coal mines are generators of oxidative stress that affects the pulmonary interstitial tissue and are key irritators for release of inflammatory mediators that may be an etiology of such disorders.

Keywords: Metals, fibrosis, radiology, induced sputum, oxidative stress, inflammatory mediators

**SPATIOTEMPORAL FLUVIAL CHANNEL DYNAMICS OF THE UPPER PADMA:
EXPLORING A MEGA-RIVER USING SATELLITE IMAGERY**

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Abstract

River channel dynamics are natural occurrences in fluvial rivers with influences from human modifications and climatic factors. River response to numerous natural forces and human activities is vital for effective river management. Important historical channel changes of many rivers have been detected using satellite imagery, and remote sensing and geographic information system tools. This research deals with the dynamic morphological properties of the Padma River, one of the three major rivers of Bangladesh. This study exclusively looks at a portion of the Upper Padma River, from Shibganj subdistrict of Chapainawabganj district where the Ganges River enters Bangladesh as Padma, to T-badh, a T-shaped embankment in Rajshahi city. Understanding the changes that occur in the river, as well as their responses to the different drivers of such changes that work on it, is crucial for improving the lifestyles of the dwellers of the channel bars and banks. Spatiotemporal dynamics of the Upper Padma was investigated using eight multispectral and multitemporal Landsat satellite images from 1975 to 2021. Changes in island area percentage, sinuosity ratio, braided index, channel migration, and erosion-accretion were analyzed. Results from this 46-year study period suggest that the island area percentage is increasing, sinuosity has been decreasing in recent few years, and braided index is increasing. The rate of channel migration is increasing in both banks but mostly towards the south banks in the middle reaches where the rate of erosion is higher. Extensive mid-channel deposition in recent years led to the formation of new channel bars. Excessive erosion in the southern banklines and formation of islands due to extensive accretion are the main reasons of the channel instability of the river. However, erosion is not so much prominent in the northern banks of the river due to the existence of several embankments and other hard points. Such knowledge of the spatiotemporal dynamics of the river will be helpful for planning and designing river management works, for construction modelling, and to develop protective measures in the study area.

Keywords: Spatiotemporal dynamics, fluvial river, channel instability and Satellite data.

**SUSTAINABLE AQUACULTURE IN MANGROVE ECOSYSTEM (SAIME)
PROJECT IN BANGLADESH**

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Abstract

The mangrove forests of the tropical coasts are among the most important and productive ecosystems on earth. They play an important role in stabilizing the world's climate through their high carbon storage capacity. Mangrove populations have declined by 20% worldwide since 1980. One of the main factors in their destruction is the unchecked spread of shrimp aquaculture, especially in the countries of South and Southeast Asia. Bangladesh Environment and Development Society (BEDS) has been implementing a Sustainable Aquaculture and Mangrove Ecosystem (SAIME) project in the Sundarbans coastal region in collaboration with the Global Nature Fund (GNF), Naturland, Nature Environment and Wildlife Society (NEWS), and with funding from the Ministry of Economic Cooperation and Development (BMZ). The goal of the project is to establish a functioning multi-stakeholder partnership that promotes the sustainable management and special protection of mangroves through consolidated dialogue structures and interaction along the value chain of shrimp aquaculture and secures the livelihoods of collectors, fishermen, and farmers in India and Bangladesh. BEDS has introduced Integrated Mangrove Aquaculture (IMA) and is piloting IMA on 20 farms and has established community-based mangrove nurseries at Paschim Dhangmari village under Dacope sub district. BEDS also established the IMA farmers' cooperative building as an information and education center. BEDS trained 1250 farmers on IMA from Dacope sub district of Khulna district, Mongla and Rampal sub districts of Bagerhat district and Shyamnagar sub district of Satkhira district. The SAIME project promotes healthy mangroves, thriving coastal communities, and robust aquaculture value chains in the Sundarbans—India, Bangladesh, and beyond.

Keywords: Integrated Mangrove Aquaculture (IMA), multi-stakeholders (MSP), mangroves, mangrove nursery, coastal community, shrimp farming, value chain, transformative change, livelihood.

ZINC ADSORPTION ON SOILS IN NaCl-HCO₃ SYSTEM: EVALUATION OF THE SURFACE COMPLEXES, SPECIATION AND PRECIPITATION PREDICTED BY MODELLING.

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Abstract

The adsorption behaviour of Zn in soil generally depends on soil pH and the presence of ions in soil solutions. Chloride (Cl) and bicarbonate (HCO₃) ions are present in relatively higher concentrations in coastal soil solutions, and they make complexes with Zn. These complexes should have different adsorbing abilities, therefore, influencing Zn adsorption on soils. In this work, we critically evaluate the adsorption of Zn on soils in the NaCl-HCO₃ systems in two different initial concentrations of Zn (0.08 and 0.8 mmol L⁻¹) using experimental observations and model predictions. Adsorption experiments of Zn on soils in different NaCl concentrations indicate that increasing NaCl concentration decreases Zn adsorption in both initial concentrations at pH 3 – 7 whereas Zn is fully adsorbed at pH > 7. The presence of carbonate in 0.1, 0.3 and 0.7 mol L⁻¹ NaCl solutions does not change Zn adsorption on soils at [Zn]_{init} = 0.08 mmol L⁻¹. At [Zn]_{init} = 0.8 mmol L⁻¹, the adsorption of Zn in NaCl solutions at pH 6 – 7.5 is increased (30 – 35 %) in the presence of HCO₃. Multi-surface models (MSMs) prediction indicate that the increasing trend of Zn adsorption in the presence of HCO₃ at pH 6 – 7.5 is due to Zn precipitations. The model predictions are good at 0.1 and 0.3 mol L⁻¹ NaCl concentration and acceptable at 0.7 mol L⁻¹ NaCl concentration. Model predictions indicate that iron hydroxides are important sorbents for Zn in alkaline pH soil, whereas SOM is an important sorbent in near neutral and acidic pH. Model uncertainties are observed at low pH (3 – 5) which indicates the need for the improvement of model databases with ternary surface complexes.

Keywords: Zinc (Zn), Adsorption, NaCl-HCO₃ systems, Multi-surface models (MSMs)

**EFFECT OF DEGRADATION STRESSORS ON LOSS OF ORIGINAL HABITAT
AND BIODIVERSITY OF “RARE AND THREATENED” MANGROVE SPECIES
AND ITS ASSOCIATES IN FRINGE MANGROVES OF INDIAN SUNDARBANS**

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Abstract

Sundarbans mangrove forest, the world's largest continuous mangrove spanning across India and Bangladesh, at present is immensely threatened by degradation stress due to climate change induced natural stressors as well as extensive anthropogenic disturbances. These aggravated degradation is causing a long term adverse effect on biodiversity of small coastal patches of mangroves outside protected areas, which in turn, destroy local resilience. Once an excellent niche of diverse, rare and threatened mangrove species, these fringes are now losing these species forever. The degradation across western part of Indian Sundarbans including both pristine and disturbed fringes, was evaluated by our group with the help of environmental criteria typical to mangrove ecosystem. Our studies clearly establish nutrient limitation, salinity rise, anoxicity increase, sulfide build-up, frequent cyclones, increasing acidification in creek waters, suspected obstruction in seed dispersal, species-poor neighbouring mangroves, drastic fall in diversity of dispersed seeds and propagules, all negatively controlled the diversity of these estuarine mangrove patches, unique and irrevocably indispensable for Indian Sundarbans. Most of the rare and threatened mangrove and its associate taxa are salt-sensitive, hence are rapidly declining in these fringes. An obvious change in species assemblage and community composition, once anticipated, is now evident. *Heritiera fomes*, *Xylocarpus* spp., *Phoenix paludosa*, *Acanthus volubilis*, *Merope angulata*, *Caesalpinia crista*, *Dalbergiacandensis*, *Intsiabijuga*, *Nypa fruticans*, *Brownlowia tersa*, *Cynometra irripa*, *Cerbera manghas*, *Acronychia pedunculata*, all failed to cope with rapid environmental changes that finally led to their complete absence from these fringe patches. Instead, *Excoecaria agallocha*, *Avicennia* spp. and *Sonneratia apetala* expanded freely into these fringes. Predictive Bayesian regression models, mixed effects models and RDA analyses indicate, osmolyte accumulation and thickness of water storage tissue could act as primary predictors of these prevailing degradation criteria. Our group is presently in search of these cryptic degradation stressors that might be behind the abrupt loss of these rare and threatened mangrove species from Indian Sundarban fringe mangrove ecosystem.

Keywords: degradation stressors, Indian Sundarbans, threatened taxa, climate change effects

FUTURISTIC MICROBIAL SOLUTION TOWARDS UPGRADATION OF OVER-EXPLOITED AGRICULTURAL LAND

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Abstract

Over-exploitation of arable lands with extensive use of agrochemicals has negatively impacted soil structure and function, lowering nutrient levels and microbiological diversity, leading to depleted crop productivity. It possesses a serious threat to the world's food and environmental security. Beneficial soil microorganisms (BSM) are the key players for maintaining soil health and promoting plant growth. A promising strategy to mitigate the problem is soil microbiome engineering that targets to increase the richness of BSM, to rejuvenate the damaged ecosystem in an eco-friendly way. A plant-favourable microbiome can be established by introducing potential single or multiple microbial-inoculants of plant-growth promoting bacteria (PGPB) in the courtyard of the soil-plant system. In the present investigation, three potential residual *Bacillus* spp. (S3, S5, R1) with multiple plant-growth promoting traits were introduced to an over-exploited agricultural soil, individually and in consortium combination, with or without vermin compost, in nine different treatments for plant-growth enhancement in a long-term used agricultural soil. *Glycine max* Merrill. (soybean) was grown as a test plant in pots in controlled conditions to evaluate the efficacy of the amendments. The impact was assessed through a tripartite approach i.e. plant-growth promotion, enrichment in soil microbial flora, and soil-nutrient status.

Maximum improvement of plant-growth parameters was observed in the pots treated jointly with the multi-strain consortium and vermicompost. Metagenomic analysis of soil indicated an increase in the diversity of some targeted beneficial bacterial genera in the soil treated concurrently with vermicompost and consortium. Analysis of soil organic carbon, nitrogen, and phosphorus content, further showed a positive change in nutrient-status following amendment. The present findings reveal that introduction of the novel consortium of three resident PGPB in soil, concomitantly boosted up plant-health in the enriched pot soil. This investigation will be helpful for designing inoculants to steer, enhance and regenerate the resident BSM instead of introducing 'plant-growth promoting traits' into the microbiome using microbial inoculants.

Keywords: Over-exploited agricultural soil, resident bacteria, plant-growth promoting bacteria, soil amendment, plant-growth promotion, targeted bacterial genera.

**SIGNIFICANT REDUCTION IN THE ANTIBIOTIC TOLERANT BACTERIAL
PERSISTER CELL POPULATION UPON MULTIPLE ANTIBIOTIC
CHALLENGES.**

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Abstract

Bacterial cell population consists of certain types of cells that can withstand lethal doses of prolonged antibiotic treatment called "Persister cells". These are not antibiotic resistant cells. Instead, they are the antibiotic tolerant, phenotypic variants of the wild type and are believed to be one of the major reasons of inability of antibiotics to fully eradicate the bacterial infections. These cells are suggested to be dormant and may later proliferate under favourable conditions and cause serious chronic infections in humans. The mechanisms of generation of persisters are unclear. The low frequency of naturally occurring bacterial persisters makes it difficult to study bacterial persistence. We have developed a method of isolating bacterial persister cells by giving prolonged treatment of Ampicillin that causes lysis of growing cells and presented the data in form of percentage of the surviving cells which are persister cells. Our study shows that prolonged exposure of bacteria with lethal doses of Ampicillin in combination with other antibiotics such as Tetracycline or Streptomycin reduces the percentage of persister formation to a large extent. This is true for both *Escherichia coli* (Gram negative) and *Mycobacterium smegmatis* (Gram positive) wild type strains that we have used in our experiment. When we compared the protein expression profiles of antibiotic treated and untreated bacteria, some differentially expressed proteins could be seen in SDS-PAGE, indicating involvement of specific proteins that could play important roles in formation of these antibiotic tolerant persister cells. Future identification and characterization of these proteins may throw some light in the understanding of the events that lead to formation of persisters. It might also reveal potential candidates as drug targets to eradicate these antibiotic tolerant persister populations and thereby eliminate the chances of recalcitrance of bacterial diseases.

Keywords: Persister cells, phenotypic variants, antibiotic tolerance, dormancy, differential expression, chronic infections.

EFFECTS OF COASTAL AFFORESTATION WITH *Sonneratia apetala* -BUCH. HAM AND ITS MATURITY ON SELECTED SOIL PROPERTIES AND THEIR VERTICAL DISTRIBUTION

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Abstract

The effects of coastal afforestation on soil properties, nutrient (NPK) status and vertical distribution of them during the pre-monsoon season were studied in the accreted lands at Patharghata upazila in Barguna district. The soil samples from the surface and successively deeper layers up to 1m under mudflat (riverside strip), young- (≤ 15 years) and mature stands (≥ 40 years) of *Son. apetala* were purposively collected and analyzed. The results showed that soil texture ranged from silty clay loam to silty clay, bulk density increased, and porosity decreased with depth under matured stand with insignificant differences between layers. The mean pH values of the layers ascended in the order of lower in the young stand (7.4), intermediate in the mature stand (7.5) and higher in the mudflat (7.7) and significantly differed ($p \leq 0.05$) between them. The electrical conductivity (EC) values indicated the prevalence of non-saline (< 2 dS/m) conditions during the pre-monsoon season. Irrespective of depth, the mean EC values of soils were significantly ($p \leq 0.05$) higher (1.73 dS/m) under the mature stand, intermediate under the young stand (0.54 S/m) and lower under the mudflat (0.43 dS/m), and showed an obvious increasing trend with increasing depth. Organic matter content (%) in the top layer was significantly higher ($p \leq 0.05$) under the mature stand and sharply declined with increasing depth while that for the mudflat and the young stand remained almost static. Nitrogen and potassium contents were significantly higher ($p \leq 0.05$) respectively in the mature stand and young stand. Irrespective of the study sites, both horizontal and vertical gradients in soil fertility were observed with a few exceptions. Overall observations of this study implicate that, *Son. apetala* plantation on coastal accreted land improves soil conditioning and fertility which strengthens with the maturity of the stand.

Keywords: Coastal afforestation, soil properties, vertical distribution, *Sonneratia apetala*.

ARSENIC RESISTANT BACTERIA: A TOOL FOR BIOREMEDIATION OF ARSENIC TOXICITY FROM SOIL, GROUNDWATER AND WASTEWATER

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Abstract

Soil and groundwater samples from Asanpara village of Bhagobangola I block of Murshidabad district (West Bengal, India), show non-permissible limit of arsenic according to BIS and US EPA standard. These samples are contaminated with other elements co-existing with arsenic in compounds like arsenopyrite, ferrous arsenate, ferric arsenate, etc. Arsenic Resistant Bacteria were isolated from the garden soil of Asanpara village, which show unprecedented tolerance towards arsenite (+3) and arsenate (+5). 16S rDNA sequencing and subsequent phylogenetic analysis identified these bacteria as *Lysinibacillus* sp. and *Bacillus safensis*. These bacteria show hyper-tolerance towards other heavy metals like copper (Cu²⁺), cobalt (Co²⁺) and chromium (Cr³⁺). The urease activity of these bacteria gets inhibited in presence of cadmium. This property can be used for design of a cadmium bio-sensor. Scanning electron microscopy depicts change in size of these bacteria in presence of arsenic, which could be explained as a defense mechanism against arsenic stress. The ability of these bacteria to bio-transform arsenite into arsenate (less toxic form), bio-accumulate or bio-absorb arsenic accounts for its uninhibited growth at very high arsenic concentration. Thus, the arsenic resistance exhibited by these bacteria could be interplay of assimilatory and dissimilatory processes. *Lysinibacillus* sp. shows 32.33%, 31.29% and 31.20% bioremediation, whereas *Bacillus safensis* shows 37.54%, 35.26% and 35.24% bioremediation in the presence of 0.027 mM (2 ppm), 0.133 mM (10 ppm) and 0.667 mM (50 ppm) arsenic, respectively. The bioremediation potential of these arsenic resistant bacteria could be exploited for removal of arsenic from soil, groundwater and wastewater.

Keywords: Arsenic toxicity; Arsenic resistant bacteria; 16S rDNA sequencing; Heavy metal hyper-tolerance; Biotransformation; Bioremediation

ROLE OF HEAVY METAL HYPER-TOLERANT BACTERIA IN PLANT GROWTH PROMOTION IN HEAVY METAL CONTAMINATED SOIL

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Abstract

Arsenic toxicity of groundwater, wastewater and soil is a major global issue of the modern world. West Bengal is one of the severely arsenic contaminated states of India. The regions adjacent to Ganga-Brahmaputra-Meghna river system are contaminated with non-permissible limit of arsenic in groundwater. Two arsenic hyper-tolerant bacteria were isolated from severely contaminated soil and groundwater samples of Murshidabad and Nadia district. 16S rDNA sequencing and phylogenetic analysis revealed that these isolates were rod shaped *Microbacterium paraoxydans* and *Enterobacter* sp. The two strains showed similar growth pattern in absence and in presence of 1000 ppm sodium arsenite. They were also hyper-tolerant to various heavy metals like iron, zinc, arsenic, etc. In a stressful environment, the defense mechanism employed by these bacteria is biotransformation of arsenite into arsenate (the less toxic form of arsenic). The genome and the plasmid in these bacteria consist of genes responsible for heavy metal hyper-tolerance and biotransformation potential. These isolates also encode for proteins and enzymes responsible for plant growth promotion and defense against pathogens. The two strains could promote plant growth by indole acetic acid production, nitrogen fixation, inorganic phosphate and potassium solubilization. The heavy metal hyper-tolerance and biotransformation potential of these bacteria might enhance the resistance of plants to various heavy metals and reduced accumulation of heavy metals. They might also promote bio-sequestration of heavy metals in various forms in soil. Therefore, these isolates can be applied for bioremediation of arsenic and plant growth promotion in heavy metal contaminated soil.

Keywords: Arsenic contaminated soil, Bioremediation, Biotransformation, Heavy metal hyper-tolerance, Plant growth promotion

EFFECT OF COVID 19 ON ECOLOGICAL FOOTPRINTING

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Abstract

Corona Virus Disease- 2019 is a pandemic that has created havoc globally affecting all dimensions of sustainability like social, economic and ecological/ environmental. The graveness of the disease and its impact on society cannot be measured by the mortality rate throughout the world but by its degree and intensity of communication. With the growth of globalisation in the present century hand in hand with technological advancement it has shown statistically significant negative impact on environmental quality, ecology and footprint values. Ecological footprints quantify the human demand on the natural environment quantified by the amount of biologically productive land and sea area being utilised to meet the individual and collective consumption of environmental resources and have the advantage that they can be linked to the (theoretical) carrying capacity of our earth's ecosystems. This is crucial as development can only be deemed sustainable if it stays within the (global) boundary conditions of the ecological environment and/or the world budget constraint. Recent research makes clear that humanity's pressures on the environment are currently unsustainable which means that our footprint exceeds than what has been allotted by nature to us. This phenomenon has led to Earth Overshoot Day. It means "Humanity as a whole is currently using nature 1.6 times faster than our planet's ecosystems can regenerate" and with every passing year it was showing increasing trajectory (as per Global Foot print network) in the pre-COVID 19 situation. This review paper intends to find out the effect of COVID-19 on Ecological footprint status globally as well as predict for the future trends. Ecological Overshoot is the summative effect of increasing deforestation, soil erosion, habitat destruction of wild-life, increase ill-legal trade of wild life, e-waste generation, accumulation of non- biodegradable waste, increase amount of greenhouse gases with logarithmic progression of vehicles on road, increased requirement of non-renewable sources of energy in technologically advanced world as well as paradigm shift in life style patterns. As all the above-mentioned factors has considerably decreased during global quarantine period for COVID-19 from April'2020 to September'2020 (approx.) therefore this health disaster has somehow shown a positive effect on environmental quality. Hence, Earth's Overshoot Day 2020 has shifted 3 weeks than 2019 which indicates 9.3% reduction in Global Ecological Foot print from 1st Jan'2020 to Aug'2020 as compared to the same period in 2019. Collective lessons learnt from the period of pandemic can be put forward for a better future and decrease Ecological Foot print.

Keywords: Corona Virus Disease- 2019, sustainability, globalisation, Ecological footprints, carrying capacity, Earth Overshoot Day, global quarantine.

EFFECTS OF ORGANIC AMENDMENTS ON THE REDUCTION OF CD IN SALT TOLERANT RRICE GRAIN GROWN UNDER CD CONTAMINATED SALINE SOILS ASSOCIATED HEALTH RISK

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Abstract

Plants that were grown in heavy metal contaminated saline soils usually accumulate higher amounts of heavy metals and contamination occurs in the food chain. Organic amendments (OAs) have emerged as highly efficient and environment-friendly immobilizers to eradicate heavy metal contamination in a wide range of environments including saline soils. Therefore, a pot experiment was conducted to evaluate the performance of different organic amendments for the reduction of Cd accumulation in the grain of a salt tolerant rice variety. BRRI Dhan-67 rice plant was used for this purpose which was grown on two levels of soil salinity (4dS/m and 8dS/m) contaminated with 5 mgkg⁻¹ Cd. Six types of organic amendments were used in this study which were cowdung (CD), oil cake (OC), waste tea (TW), saw dust (SD), vermicompost (VC) and ACI commercial organic fertilizer (ACI). Each of the organic amendments was applied at 2% and 4% rates. Soil that had no organic amendment addition was considered as control. As a result, the treatment combination for this study were: T1-control (4dS/m), T2-control (8dS/m), T3-2%OA+4dS/m, T4-2%OA+8dS/m, T5-4%OA+4dS/m and T6-4%OA+8dS/m. It was observed that the highest reduction in Cd accumulation in the rice grain was found with the addition of cowdung applied at a rate of 2% followed by vermicompost at the same rate of application. Higher salinity favors the transfer of Cd from soil to the grain which showed reduction in low soil salinity level with the addition of 2% organic amendment. K and Na content in the grain showed reverse phenomenon due to the added amendments. Growth and yield characteristics of the rice plant varied with varying the amendment types and rates. The result concluded that the addition of 2% cowdung lowered the HRI values of 0.97. Therefore, this rates of the cowdung could be used in Cd contaminated saline soils for safe rice production.

Keywords: Salinity, Cd, Amendments, Rice, Accumulation, Health risk

CHEMICAL CHARACTERIZATION OF GROUNDWATER IN KHULNA CITY

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Abstract

Khulna is the third largest with more than 1.2 million people and well known as second industrial and port city in Bangladesh. Groundwater is being widely used for domestic, industrial and agricultural purposes in this city. Enhancing urban with economic activities create pressure on aquifers and knowledge in chemical characteristics of aquifers is important. Deep aquifer water samples were collected from 21 different production wells in monsoon, winter and summer seasons. The parameters like pH , EC , TDS , Na^+ , K^+ , Ca^{2+} , Mg^{2+} , HCO_3^- , Cl^- , SO_4^{2-} , NO_3^- and PO_4^{3-} were determined by using standard methods. The results showed that the abundance of cations follow the trend $Na > Ca > Mg > K$ in winter and summer and $Na > Mg > Ca > K$ in monsoon. The anions follow the trend of $HCO_3^- > Cl^- > NO_3^- > SO_4^{2-} > PO_4^{3-}$ in winter and summer and $HCO_3^- > SO_4^{2-} > Cl^- > NO_3^- > PO_4^{3-}$ in monsoon. Molar ionic ratio of the chemical parameters suggests that carbonates and plagioclase silicates are as their source rock. It also reveals seawater intrusion to the aquifers. From Gibbs plot it is evident that rock dominance and evaporation and crystallization dominance process are controlling the mechanism of groundwater chemistry. Piper plots reveals that two major chemical facies are dominating mixed Ca-Mg-Cl and mixed Ca-Na- HCO_3^- in monsoon, mixed Ca-Na- HCO_3^- and Na- HCO_3^- in winter but in summer Na-Cl mixed Ca-Na- HCO_3^- mixed Ca-Mg-Cl. However facies like Ca-Cl and Ca- HCO_3^- are also identified but not significantly. From Chadha's plot it is found that most of the water samples are $Na^+ - HCO_3^- / Na^+$ dominant HCO_3^- / HCO_3^- dominant Na^+ type in all three seasons however some samples are $Na^+ - Cl^- / Na_2SO_4 / Na^+$ dominated Cl^- / Cl^- dominant Na^+ types in winter and summer. In monsoon water samples shows suitability for drinking according to WHO guidelines but in winter and in summer the quality gradually deteriorates. Water extraction should be maintained from the aquifers for its sustainability.

Keywords: Chemical characterization, Groundwater and Khulna City

EVALUATION OF PHYTOTOXIC, CYTOTOXIC, MITODEPRESSIVE AND PHARMACOLOGICAL PROPERTIES OF CASCABELA THEVETIA (L.) LIPPOLD, SEED AQUEOUS EXTRACTS ON GERMINATING ROOT TIP CELLS OF LATHYRUS SATIVUS L., ALLIUM SATIVUM L., WASHED RBC AND ISOLATED TISSUES: A COMPARATIVE TOXICOLOGICAL STUDY.

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Abstract

Cascabela thevetia (L.) Lippold, a well-known plant of family Apocynaceae, popular as Yellow Oleander, is cultivated as an ornamental tree in tropical and subtropics including India. In India and in Sri Lanka swallowing the seeds of *Cascabela thevetia* is one of the preferred methods for suicides in villages. Pharmacologically active constituents include terpenoids, flavonoid, steroids and glycosides in seeds. In this experimental effort, some important alkaloids are being identified in the dried seed powder of *Cascabela thevetia* (L.) Lippold. Preliminary qualitative chemical analyses revealed the presence of Carbohydrates, proteins, tannins, phenolics, terpenoids and alkaloids in the dried seed powder. During the pharmacological experiments it was established that the aqueous seed extract (CTSAE) produced very low haemoglobin release from chicken heart and liver tissue strips and moderate haemoglobin release from chicken lung tissue strips. The seed aqueous extract when mixed with different chordate 2% RBC that produced moderate hemolysis of chicken RBC, but pig and goat RBC were most resistant to CTSAE hemolytic actions. Healthy human blood samples also produced moderate hemolysis but 2% H₂O₂ treated human RBC samples were found to be hemolysed maximum in comparison to controls. CTSAE produced significant root length inhibition in pretreated germinating *Lathyrus sativus* L. seeds with serially diluted concentrations (20, 10, 5, 2.5 and 1.25 µg/ml). There was marked reduction in the root length in all applied doses in comparison to control and at 20 and 10 µg/ml pretreatment doses the tolerance index percentages were 57 % and 71% respectively in comparison to control (which was the negative control showing 100% tolerance). In the lower subsequent doses the tolerance index % increased gradually showing 84.5 and 95.42% respectively at 5 and 2.5 µg/ml pretreated germinating seeds. There was significant occurrence of abnormal cells in the said serially diluted pretreated seeds in *Lathyrus* and *Allium cepa* root tip cells. There was significant induction of almost all types of clastogenic and aneugenic cytotoxic chromosomal aberrations. The said pretreatments induced significant increase in nucleolar index followed by decreased nucleolar volume and morphometrics. There was high frequency of occurrence of giant cells and apoptotic cells. At 20 µg/ml root tip cells there were higher degree of apoptotic responses showing nuclear fragmentations and dislodged nucleolus showing shifting on one corner of the cell showing vacuolated cells. CTSAE produced significant increase in root oxidizability leading to mitochondrial ETS disruption (Formazan formation) and root cellular death (Evans Blue uptake). So it might be conclusively inferred that the seeds of *Cascabela thevetia* (L.) Lippold, is highly toxic not only for human beings but can evoke elicitation of variable degree of cytotoxicity in *in vitro* animal tissues and *in vivo* plant genome.

Keyword: Suicide plant, hemolysis, haemoglobin release, tissue damage, root tolerance index, cytotoxicity, chromosomal aberrations, nucleolar damage, apoptosis, root oxidizability, cellular death.

**EFFECT OF INGESTED MICROPLASTICS ON PHENOTYPIC TRAITS AND
BIOCHEMICAL ACTIVITIES OF *Oreochromis niloticus* JUVENILES**

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Abstract

Microplastics (MPs) pollution has drawn global concern due to their adverse effects on both marine and freshwater biota. The variation of different phenotypic traits of Nile tilapia (*Oreochromis niloticus*) juveniles was explored by rearing them in three different treatments such as 1) control (only feed twice daily), 2) treatment_1 (2% feed and 2% MPs twice daily), and 3) treatment_2 (one day 4% feed and another day 4% MPs twice daily). In addition, survival rate, enzymatic activities and biochemical analysis were examined during this study. The findings revealed that MPs treated tilapia had significantly lower survival rate, reduced body weight and shorter standard and other lengths, smaller eye diameter and reduced body area than that of control fish. MPs treated juveniles also showed significantly higher superoxide dismutase enzyme activity and lower catalase enzyme activity than the control fish. The proximate analysis revealed that crude protein, moisture and lipid were insignificant in fish of different treatments except ash which was significantly higher in MPs treated fish. The geometric morphometrics revealed no significant shape variation in fish of different treatments, however, control fish had significantly larger centroid size (body size) than the MPs treated fish. Overall, the findings show that ingestion of MPs by tilapia juveniles can adversely affect survival, growth, enzyme activity and biochemical compositions which must be considered seriously during their farming in open water bodies.

INVESTIGATION OF ANTIDIABETIC PROPERTY OF LEAVES OF *Sarcolobus globosus* WALL., A MEDICINAL PLANT OF SUNDARBANS, AND ISOLATION OF BIOACTIVE COMPONENT

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Abstract

Sarcolobus globosus (Baolilata) is a medicinal plant grown in Sundarbans used for rheumatism, dengue, and feverin traditional medicine. The antidiabetic potential of *S. globosus* leaves (reported 15-LOX enzyme inhibitory activity that is a target of glycemic control) was investigated in this study. In the acute toxicity test, no mortality was found. In OGTT, in comparison to standard glibenclamide, the extract significantly lowered the blood glucose levels in a dose-dependent manner. The extract inhibited the alpha-glucosidase enzyme ($IC_{50} = 0.407$ mg/ml) compared with standard voglibose ($IC_{50} = 0.329$ mg/ml). The capacity of the extract to scavenge DPPH ($SC_{50} = 86$ μ g/ml) was comparable to that of standard ascorbic acid ($SC_{50} = 40$ μ g/ml). Total phenolic, flavonoid, and tannin contents were approximately 45 mg GAE/gm, 364 mg QE/gm, and 120 mg GAE/gm, respectively. Following alpha-glucosidase enzyme inhibitory activity, one triterpene alcohol, cycloeucalenol was isolated that exhibited the IC_{50} value of 0.423 mg/ml. Subjecting to docking against the protein model (PDB ID: 3A4A), cycloeucalenol showed a greater binding affinity of -9.3 kcal/mol than voglibose (-6.1 kcal/mol) and closer to acarbose (-9.7 kcal/mol). Cycloeucalenol also demonstrated better binding affinity (-7.6 kcal/mol and -8.9 kcal/mol) against the human alpha-glucosidase protein model (PDB ID: 3TOP and PDB ID: 5NN8). Cycloeucalenol and acarbose were selected for finding thermal stability using MDS. Those exhibited stable dynamic behavior with alpha-glucosidase protein over the 100 ns MDS timescale. Additionally, the ADMET analysis demonstrated the suitability of using cycloeucalenol orally as well as safety in the treatment of hyperglycemia. The overall result of this study suggested that cycloeucalenol might be considered the antidiabetic component of *S. globosus* leaves, that acts through the alpha-glucosidase enzyme inhibitory pathway.

**BUILDING A TRANSNATIONAL, CIVIL SOCIETY PARTNERSHIP TO
INCREASE THE RESILIENCE OF COASTAL POPULATIONS IN SOUTH ASIA.**

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Abstract

The coastal region of South Asia are particularly hard hit by the consequences of global climate change that is threatening the livelihoods of millions of people in south Asia and they are threaten to worsen in the near future. This project contributes to increasing the resilience and sustainable safeguarding of the natural livelihoods of the rural coastal population of South Asia with the funding of Global Nature Fund (GNF) against the impacts of global climate change through the conservation and sustainable use of coastal ecosystems (SDG 13-15) in the context of a transnational partnership (SDG 17). BEDS is implementing this transitional project in Bangladesh where total 529 villagers from 114 fisher families and 17 Munda families are direct target group of this project. BEDS will ensure community based ecological mangrove restoration (CBEMR), promoting local level climate based livelihood adaptation techniques and practices, establishment of a digital knowledge hub for coastal resilience, establishment of a Mangrove Information, Education and Research Centre in Bangladesh and construction of solar service entrepreneurs in the project area. As a part of project BEDS will arrange six national forums and also be a host of one regional forum in Bangladesh for organizational development, cross boundary learning sharing and policy advocacy. Up- to now BEDS has started mangrove restoration works and cover almost 50% of area of 3.6 ha along with a mangrove nursery and empowerment of youth climate leaders for boosting the climate resilience work. However it is expected that, specific seven sub-goals will be achieved in Bangladesh along with the others partners from India, Sri Lanka and Maldives.

Key Words: Climate resilience, adaptation, mangrove restoration, clean energy, education, knowledge sharing.

**OPTIMIZATION OF GRAZING HOUR FOR INDIGENOUS SHEEP OF
SOUTHWESTERN COASTAL REGION OF BANGLADESH**

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Abstract

The southwest coastal region of Bangladesh is at the forefront of climate change impacts. Among other components of coastal ecosystems in southwestern Bangladesh, sheep are also under threat from the effects of climate change. Therefore, the experiment was conducted to optimize the grazing time of indigenous coastal sheep in the southwestern coastal region of Bangladesh. Twenty female sheep were divided into five treatment groups before first lambing aged 4 to 6 months and randomly allowed five different grazing periods. The experimental design was based on a randomized complete block design (RCBD). The grazing hours allocated to the five treatment groups were 4, 6, 8, 10 and 12 hours respectively. All groups of sheep were allowed to graze from 6 am to 6 pm. During this period, sheep in the special treatment group were housed when their allotted grazing period ended. All relevant information was regularly recorded in a registrar. Results showed that sheep body weight increased with increasing grazing time but the mean difference did not differ significantly. In most cases, the maximum body weight was observed in sheep grazed for 10 hours per day. The average growth rate of sheep at third and ninth weights varied significantly ($p < 0.01$) between sheep groups grazed 4, 6, 8, 10 and 12 hours. At third weight, the highest growth rate (g d^{-1}) was 87.50 for sheep graze 10 h, followed by 12 (68.83), 8 (60.17), 6 (57.67), and 4 (39.00) hours of grazing respectively. It can be concluded that body weight and growth rate of native sheep increased with increase in grazing time. However, 10 hours of grazing meets the requirements for their maintenance and growth due to good pasture quality.

Keywords: Body weight, coastal sheep, grazing hour, growth rate, performance

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Abstract

Pollution in Bangladesh has increased significantly with the rapid population growth, economy, and industrialization. The Sundarbans is the largest single tract of mangrove ecosystems and is rich in floral and faunal diversity. Rapid unplanned urbanization and industrial activities are taking place upstream of the Sundarbans. These activities were likely to influence the Sundarbans by discharging different pollutants into the river system. Mangrove ecosystem act as a sink of heavy metals. But the high concentration of heavy metals affects the plants and aquatic species by disturbing their physiological functions like disrupting the cell structure, low biomass accumulation, chlorosis, inhibition of growth and photosynthesis, altered water balance and nutrient assimilation, and senescence, which ultimately cause plant death. Moreover, metal has a severe impact on wildlife, and humans, such as reduced growth and development, cancer, organ damage, and nervous system damage, which causes death. Seedlings of the mangroves are the most vulnerable to metal toxicity. This study compiled the available literature on the heavy metal (cadmium, chromium, copper, nickel, lead, mercury, and arsenic) in different components of the Sundarbans and their possible impact on the biota. The range of cadmium, zinc, lead and iron concentration in river water of the Sundarbans was 0.04–0.10 µg/ml, 0.01–9.66 µg/ml, 0.03–0.16 µg/ml, and 14.3–170.0 µg/ml respectively. While the concentration of cadmium, chromium, lead, copper, and zinc in sediment content was 6.25–7.38 µg/g, 46.8–78.50 µg/g, 33.7–50.33 µg/g, 20.38–42.01 µg/g, 24.91–62.0 µg/g and macro ben 14.63 µg/g, 18.76 µg/g, 174.84 µg/g, 90.02 µg/g, 268.91 µg/g respectively. According to WHO the recognized threshold level for cadmium, chromium, copper, and lead is 0.02 µg/g, 1.3 µg/g, 10 µg/g, 2 µg/g for soil and plants, while 0.01 µg/ml, 0.1 µg/ml, 2 µg/ml, 0.05 µg/ml for water respectively.

Keywords: Pollution, Heavy metal, Environment, Toxicity, Sundarbans.

METAGENOMIC ANALYSIS OF RABINDRA SAROVAR LAKE DEPICTING THE IMPROVEMENT OF ITS WATER QUALITY

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Abstract

Rabindra Sarobar Lake is situated at the heart of Kolkata at 22°30'.30"- 22°30'42"N longitude and 88°21'-88°22'E latitude. It is a man-made freshwater lentic ecosystem that was established in 1935 by NichidatshuFujii. This lake is the abode of variety of fishes among other aquatic life and water activities like rowing and swimming are also very common. However there have been annual reports on fish death in this lake yet it has maintained a sustainable lentic ecosystem. Investigation carried out on this urban freshwater ecosystem showed slight changes in the physico-chemical parameters including low phosphate and nitrate concentration in the water and a unique microbial variation throughout the year. Further study was carried out with the metagenomic analysis of the water sample depicting a cyclic appearance of green algae and blue-green algae, the former increasing the oxygen concentration supported by the bacteria during summer, which might be through nutrient leaching. These pre-dominant green algae maintain the lentic ecosystem by increasing the dissolved oxygen concentration and reducing the biological oxygen demand, thus providing a sustainable environment for the fish and other aquatic flora and fauna. The metagenomic analysis indicated a minimum cyanobacterial and maximum bacterial population, which ensures the safety of the aquatic fauna including fishes. The prevalent bacillus in the metagenome was also indicated by the 6 strains grown in the laboratory.

Keywords: Metagenomic analysis, algal bloom, Rabindra Sarobar Lake, green algae dominance.

**INVINCIBLE DUO IN MITIGATION OF LEAD IN THE *Cucurbita maxima*
RHIZOSPHERE IN EAST KOLKATA WETLAND BACKDROP**

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Abstract

Wetlands, include an interface of land and water having a rich biodiversity with multifarious functions. According to Ramsar Convention, August 2002, East Kolkata Wetlands have been considered to be of international importance. Although improper management of these wetlands, has led to the gradual degradation of this wetland. In this present study, the soil sample was collected from these reclaimed agricultural lands, and their physico-chemical parameters during the initial, peak and inter cropping periods of *Cucurbita maxima* were analysed. They had dissimilitude in their values, representing the fact that prolificacy of the soil was greatly dependent on their physico-chemical parameters. In this investigation, the plant growth promotion properties of the predominant bacterial flora present in the soil surrounding the rhizospheric region of *Cucurbita* sp was analysed. These PGPR, which included some species of *Bacillus*, that can augment plant growth by different methodologies like nitrogen fixation, phosphate solubilization, phytohormone synthesis, siderophore production. These agricultural lands were found to have very high quantities of heavy metals, especially lead. Amongst the bacterial isolates, two of them were found to have great potential in lead mitigation, whereby they could adsorb 5.24% and 5.16% of lead respectively. The prospective potential use of PGPR has gradually escalated, since it is one of the best substitutes against the use of chemical fertilizers and pesticides. The use of these PGPR is one of the most reliable methods for ensuring sustainable agriculture. Furthermore, in future the nutrient quality of the soil will also be correlated with the age of the plant, so that the exact requirement of the soil nutrition is easily understood.

Keywords: East Kolkata Wetlands, *Cucurbita* sp, physico-chemical parameters, soil, microbial flora, PGPR, lead mitigation

**PHTHALIC ACID ESTERS (PAES), AN ENDOGENOUS SECONDARY
METABOLITE FREQUENTLY OBSERVED TO BE PRESENT IN MANGROVE
SPECIES OF INDIAN SUNDARBANS AND ITS ECOLOGICAL/TOXICOLOGICAL
RELEVANCE OF PRESENCE**

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Abstract

Phthalic acid esters (PAEs) are common plasticizers which are very commonly used in several industries. These are basically dialkyl or alkyl aryl esters of 1, 2-benzenedicarboxylic acid, usually named as PAEs, phthalate esters, or just phthalates, and happen to be a group of important derivatives of phthalic acids synthesized from phthalic anhydride and specific alcohols by Fischer esterification. The conventional view is that PAEs are continuously released to the environment via industrial effluents. Therefore, the presence of phthalates in plants used to be considered as a result of environmental pollution. However, researchers revealed that PAEs are also biogenic secondary metabolites. Di-butyl phthalates and di-ethyl phthalates are the most abundant PAEs in plant species. Our research studies find that most of the mangroves and mangrove associates from Indian Sundarbans are synthesizing these phthalates as secondary metabolites which have been detected via GC/MS, GC/FID and spectrophotometric assays in the organic extracts of respective mangrove plant parts.. The PAEs in plants like any other secondary metabolites, act as defense molecules for plants against invading pathogens. The PAEs excreted in the litter and root exudates of plants, are considered as allelo-chemicals to the external environment that affect neighbouring plants' growth, an obvious physiological dominance establishing mechanism adopted by many invasive plant species. Our results speculate that mangrove excreted PAEs have significant role in displaying allelopathy thus facilitating development of monotypic mangroves in conventional large scale mangrove plantation programs.

Keywords: PAE, biogenic secondary metabolite, defense molecule, allelo-chemical, monotypic mangroves

**MAJOR BACTERIAL COMMUNITIES PRESENT IN MANGROVE FOREST
ECOSYSTEM IN INDIAN SUNDARBANS AND THEIR ECOLOGICAL
SIGNIFICANCE**

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Abstract

Next-Generation Sequencing (NGS) of V3-V4 region of 16S rRNA gene using Illumina MiSeq platform is now the most widely used tool to assess both cultivable & non-cultivable microbial diversity at the metagenomic level for any particular biome. The traditional culture methods (TCMs) are essential to obtain the cultivable microbe at culture for their intensive utilization purposes. Knowledge of the composition and abundance of soil microbial communities by both NGS and TCM can be used to predict soil physico-chemical trends, hence useful in unravelling the cryptic/obvious adverse stressors present in any ecosystem or cultivated consortia/pure cultures could be utilized for reclaiming ecosystem or for yields of economically important/bioactive compounds. Plants and the microbes in the surrounding niches interact with each other and together form an assemblage of species in the phyllosphere, rhizosphere and plant endospheric compartments. Selective external environmental abiotic/biotic pressure on these specific microbial congregation act in three major ways- (1) primarily, increasing the bioavailability of soil-borne nutrients (2) outcompeting pathogenic microbial strains and finally (3) re-orienting the hormonal signalling of plants towards better resilience. Sundarbans estuarine mangrove environments are one of the most productive ecosystems. Our research group is dealing with 30 degraded sites (covering ~60 hectares) of Indian Sundarbans with the aim to ecologically restore these degraded mangrove ecosystems. The relative abundances of major bacterial communities like Alpha and Gamma Proteobacteria, Planctomycetes, Actinobacteria and Firmicutes across pristine and degraded mangroves reveals their signature microbial assemblages as well as role of microbes in restoration of mangrove forests in a scientific way by ecological restoration. This could be a key fine-tuning criterion in transforming the degraded mangrove sediments slowly and gradually towards pristine mangrove sediment-like condition.

Keywords: NGS, TCM, abundance, bacterial community, estuarine mangrove sediment.

RESTORATION ATTEMPTS OF RARE AND NEAR THREATENED SPECIES IN INDIAN SUNDARBANS WITH REFERENCE TO CONVENTIONAL AND NON-CONVENTIONAL TECHNIQUES

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Abstract

Sundarbans is the largest contiguous mangrove ecosystem in the world, spread across India and Bangladesh. In India, this mangrove ecosystem is a rich abode of almost 60 species of true mangroves and mangrove associates, out of which about 20-22 species either belong to IUCN globally threatened list or under Least Concerned category with major declining trend of population and also included under threatened taxa enlisted by National Botanical Research Institute, Lucknow, India (<https://nbri.res.in/threatened-plants-conservation/>). Dependent upon the niche of this eco-physiologically specialized, convergently evolved, heterogeneous halophytic assemblage of plant species, a diverse epifaunal assemblage and unique near-shore fish community have also flourished at the intertidal zones. Soil microbiota has also diversified appropriately depending on this typical floral and faunal assemblage, in a unique style, having little similarity with other mangrove niches across the world. In this era of climate change, this estuarine mangrove ecosystem is continuously losing its biodiversity, ecosystem function including its resilience to adversities. Our quadrat analyses data from several fringe mangrove patches of high ecological significance (outside protected area) and some parts of protected forests of Sundarban Biosphere Reserve in India, have shown that these fringes, once a hub of diverse mangrove species, are now simply dominated by only 4-5 species of mangroves. Even the natural secondary regeneration in these areas is limited into only a handful of species. Under this backdrop, our group is trying to restore this diversity of mangrove species at least at the fringe mangroves outside protected areas. We are generating saplings of these threatened taxa by adopting conventional seeds and propagules based propagation as well as following a non-conventional seed ball technology for some threatened taxa. We are in the process of establishing these rare and threatened mangrove species across ~60 hectares of degraded mangrove of Indian Sundarbans.

Keywords: mangrove ecosystem, IUCN threatened taxa, propagules, seed-ball, propagation

ZIKA VIRUS: A POTENTIAL MENACE.Shilpa Rudra¹, Subham Das^{2*}¹Department of Microbiology, Diamond Harbour Government Medical College,²Virus Research & Diagnostics Laboratory (VRDL), Department of Microbiology, Malda Medical College

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Abstract

Zika virus is gradually emerging and leading to an alarming concern all over the world in recent times. Zika virus is considered as positive strand single stranded RNA virus belonging to the genus *Flavivirus* in the *Flaviviridae* family. The nonsegmented virus possesses an icosahedral shape with a virion of size ranging from 40-60nm in diameter where the genome size is of 11kb approximately. This arbovirus is a mosquito-borne virus which was first isolated from rhesus monkey in the ZIKA forest, Uganda in the year of 1947. In India the first reported case of ZIKA was noted in Bapunagar area, Ahmedabad District, Gujarat in 2017 and the biggest outbreak in India happened in 2018 which strikes two states that is Rajasthan, Madhya Pradesh. The most recent outbreak reported in India was in the year 2021 during the second wave of the COVID-19 pandemic situation in the state of Kerala. The presence of this virus in different body fluids including Semen, Urine, Serum, Saliva plays a vital role in the spread of this virus. The infection gets transmitted to humans through several ways such as bites of infected mosquito vectors in the genus of *Aedes*, from mother to fetus in pregnant lady, from mother to infant while breastfeeding and transmission through interpersonal sexual contact and blood transfusion. *Ae. aegypti*, *Ae. albopictus* act as a secondary vector in the spread of this virus mainly in urban and suburban regions. The autoimmune disorders like Guillain–Barré syndrome caused by the infection and transmission from mother to fetus resulting in microcephaly give rise to a potential threat to the human race. At current scenario, proper management and control is required to prevent possible outbreaks in the coming future as no particular drugs or vaccines are available for the treatment of this virus.

Keywords: Zika virus, arbo virus, flaviviridae, zika epidemiology and outbreak, congenital zika syndrome, diagnosis and prevention of zika.

**UTILIZATION OF WATER HYACINTH TO PRODUCE CLEAN ENERGY: A
STRATEGIC WASTE MANAGEMENT FOR RURAL COMMUNITIES**

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Abstract

Water Hyacinth, an aquatic macrophyte, has a high growth rate and fast spreading characteristics in the water bodies. The dense mat of water hyacinth curtails the quotidian and economic lifestyle of the communities and disturbs the aquatic ecosystem. In rural communities, these thick mats are discarded as waste from time to time and kept on the banks of the water bodies. This study proposes a strategic approach to convert the water hyacinth waste to clean cooking energy, nitrogen-rich bio-slurry and handicraft products. A survey of 50 rural households affected by the water hyacinth infestation in the surrounding ponds is conducted. A strong relationship between the women with the ponds is found, and they are more affected by waterborne diseases. A strategic waste management concept is also proposed and analyzed to curtail the overall effects of water hyacinth infestation. The Cost-Benefit analysis of the end products shows a positive economic upliftment of a rural household when the approach is acceptable to its full potential. This strategic approach unanimously delivers clean cooking energy, clean water, nitrogen-rich low-cost organic fertilizer and entrepreneurship development, responding to the Sustainable Development Goals 3, 6, 7, 8 and 13.

Keywords: Water hyacinth, Biogas, Bio-slurry, Entrepreneurship development, Waste management

TRANSFORMATION OF LIVESTOCK WASTE TO BIOGAS ENERGY: A CASTE-BASED IMPACT ON GREEN COOKING ENERGY USAGE IN RURAL INDIA

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Abstract

In India, 65% of the population still lives in rural areas and largely depends on agriculture. The cattle population of India is also the highest in the world, leading to a vast production of biomass from livestock. Therefore, this biomass has tremendous potential for the production of biogas. The present paper envisages the potential of biogas generation in households based on the cattle population in a rural village of West Bengal. However, the interesting spotlight of the energy production from the cattle population largely depends on who owns the cattle in rural India. This makes a substantial difference in the energy power structure in the rural areas of rural Bengal. The findings show that General Caste (GC) population still holds a larger share of the cattle population than other castes like Scheduled Caste (SC) or Scheduled Tribe (ST). The average cattle holding of the study village by the GC is 1.63 cattle per household which comprise 44 per cent of the total cattle in the village. Average annual livestock waste production is estimated to be 464.4 tonnes, with a potential annual biogas production capacity of 18576 m³ in the study area. It is noticed that the SC and ST households have less access to cattle populations and less capacity to produce biogas than the GC group of households. This paper highlights the accessibility and socio-economic relationships of all these power groups and the consequences on energy structure in rural areas.

Keywords: Caste-based power structure, Livestock, Cattle, Waste, Biogas

**RELATIONSHIP BETWEEN ENERGY POVERTY AND INDOOR AIR
POLLUTION: A MICROLEVEL STUDY OF AN INTERIOR VILLAGE IN
NORTHEAST INDIA**

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Abstract

The inaccessibility to contemporary energy services is referred to as energy poverty. Household access to power and clean cooking facilities are considered services like fuels and stoves that do not trigger indoor air pollution in houses. The primary causes of the low living standard in most developing nations are the lack of appropriate access to a clean and affordable energy supply and the widespread use of solid fuels. Despite SDG7 guaranteeing access to affordable, dependable, sustainable modern energy, approximately three billion people use solid fuels for cooking worldwide. Only 59% of Indian households have access to clean cooking fuel. Every year, almost four million people succumb to illnesses brought on by indoor air pollution from ineffective cooking techniques. Children exposed to indoor air pollution have an increased risk of developing pneumonia, chronic obstructive pulmonary disease (COPD), and stroke. Given this context, the current study's goals are to (i) to analyse the household energy use pattern and (ii) find out the relationship between household energy poverty and indoor air pollution. The primary data used in the research was gathered through a face-to-face survey in the Indian state of Manipur's Hengbung village. The current study refutes the idea of an 'energy ladder. It shows that stable income, education, and family status do not impact people's inclination to use traditional cooking fuels. On the contrary, locational data analysis shows people are more likely to use conventional fuels in regions with dense forest cover.

Keywords: Energy Poverty; Household energy use pattern; Clean cooking fuel; Traditional cooking fuel; Indoor air pollution

ISOLATION OF LIGNINOLYTIC BACTERIA: A INITIAL STEP FOR LIGNOCELLULOSE AND OTHER RECALCITRANT WASTE BIOREMEDIATION

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Abstract

Lignocellulolytic microorganisms such as bacteria are responsible for much lignocellulase production. Despite the vast number of lignocellulose degrading enzyme producers, there is a deficiency of microorganisms that can produce a significant amount of the lignin and cellulose's three components system: CMCase, Exo-glucanase, and β -glucosidase. The present study isolated lignocellulose degrading bacteria from a termite gut environment. The serial dilution method was used for bacteria isolation. After appropriate dilutions (10^0 – 10^6), bacterial solutions were streaked on Bushnell Haas agar (BHA) and minimal salt medium (MSM) plates having alkaline lignin and carboxymethylcellulose Sodium Salt (CMC) as the sole carbon source. 23 bacteria (12 cellulose degraders and 11 lignin degraders) were isolated. The screening was done by utilizing Congo red and methylene blue dye decolorization. Estimating the transparent zone around the colonies assessed bacteria's ability for lignin and cellulose degradation. The apparent area around the isolates showed efficient cellulose degradation activity of bacteria. Potent isolates were further screened for various biochemical assays, and SEM observation was done to study the structures of the bacterial isolates.

Keywords: Lignocellulose, bacteria, CMC, termite gut, alkaline lignin.

ENHANCEMENT OF BIOGAS PRODUCTION FROM WATER HYACINTH BY ALKALI PRETREATMENT

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Abstract

Water hyacinth (WH) is used as the substrate for biogas production due to its high lignocellulosic composition and natural abundance. In this present study, thermal and chemical (alkali) pretreatment techniques were used to enhance biogas production from water hyacinth using as a substrate by anaerobic digestion. Thermal pretreatment was done using an autoclave (thermal pretreatment) at 121°C and 15lb (2 bar) pressure and alkali pretreatment by NaOH at two different concentrations (2% and 5% w/v). The inoculum: substrate ratio for biogas production was 2:1, where cow dung was used as inoculum. Results indicate that the pretreatments increased biomass degradability and improved gas production. Pre-treated water hyacinth with 5% NaOH shows maximum methane (64.59 %) and biogas production (142.61 L/Kgvs). The present study found that alkali pretreatment can modify the chemical structure and enhance the hydrolysis of WH for developing energy generation and economic upliftment.

Keywords: Water hyacinth, alkali pretreatment, biogas, methane, bioenergy.

BIOLOGICAL METHANE POTENTIAL OF AQUATIC WEEDS AS THE NEXT GENERATION FEEDSTOCK FOR BIOENERGY PRODUCTION

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Abstract

Aquatic weeds have exceptionally high reproduction rates, are rich in cellulose and hemicellulose, and contain a negligible amount of lignin, making them an ideal crop for the next generation of biofuels. The purpose of this study was to investigate the viability of four aquatic weeds as substrates for anaerobic digestion: Water Hyacinth (*Eichhornia crassipes*), Water Lettuce (*Pistia stratiotes L.*), and common duckweeds (*Lemna perpusilla* and *Lemna minor*). To assess the Biological methane potential and degradation rate of each plant species, a batch digestion was conducted. A series of biological methane potential (BMP) tests on a small scale (150 ml) were designed to compare the methane production potentiality of the four aquatic weeds. Water Hyacinth has the highest BMP after 30 days of anaerobic digestion (217.22 ml/gmVs), followed by *Lemna minor* (187.30 ml/gmVs), *Lemna perpusilla* (70.94 ml/gmVs), and *Pistia* (146.51 ml/gmVs). It has been observed that maximum the Chemical Oxygen Demand (COD) reduced by 82% for water hyacinth while 68%, 64%, 66% reduction observed for *pistia*, common duckweeds (*Lemna minor*, *Lemna perpusilla*) respectively. The significant reduction has been observed in volatile solids (vs) after 30 days of anaerobic digestion.

Keywords: Aquatic Weeds, Anaerobic Digestion, BMP, Biogas

MICROPLASTICS IN THE COMMERCIAL FISHES FROM THE SUNDARBANS OF BANGLADESH

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Abstract

Microplastics (MPs) in fish species has been recognized as one of the emerging appalling problems due to proliferation of plastic pollution in the environment. This study investigated the abundance and characteristics of MPs in the gastrointestinal tracts (GT), gills and muscles of nine commercially important fish species (n=81) (*Liza parsia*, *Acanthopagus latus*, *Pampus argenteus*, *Glossogobiusgiuris*, *Otolithoides pama*, *Johnius argentatus*, *Mystus gulio*, *Lates calcarifer* and *Hyporhamphus limbatus*) caught from the rivers of Sundarbans in Bangladesh. Alkali digestion technique was used to conduct the experiment, then microscopic observations were used to assess the MPs' morphotypes. Polymer characterization was done by Fourier Transformed Infrared Spectroscopy (FTIR). MPs were detected in all parts of the fishes except the muscle of *M. gulio*. Positive relationship was found between MPs abundance and body weight of the fish species. Average MPs abundance in nine species were 7.74 items/g in GT, 7.24 items/g in gill and 1.77 items/g in muscle. A remarkable number of MPs were identified in muscle of eight fish species. Among the various types, shapes and colors of MPs, fiber (64.89-96.77%), filament (78.26-100%) and black (30.83-92.86%) respectively, were dominant. The dominant polymer identified by FTIR analysis was ethylene vinyl acetate (EVA) (19%), while low-density polyethylene (LDPE) (13%) and high-density polyethylene (HDPE) (13%) were ranked second. The study results show the presence of MPs particularly in the muscle of fishes from the Sundarbans of Bangladesh that can be a major threat for human health due to being transferred through the food chain. Immediate measures must be taken to overcome this major threat.

Keywords: Microplastics, fish, FTIR, Sundarbans, Bangladesh.

**INFLUENCE OF PHOSPHORUS SOLUBILIZING BACTERIA ON THE GROWTH,
YIELD AND NUTRIENT CONTENT OF MUNG BEAN (*Vigna radiata* L.)**

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Abstract

Phosphorus (P) deficiency is the main hurdle in achieving sustainable crop production. Using bio-fertilizers like phosphate solubilizing bacteria (PSB) could be a useful approach for sustainable P management as they improve P availability in soil. The present study aimed to evaluate the Influence of Phosphorus Solubilizing Bacteria on the Growth, yield and nutrient content of Mung Bean (*Vigna radiata* L.) All the pots were arranged in CRD way with three replications. PSB and recommended dose of fertilizer (RDF) with varying in rates were used for this study. The seeds are treated with PSB at the rate of 10g kg⁻¹. The treatment comprised of (T1=Control; T2=25% RDF; T3=50% RDF; T4=75% RDF; T5=100% RDF; T6=PSB only; T7=25% RDF+PSB; T8=50%RDF +PSB; T9=75%RDF +PSB; T10=100%RDF+PSB). PSB inoculated with inorganic fertilizer improved soil fertility status by improving soil organic carbon from 1.22% to 1.48%, lowering pH from 7.46 to 7.00, and improving soil total N from 0.04 to 0.09%, available P from .002% to 0.003%, potassium (K) concentrations from 0.01% to 0.02% and sulfur concentrations from 0.004% to 0.01%. Approximately 2.32 times higher grain yield of mung bean plant was recorded due to the application of PSB with RDF. The increase in grain yield was attributed mainly due to increase in plant height, leaf number, biological yield and harvest index. The contents of N, P, K and S in the plant were also boosted by 0.11%, 0.15%, 0.24% and 0.03% respectively with PSB that solubilize, mineralize and mobilize these nutrients through the production of organic acids. Moreover, the study revealed that 25% RDF can be curtailed by using PSB. In addition, it is concluded that PSB influenced remarkable results in measured growth parameters and nutrient content of plant compared to the control. Finally, it was concluded that PSB in combination with inorganic fertilizer could be an effective natural sustainable fertilizer for mung bean cultivation.

Keywords: Mungbean, Phosphorus solubilizing bacteria, Phosphorus

UTILIZATION OF EGGSHELLS FOR THE RECLAMATION OF ACID SOILS

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Abstract

Eggshell has potential to reclaim acidic soils due to its high Ca content. An eighty days incubation experiment was conducted aiming to characterize pulverized eggshell and to reclaim acid soil and acid sulphate soil. The experiment was laid out in a completely randomized design (CRD) with six treatments viz. T₁= Flooded condition, 0% eggshell; T₂= Flooded condition, 0.5% eggshell; T₃= Flooded condition, 1% eggshell; T₄= Field Capacity condition, 0% eggshell; T₅= Field Capacity condition, 0.5% eggshell; T₆= Field Capacity condition, 1% eggshell with 3 replications. The soil was collected for analysis twenty days interval throughout the incubation period. Toxic metals (Zn, Cd, As, Cr and Cu) in the eggshell were found negligible. At the end of incubation period, pH of acid soil and acid sulphate soil raised to 6.61 and 5.03 respectively at T₃ treatment. Eggshell addition increased soil N and P availability to 0.08% and 0.0063% for acid soil as well as 0.088% and 0.0064% for acid sulphate soil respectively at T₆ treatment. K availability was also found to be increase significantly in the eggshell treated soil. At the end of the incubation period, the water soluble and exchangeable Ca increased to 0.42% and 0.47% respectively for acid soil and acid sulphate soil at T₆ treatment. This could be attributed to the high content of Ca (36.5%) found in eggshell. The higher Mg availability was obtained at early stage of incubation and it gradually reduced as the incubation period proceeded to the end. Finally, this study revealed that application of eggshell at the rate of 1% in field capacity state improve the pH and nutrient conditions of acid and acid sulphate soils.

Keywords: Acid Soil, Acid Sulphate Soil, Eggshell, Reclamation

IMPACT OF CLIMATE CHANGE ON ANTIBIOTIC RESISTANCE

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Abstract

In recent years, rapid changes in climate result in global temperature rise, UV exposure, CO₂ emission, increase in relative humidity and many more which have impacted detrimentally on humans and environment. These changes have resulted repeated mutations in different microbial cell walls and physiology, as a result of which sensitivity of some antibiotics have been lost. Several antibiotics like Methicillin, Vancomycin, Metronidazole, Amoxicillin have lost their sensitivity against some specific microbes like *E.coli*, *S.aureus*, *K. pneumoniae* etc. due to global temperature rise via genetic modification. Dry and humid condition may also inhibit Triclosan antibiotic activity in *Staphylococcus* species. Apart from temperature and relative humidity, UV exposure and CO₂ emission also result in decreasing physiological activities of several class of antibiotics like Quinolone, Penicillin, Tetracycline, Streptomycin and many others. This study focusses on antibiotic resistance induced by climate changing factors along with their mechanisms and also comments on the future of these antibiotic resistivity which is believed to be regained back after a couple of years.

Keywords: β -lactamase, Triclosan, Ephaloridine, Shock Treatment Response, Horizontal Gene Transfer

SOIL MICROBIOME AT THE NEXUS OF CLIMATE CHANGE AND BIOGEOCHEMICAL CYCLES.

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Abstract

We are solely dependent on soil for agricultural productivity; Soil microbiome plays an important role in making the nutrients available for plant use and also carbon, Nitrogen cycling. In a respective soil niche, each microbe functions in perfect harmony with other microbes of the same niche. But severe rainfall, flooding, drought, land submergence due to rise of sea-water level, desertification resulting from climate change effects immensely on the physiochemical properties of soil, which in turn changes the microbial signature of the soil-affecting on the agricultural yield. Soil is a huge storehouse for carbon, and it is abundant in the agricultural land having high plant diversity and sufficient soil moisture or in soil-microbes capable of withstanding stress caused by drought. If soil-microbial diversity decreases, plant viability and diversity decrease and thus hampers the carbon cycle. In an experiment conducted to simulate the effect of saline water flooding in coastal areas, a clear shift is noticed in microbiome. The results were analysed by 16S rRNA sequencing and T-RFLP analysis. Initially microbes are resilient to the harsh condition and heterotrophic activity pertaining to nitrogen removal is noticed. But gradually aerobic bacteria are depleted, bacterial activity is found to be receding due to less available Soil Organic Matter. Original taxonomic unit of bacteria at the soil with direct contact of flooded sea water dropped almost to zero. But silver lining to this experiment is the microbial consortia when introduced to flooded soil, could establish their community. Since the coastal areas of Sundarban and the surrounding islands suffers from severe flooding and has consequently loses soil fertility and has less agricultural produce, a microbial consortium can be produced which can tolerate the salinity, osmotic pressure and anaerobic condition caused by flooding.

Keywords- Soil microbiome, Climate change, Carbon cycle, Nitrogen cycle, Microbial Consortium

PATHOGENIC BACTERIA IN MUNICIPAL SLUDGE IN THE OUTSKIRTS OF KOLKATA

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Abstract

The outskirts of Kolkata are lined with many industries, which are situated close to semi-urban residential areas. Often the industrial effluents are mixed with the municipal waste, after being discharged. Previous studies have shown that this mixed urban and industrial waste water may harbour a unique microbial population. There are possibilities of finding pathogenic bacteria, antibiotic resistant strains, strains tolerant to heavy metals and more. Here our aim was to study the microbial communities; the physical and chemical characterization like pH, dissolved oxygen levels, electrical conductivity; presence of heavy metals and finally the complete metagenomic analysis of the wastewater sample that was collected from a municipal waste water discharge point located in close proximity to some factories, in Khardaha, situated 32kms from the city centre, in order to classify and subclassify the microbial communities in a water sample. Further To study the bacterial population in the water sample a differential medium, that is recommended for presumptive identification and confirmation of microorganisms that cause urinary tract infections, and testing water, food, environmental and other clinical samples, was used. Among the various bacteria present, we observed the prevalence of *Klebsiella* spp., *Escherichia coli*, *Enterococcus* spp. and *Bacillus* spp. A high concentration of iron was observed in the water sample as well. These organisms are pathogenic and do impose a lot of threat to human life and lifestyle. Lastly it shows a distinctive tolerance to heavy metal concentration and their subsequent bioleaching activities have also been studied.

Keywords: antibiotic resistant strains, metagenomic analysis, presumptive identification, tolerance to heavy metal, bioleaching activities,

FUTURISTIC APPROACH TO PROTECT SUNDARBANS.

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Abstract

The Sundarbans is the world's largest littoral forest and is an area of rich heritage and biodiversity. It has a vast location which includes the river Baleshwar in Khulna, Bangladesh, to Hooghly, West Bengal. It protects the coastal habitat from devastating cyclones, helps in the reclamation of the land, acts as a natural flood barrier, and provides a livelihood for local people. Due to anthropogenic factors which are leading to global climate change, the current status is that – there is an increase in the mean sea level, thereby posing a negative impact on the Sundarbans. This is causing salinity intrusion which is a major threat in most parts. It is leading to soil and river salinization, hence affecting people, their livelihood, and their occupation. There is a loss of income, a decrease in freshwater for drinking and irrigation, alteration in mangrove ecosystems, and agricultural loss. Moreover, this is leading to a rapid decrease in many native species of plants and animals. The Sundarbans soak a huge amount of carbon dioxide, thus the increase in salinity can lead to an increase in the amount of carbon. If this continues, in the next twenty years, there would be 98 percent inundation of Sundarbans. Hence, the solutions for these problems include – regular tree plantation in every house which should be a conscious personal initiative, propagation of roots using microbial consortia, freshwater management, reshaping the land, and alternate livelihoods such as handicrafts, pharmaceuticals, honey processing, tannin, and dye processing can be adopted. Sustainable farming and the use of biomass energy instead of wood as a fuel for cooking also create an impact. It is necessary for researchers and other people to reach out to the dwellers there and provide them with essential help.

Keywords – Sea level rise, salinity intrusion, soil and river salinization, Sundarbans, inundation, ecological imbalance, climate change, microbial consortia.

INCREASING SHELF LIFE OF SPICES: MICROBIAL INPUTSDebjani Dutta^{1*}, Debdatta Das¹, Debapriya Maitra¹, Bedaprana Roy¹, Arup Kumar Mitra¹¹Department of Microbiology, St. Xavier's College (Autonomous), Kolkata

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Abstract

Spices are indispensable for improving the flavor and aroma of food. Like other food products, spices too have their inherent microflora which serve diverse functions and often interact amongst themselves. In this study, cumin and coriander were chosen for their high nutritive value and omnipresence in human diet. After rigorous screening, a total of fifteen bacterial isolates were selected from the indigenous microflora of the spices, and analyzed. These strains were then purified and colony characteristics as well as morphology of the isolates including Gram characteristics were studied. Enzyme assay was done to check the production ability of various degradative enzymes like catalase, amylase, pectinase, laccase, lignin peroxidase and lipase by the selected bacterial isolates, and based on the relative absence of the enzymes, three bacteria were deemed to be relatively harmless for plant products. They were identified as *Bacillus subtilis*, *B. cereus* and *B. australimaris* by 16S rRNA sequencing. These bacteria were then allowed to interact with one of the fungal isolates, which was identified to be *Aspergillus flavus* by 18S rRNA sequencing. An antagonistic relationship was observed between the fungi and the bacteria, wherein the later was able to control the growth of the fungus at optimized concentrations. Inoculation with optimized doses of inherent microbial flora has promising future prospects in terms of increasing the shelf life of spices by controlling the growth of the harmful fungus, and also boost their nutritive value.

Keywords: Cumin, Coriander, *Aspergillus flavus*, *Bacillus subtilis*, *B. cereus*, *B. australimaris*, Nutritive value, Shelf life

**MOLECULAR DIAGNOSIS OF WHITE SPOT SYNDROME VIRUS (WSSV) AND
ACUTE HEPATOPANCREATIC NECROSIS DISEASE (AHPND) CAUSATIVE
AGENT IN BLACK TIGER SHRIMP HATCHERIES**

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Abstract

Shrimp aquaculture is a very promising and fast-developing industry in Bangladesh that contributes about 3.78% of the national GDP. However, this sector has been suffering from different diseases especially viral and bacterial diseases. White Spot Disease (WSD) and Acute Hepatopancreatic Necrosis Disease (AHPND) are considered serious intimidation to the commercial tiger shrimp (*Penaeus monodon*) farming industry. White spot syndrome virus (WSSV), a DNA virus, and *Vibrio parahaemolyticus*, a bacterium, are the causative agent of WSD and AHPND, respectively. The study aimed to investigate the scenario of viral and bacterial contamination in broods, nauplii, zoea, mysis, post larvae (PL) of shrimp, and other hatchery inputs like artemia, algae, squid, and mussel in commercial shrimp hatcheries in Cox's Bazar. The prevalence of these dreadful viral and bacterial infections was studied in 10 randomly chosen hatcheries in Cox's Bazar district of Bangladesh. WSSV and AHPND causative agents were detected using nested polymerase chain reaction (PCR). Out of 118 randomly selected samples including brood, PL, nauplii, zoea, mysis of shrimp, artemia, algae, squid, and mussel, 28.81% and 5.08% of the total samples were found positive for WSSV and AHPND, respectively. The study showed that the diseases affected all stages of the life cycle of shrimp as well as squid, mussel, and other hatchery inputs were also potential hosts for WSSV and AHPND. Hence, the present study suggests focusing on ensuring the production of specific-pathogen-free (SPF) shrimp PL in commercial shrimp hatcheries by maintaining proper biosecurity management. The findings of this study would aid farmers and decision-makers in developing plans to protect the shrimp sector from WSD and AHPND and thereby maintain sustainable shrimp farming in Bangladesh.

**ASSESSMENT OF INFECTIOUS HYPODERMAL AND HEMATOPOIETIC
NECROSIS VIRUS AND MONODONBACULOVIRUS BY MOLECULAR
TECHNIQUE IN PENAEID SHRIMP HATCHERIES**

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Abstract

Shrimp viruses are the primary factor for increasing infection-driven mortality and decreasing shrimp production. There are several potential viruses responsible for shrimp diseases. Among them, infectious hypodermal and hematopoietic necrosis virus (IHHNV) and monodonbaculovirus (MBV) are considered great threats to the commercial farming of tiger shrimp (*Penaeus monodon*). The present study aimed to investigate the prevalence of IHHNV and MBV infection in samples of commercial shrimp hatcheries in Bangladesh by applying polymerase chain reaction (PCR). A total of 118 samples including broods, post larvae (PL), nauplii, zoea, and mysis of shrimp, and other hatchery inputs namely algae, artemia, squid, and mussels were randomly collected from ten commercial shrimp hatcheries in Cox's Bazar. IHHNV and MBV were detected in 47% and 43% of the total hatchery samples, respectively. The study showed that all stages of the shrimp life cycle were affected by the diseases, with zoea, mysis, and PL showing the highest prevalence. In contrast, shrimp brood exhibited a lower prevalence of both viruses, indicating that shrimp fry is more susceptible to the virus. These viruses were also found in algae, artemia, and squid, indicating the horizontal transmission of these pathogens occurred through contaminated water. It is noted that the infected shrimp fry will be an obstacle to obtaining higher production of shrimp at the farm level in Bangladesh. Hence the result of the study would help the farmers to know about the present management way of those selected hatcheries and to take preventive measures to protect the shrimp industry from IHHNV and MBV infection. This study also recommends focusing to ensure the production of specific-pathogen-free (SPF) shrimp broods and PL in commercial shrimp hatcheries to preserve sustainable shrimp farming in Bangladesh.

BIOREMEDIATION: A SOLUTION TO PLASTIC POLLUTION.

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Abstract

Scientific researchers are concerned about the current state of rapidly expanding plastic pollution. "Plastic" is an umbrella term for a diverse variety of organic polymers having high molecular weight obtained from different hydrocarbons and petroleum derivatives. Non-biodegradable plastics and their degradation products, like microplastics, are among the most dominant anthropogenic factors impacting the terrestrial and aquatic ecosystems worldwide. Natural factors act on plastic materials, fragmenting them into microplastics that endanger all ecosystems and their inhabitant organisms. Marine microplastics are transporters of hazardous and chemical contaminants, because once they enter the ocean, it is challenging to remove them due to their small size. They pose a potential threat to oceanic fauna as these micro-fleeces can enter the food web through inadvertent ingestion and get trapped in the intestines of marine and terrestrial animals, including cattle, killing them and endangering many crucial species. Non-biodegradable microfibers continue their life cycle from prey to predators in various food chains. Traditional plastic-free-environment solutions are insufficient owing to the emission of hazardous byproducts and complex recycling. As a result, producing biodegradable polymers and screening for microbial species that degrade the current buildup of plastics in our environment is a viable approach of remediation. Plastic trash may be degraded using a targeted conversion of polymeric materials into bio-gas and biomass by anaerobic bacteria that efficiently exploit the polymers as a carbon source for their development. This research demonstrates the convergence of biochemical and engineering advances in synthetic microplastic biodegradation, mitigation strategies, and prospective management alternatives of synthetic microplastic pollutants with particular emphasis on some evolved microbes capable to degrade plastic.

Keywords: Bioremediation, non-biodegradable microplastic, climate change, pollution, biochemical engineering, metabolic pathways, anaerobic bacteria.

**TRACE METAL AVAILABILITY AND EFFECTS ON BENTHOS COMMUNITY
STRUCTURE IN RUPSHA-PASSUR RIVER AND ITS ADJOINING MANGROVE
AREAS**

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Abstract

Metal pollution is one of the major concerns for aquatic ecosystems due to their persistence, non-degradability, bioaccumulation and inherent toxicity on living organisms and potential ecological effects. The bioaccumulation of the trace elements in the tissues of aquatic animals through the food chain results in hazardous effects to aquatic ecosystem and human health. The present study aimed to analyze the trace metal availability and its effects on benthos community like carb, mollusk structure in Rupsha- Passur river and its adjoining mangrove areas.

The samples of sediment, water and organisms were collected randomly at high tidal and low tidal zone during summer, winter and rainy season from four different locations namely forest ghat, mongla, karamjol and herbaria. Sediment and water samples analyzed by using Atomic Absorption Spectrophotometer. The physic-chemical water quality parameters were also monitored.

The metals of Zn, Pb, Cr, Cu, Fe and As in sediment, water, crabs and mollusk were detected. In summer, the concentrations of Zn was highest in sediment and crab whereas Pb in water and Fe in mollusk. High concentration of Cr observed in crab at forest ghat. In winter, considerable amount of Zn, Pb and Fe were present in sediment, water and mollusk, respectively. Cu, As found almost zero in both season but excessive amount Pb and Cr detected in water at forest ghat during winter. The Shanon-Wiener diversity index showed that large numbers of organism were present in high tidal zone during winter season. No variation observed in rainy season. Redundancy analysis indicates that trace metal pollution contributed almost 75% of the variation in community structure among the seasons. The findings of the study will provide a baseline on trace metal pollution and its effects which help us to establish a regulatory framework and bio-monitoring strategy for mangrove ecosystem in future.

PERFORMANCE EVALUATION OF VIOLET RICE INTRODUCED TO SALINE SOIL CONDITION

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Abstract

Increasing salinization and food demand in future the use of marginal lands may be an option for ensuring food security. Being an indigenous rice variety of Sundarban area of Bangladesh, violet colored rice has a great potential for cultivation in saline soil. For this, a field experiment was conducted on strongly saline soil (10.2 dS/m) of Batiaghata upazila under Khulna district to find out the optimum planting geometry of violet rice. The study considered three types of plant spacing S, (10 cm × 10 cm, 15 cm × 15cm and 20cm × 20 cm) and four seedling variations, N (1, 2, 3 and 4). Treatment combinations were N1S1, S1N2, S1N3, S1N4, S2N1, S2N2, S2N3, S2N4, S3N1, S3N2, S3N3 and S3N4. All the plots (dimension, 3m x 2m = 6m²) were arranged in a randomized completely block design with three replications. Morphological (Plant height, leaf area, leaf per plant, tiller per plant) and yield attributes (panicle per plant, grain yield, 1000 grain weight, harvest index) of violet rice were investigated in this study. The result showed that S3N3 treatment had the highest grain yield of 2.33 tha⁻¹ followed by S3N4 with a grain yield of 2.20 tha⁻¹. Grain yield ranges from 0.7 – 1.93 tha⁻¹ for rest of the treatments with the lowest yield obtained in S3N1. The result indicated that, biological yield (204.66 g/hill), straw yield (3.95 t/ha), harvest index (48.03 %), total grain per panicle (136), tiller number per hill (25.33) and panicle number per hill (20.67) were found highest with S3N4 treated plot. Results of the present study revealed that S3N3 and S3N4 treatments were found to be the best combinations for obtaining the maximum grain yield of violet colored rice plant in strongly saline soil. Increasing salinization and food demand in future the use of marginal lands may be an option for ensuring food security. Being an indigenous rice variety of Sundarban area of Bangladesh, violet colored rice has a great potential for cultivation in saline soil. For this, a field experiment was conducted on strongly saline soil (10.2 dS/m) of Batiaghata upazila under Khulna district to find out the optimum planting geometry of violet rice. The study considered three types of plant spacing S, (10 cm × 10 cm, 15 cm × 15cm and 20cm × 20 cm) and four seedling variations, N (1, 2, 3 and 4). Treatment combinations were N1S1, S1N2, S1N3, S1N4, S2N1, S2N2, S2N3, S2N4, S3N1, S3N2, S3N3 and S3N4. All the plots (dimension, 3m x 2m = 6m²) were arranged in a randomized completely block design with three replications. Morphological (Plant height, leaf area, leaf per plant, tiller per plant) and yield attributes (panicle per plant, grain yield, 1000 grain weight, harvest index) of violet rice were investigated in this study. The result showed that S3N3 treatment had the highest grain yield of 2.33 tha⁻¹ followed by S3N4 with a grain yield of 2.20 tha⁻¹. Grain yield ranges from 0.7 – 1.93 tha⁻¹ for rest of the treatments with the lowest yield obtained in S3N1. The result indicated that, biological yield (204.66 g/hill), straw yield (3.95 t/ha), harvest index (48.03 %), total grain per panicle (136), tiller number per hill (25.33) and panicle number per hill (20.67) were found highest with S3N4 treated plot. Results of the present study revealed that S3N3 and S3N4 treatments were found to be the best combinations for obtaining the maximum grain yield of violet colored rice plant in strongly saline soil.

**EFFECTS OF SALINITY AND CADMIUM INTERACTION ON GERMINATION
AND SEEDLING GROWTH OF CHICKPEA (*Cicer arietinum* L.)**

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Abstract

Salinization and heavy metal pollution are now a growing concern throughout the world. Salinity and heavy metal stress drastically impair seed germination, plant development, and availability of nutrients. For this reason, an incubation study was conducted to assess the interactive effects of salinity and Cd separately and in combination on germination and growth of the seedlings of the chickpea (*Cicer arietinum* L) plant. Nutrient content in the seedlings was also investigated. Seeds of chickpea were allowed to germinate and grow for 10 days, subjected to the individual and combined effect of Cd (0, 5, and 10 mg L⁻¹) and NaCl (0, 25, 50, 75, and 100 mM). Germination was unaffected by Cd treatments where the increasing concentration of NaCl reduced the germination rate. The interactive effects of Cd and salt did not appear to have significantly contributed to growth impairment, and signs of decay were solely related to the individual effect of Cd and NaCl. Increasing concentration of Cd and NaCl treatments imposed negative effects on the seedling's growth indices compared to control. Moreover, the plant's nutrient (N, P, K, S) contents were also retarded due to the applied stresses. It was found that the combined effects were more drastic as compared to single stress on the nutrient content of chickpea seedlings.

Keywords: Salinity, Cadmium (Cd), Germination, Chickpea, Seedlings growth, Nutrient.

**EFFECT OF OXYTETRACYCLINE ON MORPHOMETRY AND METABOLIC
ACTIVITIES OF POLY-CULTURED TILAPIA (*Oreochromis niloticus*) AND ROHU
(*Labeorohita*)**

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Abstract

Oxytetracycline, an antimicrobial agent is widely used in aquaculture but its use is accompanied by undesirable ecological effects. The effect of this antibiotic on the morphometry and metabolic activities of poly-cultured freshwater fish species and primary productivities in the aquaculture ecosystem has not been comprehended yet. The present study aimed to assess the effects of dietary oxytetracycline on the growth performance, proximate composition, digestive enzyme activity, and immunity performance of tilapia (*Oreochromis niloticus*) and rohu (*Labeorohita*) and primary productivity in a polyculture system. Oxytetracycline was applied with feed at 100 mg kg⁻¹ fish biomass day⁻¹. A total of 240 tilapia and 240 rohu, with an average length of 6.8 cm and weight of 6.6 g were cultured for 70 days. Six fishes of each species were randomly sampled for estimation of growth, enzymatic activities, non-specific immune parameters, and proximate composition of the body muscle. The result showed that there was no significant ($p > 0.05$) difference in the growth for treated fishes in comparison with the control ones. Amylase activity was enhanced significantly ($p < 0.05$) while superoxide dismutase activity also increased but in a non-significant ($p > 0.05$) way in both fish species. Protease and catalase activities were found to be decreased significantly ($p < 0.05$) in both species. There was no significant increase in plankton abundance in the treatment ponds. Spectrometry study of chlorophyll-a sample also revealed that in both control and treatment ponds there was no significant ($p > 0.05$) difference among each week. These results suggest that oxytetracycline dosing at 100 mg/kg had no significant impact on the growth rate and enzymatic activity of poly-cultured *O. niloticus* and *L. rohita* as well as on the primary productivity of the pond. A therapeutic dose (100 mg/kg b. w./day) of oxytetracycline is subjected to be safe for use when fish species are cultured using the polyculture technique.

**HEAVY METAL, TRACE ELEMENT AND BIOCHEMICAL COMPOSITION OF
ASIAN SEABASS (*Lates calcarifer*) IN COASTAL AREAS OF BANGLADESH**

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Abstract

Asian seabass (*Lates calcarifer*) is considered as a nutritionally and commercially important fish species all over the world because of its high-quality dietary protein, omega-3-polyunsaturated fatty acids and minerals. But its nutritional value may be affected by the environment in which it exists. Toxic level of trace and heavy metals in the environment has deleterious effects on human health through consumption of heavy metals contaminated fish. This study aimed to estimate the trace element, heavy metal and biochemical composition in seabass collected from six different coastal locations namely Satkhira, Khulna, Bagerhat, Patuakhali, Bhola and Cox's Bazar. Trace elements and heavy metals in muscle of seabass were analysed by Atomic Absorption Spectrophotometer (AAS) and biochemical composition was determined by the procedure of wet digestion and analytical determination method. The heavy metal and trace element profile showed that Fe (3.578±0.03ppm) was the most abundant mineral followed by As(2.55±0.08ppb), Zn(0.864±0.07ppm), Cr(0.757±0.07ppm), Pb(0.118±0.01 ppm) and Cu(0.0036±0.001 ppm). The highest amount of Fe, Zn, Cu and Cr were found in Patuakhali but As and Pb were found to be most abundant in Khulna. Concentration of heavy metals in all fish population were below the Food Safety Guideline (FSG) by WHO/FAO.

Proximate analysis revealed that the maximum range of crude protein, lipid, ash and moisture content were 15.85-18.76%, 0.71-1.74%, 0.64-1.12% and 75.92-81.13% respectively. The maximum content of protein, lipid and ash was found in Patuakhali, whereas the lowest amount of protein was found in Satkhira and the lowest amount of lipid and ash were observed in Bhola. The study suggests that seabass population from Patuakhali had a better biochemical composition with high nutrients and can be suggested to select for future culture. In addition to this, seabass from different coastal regions of Bangladesh is safe for human consumption and free from health hazard.

THE CHANGES IN LAND USE/LAND COVER DURING POST-POLDERIZATION PERIOD AND ITS IMPACT ON OCCUPATIONAL AND SOCIAL STRUCTURE IN A *Poldered* ECOSYSTEM IN THE LOWER BENGAL DELTA, BANGLADESH

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Abstract

The Lower Bengal delta – representing the sea front region of the prograding Bengal Delta – is an entity experiences regular tidal impulses and frequently visited by extreme climatic events – have been *poldered* during 1960s by construction of embankments to protect the tidal floodplains (and thereby the rice fields) from sea water invasion during growing seasons. Such massive investment in infrastructural development resulted in anthropogeomorphological changes of the *poldered* ecosystem by changing the geomorphological configuration of the region that maldistributed the tide driven suspended sediments in the tidal floodplain; thus resulted in raising the baseline of the natural drainage system with reference to the proximate tidal floodplain and drainage congestion leading to water logging in the region ensued. This article strives to analyze the trend of land-cover and land-use (LCLU) dynamics during post-*polderization* period (2000 to 2020) applying Geographical Information System (GIS) lead quantification of the attributes and assesses the impact of such changes in the physical environment on occupational dynamics (along with dynamics of societal structure) of human community of the *poldered* ecosystem (Polder # 25). An unsupervised classification approach have been followed in classifying five time-series Landsat imageries (Landsat 5-8) into six classes such as waterbody, aquaculture, mixed culture, crop-agriculture, yellow zones and vegetation cover. (Please elaborate the abbreviation !!) (NDWI) operation was carried out to delineate the alteration of the land-water interface along with the timeframe. Household questionnaire survey on purposively selected 410 respondents was conducted having age above 40 years in order to assess the influence of temporal and spatial dynamics of LULC on occupational and societal structure (social institution, social status and roles, and social groupsetc). The spatial extent of aquaculture and mixed culture is quite significant (increased by 113% and 54.48% respectively) during the assessment period and the domain of crop- agriculture and vegetation shrinked to 40.37% and 40.85% respectively. The built-up and the barren land (yellow zones) have been increased to 63.23% while the extent of waterbody decreased to 29.67% suggesting encroachment of human settlement. Mann-Kendall test showed statistically significant trends in the extend of waterbody ($p = 0.027 < \alpha$), vegetation cover ($p = 0.027 < \alpha$), crop-agriculture ($p = 0.027 < \alpha$), and mixed culture cover ($p = 0.027 < \alpha$). However such trend is absent with spatio-temporal extent of aquaculture ($p = 0.221 > \alpha$) and yellow zones ($p = 0.086 > \alpha$).

Keywords: polderization, vulnerability, landscapes and GIS.

**CONTRIBUTIONS OF CO-MANAGEMENT APPROACH IN INFLUENCING
COGNITIVE BEHAVIOUR OF THE STAKEHOLDERS: A CASE IN CONSERVING
THE SUNDARBANS MANGROVE FOREST, BANGLADESH**

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Abstract

The Sundarbans – the single largest mangrove forest in the world is under significant pressure of more than 3.5 million people surrounding the forest who are either partially or completely dependent on the natural resources of the forest for their livelihoods. The management of this reserved forest was found ineffective for several decades mainly due to increased population pressure. It has been more than a decade since the government of Bangladesh have introduced co-management approach (CMA) which involved the local communities to the management functions of the forest. After the completion of several CMA-based projects, this research explored the impacts of CMA by influencing the cognitive behaviour of different stakeholders which facilitated the conservation efforts of the Sundarbans. Factors affecting the changes in the local stakeholders' behaviour viz., literacy rate and alternative income generating sources, attitude, performance experience, observational learning, and emotional arousal were revealed in this qualitative study. It inquired how CMA influenced the behavioural changes of the local stakeholders by improving social and environmental awareness. This study also identified the problems and role of higher institutional bodies in changing the locals' attitude towards the co-management functions. It also found the relationship among the components of CMA and the elements of cognitive behaviour influencing the decision-making process of different stakeholders. The study examined whether this process moved forward or not to a sustainable solution for the conservation of the mangrove forest. The findings of the research are expected to help the policy makers to take various policy decisions for the improved and sustainable management of the Sundarbans mangrove forest. Moreover, the findings are also applicable as nature-based solutions for climate-change adaptation through changed attitudes and behaviours of local community people.

Keywords: Co-management approach, cognitive behaviour, conservation, Sundarbans, Bangladesh

**EFFECTS OF SOIL CHARACTERISTICS ON THE GROWTH OF NYPA PALMS
DUE TO VARIOUS ENVIRONMENTS IN KOLAPARA UPAZILLA, BARISHAL**

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Abstract

With naturally growing, Nypa palms (*Nypafruticans* Wurm., Arecaceae) is also now commercially cultivated in Kolapara Upazilla, Barishal District where two different land characteristics, inland and swampy have been observed. Soil samples from these artificial and natural cultivation with inland and swampy environments were collected to reveal the effects of soil characteristics on the growth of Nypa palm. Laboratory analysis showed that Nypa cultivation with artificially managed inland soil have higher soil pH, EC, total organic carbon, total N, available P, available K, available S, available Na and Total Ca and Mg due to the frequent manual application of fertilizers than that of natural swampy vegetation. Field observation also proved that Nypa palm's growth and response was also higher in artificially managed system than natural.

Keywords: Nypa palm, Soil nutrients, Organic carbon, Kolapara

SITE-SPECIES SUITABILITY OF NYPA PALM IN DACOPEUPAZILA, KHULNA

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Abstract

The current study was initiated to determine the site-species suitability of Nypa palm (*Nypafruticans wurmb*) in Dacopeupazila, Khulna by characterizing soil and water quality of the study area and compare those data with palm's growth requirements. Soil and water samples were collected from four different palm's farm site where depth wise vertical distribution for soil samples was also maintained. Laboratory analysis was conducted to reveal the physical and chemical properties and characteristics of collected soil and water samples. The obtained results showed that among four farms soil texture varies from sandy loam to loam soil which is the Nypa Species growth requirements. Bulk density ranges from 1.04 to 1.61 g/cm³. Soil pH at surface soil varies among four farms and within the farm at varying depth but mostly ranges from 7.1 to 7.6. EC ranges from 8.84 to 15.3 (dS/m) and showed a decreased pattern with increasing depth in all farms except farm 1 where it was vice versa. CEC ranges from 2.66 to 6.32 (meq/100g) and showed a gradual increase with increasing depth similar to Mantiquilla et al (2020) findings. Carbonate content (ranges from 0.0151 to .0306 %) decreases with increasing depth in contrast with bicarbonate content (ranged from 0.030 to .181%) which increases with depth. The total organic matter ranged from 0.66 to 2.57 % with inconsistent vertical distribution among four farms. The total nitrogen and available nitrogen ranges from 0.504 to 1.306 % and 0.0252 to 0.091 % respectively. Different physico-chemical parameters of water varies greatly in different locations of selected sites. Water samples showed various characteristics among four farms may be due to other environmental factors.

Keywords: Nypa palms, soil-water nutrients, CEC, pH

EFFECTS OF AIR POLLUTION ON BIOCHEMICAL AND ANATOMICAL CHARACTERISTICS OF SOME SELECTED PLANTS IN THE KHULNA REGION

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Abstract

Three types of vegetation i.e., forest plant (*Swietenia macrophylla*, commonly known as mahogany), fruit trees (*Mangifera indica* commonly known as Aam and *Artocarpus heterophyllus*, commonly known as) and vegetables (*Spinacia oleracea*) commonly known as Palong Shak and *Red amaranthus*, commonly known as Lal Shak) were selected under three different Level of Air Quality Index (AQI) i.e., Good, Moderate, and Sensitive (Department of Environment, 2018) at the Fakirhat Upazilla of Bagerhat districts in Khulna division, Bangladesh. The objective of this study was to evaluate the physiological (pH, chlorophyll and carotenoids, relative water content) and leaf anatomical (epidermis, cortex, pith area, xylem and phloem tissue) responses of these three types of species to different levels of AQI. The obtained results revealed that forest plants are more susceptible to pollution in contrast with fruit trees and vegetables. The pH of plant cell sap (6.83 ± 1.24) was almost neutral at good ambient air quality (control) whereas in sensitive areas, it was slightly acidic to acidic (5.17 ± 1.45) in range. All three types of plant species showed a negative response to air pollution possessing a reduction in total chlorophyll and carotenoid content in sensitive areas compared to the control. The maximum relative water content obtained from control (good ambient air quality) is about 73.34% and decreased with increasing pollution level having no visible impact on vegetables. From leaf anatomical point of view, some internal injuries to the leaf were observed with no external injury due to the increase in air pollution. In sensitive areas, a significant reduction in epidermis, cortex, pith area and xylem & phloem were observed within all three species compared to control (good ambient air quality).

Keywords: Air pollution, Plant species, AOI, pH, Cell sap, xylem, Phloem

CHEMICAL AND BIOLOGICAL EXPLORATION OF *Hygrophila phlomoides*

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Abstract

The methanol extract of the aerial part of *Hygrophila phlomoides* (Family-Acanthaceae) was investigated for its phytochemical constituents and pharmacological activities (blood coagulation, antibacterial, antihyperglycemic, diuretic, and neuropharmacological behaviour). Preliminary phytochemical screening of *H. phlomoides* extract revealed the presence of reducing sugar, phenolic compounds, flavonoids, tannins, protein, alkaloids, glycosides, saponin, steroids, terpenoids and acidic compounds. In-vitro blood coagulation activity was measured for *H. phlomoides* extract by recording the clotting time 4.51, 5.24,

7.56 and 8.19 minutes at the doses of 200, 100, 50, 25 mg/mL respectively compared with the control group where the clotting time was 6.67 min. The extract showed no antibacterial activity against *S. aureus*, *S. enteritidis*, *E. coli* and *B. subtilis* species at the dose of 250 and 500 µg/disc in comparison with standard drug Ciprofloxacin (30 µg/disc). In the oral glucose tolerance test, *H. phlomoides* extract significantly reduced the blood glucose level (Mmol/L) in the Swiss albino mice, and displayed α -glucosidase inhibitory activity with an IC₅₀ value of 0.520 mg/mL which is comparable to the standard acarbose (IC₅₀=0.323 mg/mL). In the evaluation of diuretic activity on mice, the extract showed an increase in elimination of urine volume at two different doses of 250 and 500 mg/kg body weight which was comparable to the standard (Furosemide). In the evaluation of neuropharmacological behavior, both of the extracts showed CNS depressant activities by decreasing the no. of squares travelled by the mice in the open field model. The phytochemical groups present in this plant may be responsible for the aforementioned pharmacological effects.

Keywords: *Hygrophila phlomoides*, Blood Coagulation, Antibacterial, Antihyperglycemic, Diuretic and Neuropharmacological Behaviour.

TRANSFORMATION OF CATTLE BLOOD INTO AN ORGANIC MANURE

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Abstract

Cattle blood is a cheap and available source of nitrogen (N) with high nutritional and functional quality. In Bangladesh, thousands of cattle are slaughtered and a huge amount of blood waste is generated which pollutes preferentially the aquatic environment. A study was conducted to transform this cattle blood into blood meal organic manure. The annual cattle blood production in the slaughterhouses of Khulna City Corporation (KCC) was estimated, blood samples were collected and blood meals were manufactured by employing three different methods. The blood meals were characterized for their pH, EC and organic matter content. The blood meal was incubated in the soil for 120 days at different doses (1, 5, 10, 15, and 20 t/ha) for its ability in the mineralization of major (NPK) nutrients. The study estimated that KCC produces approximately 58.62 tons of blood per annum which projects that annually about 10.70 tons of blood meal could be produced. Among the methods, oven drying produced the highest blood meal yield. The blood meal produced by the conventional method had significantly ($p < 0.05$) higher N, P, K, S, pH, and EC and significantly lower organic matter while the blood meal produced by the oven drying method contained significantly ($p < 0.05$) higher secondary nutrients (Ca and Mg), micronutrients (Fe, Cu, and Mn) and heavy metals (Cr, Pb, Cd, and Ni). The amount of available N and K increased with increasing doses of blood meal incubation and the incubation at the rate of 5 t/ha produced the highest N mineralization provided that P availability decreased over time. This study evidently suggests that blood meal can be used as an organic source of nitrogen and the application of blood meal has manifold benefits.

Keywords: Cattle blood, organic manure, blood meal, nutritional value, mineralization

**GEOSPATIAL MAPPING APPROACH AND EVALUATION OF IRRIGATION
WATER QUALITY INDEX (IWQI) IN DACOPE UPAZILA, KHULNA,
BANGLADESH**

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Abstract

Irrigation water of standard quality and quantity is critical for sustainable agriculture. The coastal area in Bangladesh covers 32% of its net cultivable land which faces inundation by tidal floods throughout the monsoon period, flooding by saline water, and saline groundwater rises or shifts laterally during the post-monsoon period, developing varying degrees of soil salinity. Surface water irrigation in the post-monsoon brings high sodium percentage to the soil. As a consequence, salinity hazards decline in irrigation water quality which restricts the normal crop production in coastal Bangladesh. Seemingly, the quality of irrigation water requires to be monitored over the year for successful agricultural productions. The purpose of the study is to assess the geospatial variations of the water quality index (WQI) to identify its suitability for irrigation purposes. A total of 100 water samples were collected, which is used for irrigation in Dacopeupazila, Khulna, Bangladesh. The water samples were analyzed for pH, EC, Na⁺, K⁺, Ca²⁺, Mg²⁺, B, Cl⁻, HCO₃⁻, NO₃⁻, and SO₄²⁻. These data were used for calculating hardness, alkalinity, Na%, SAR, RSC, PI, KR, MAR, PS, NPI, B and IWQI for a better understanding of the suitability of irrigation water. A spatial distribution map for each calculated index was produced using GIS through the inverse interpolation technique (IDW). Results indicated that about 1% of the studied water samples were in Low Restriction (LR), 15% Moderate Restriction (MR), 52% High Restriction (HR), and 32% Severe Restriction (SR) categories based on IWQI values. LR suggests for irrigation in light texture or moderate permeable soils, MR for moderate to high permeable soils, HR for high permeable soils without compact layers, and SR suggests should avoid for irrigation. The findings of the research will help the farmers to choose the crops for cultivation without hindering production due to irrigation water quality.

Keywords: Salinity, IWQI, Irrigation, Suitability, GIS

**PHYTOEXTRACTION OF SOIL SALINITY USING LEGUMINOUS DHAINCHA
(*Sesbania spp.*) PLANT**

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Abstract

Salinity is one of the rising problems causing tremendous yield losses in many regions of the world. The most important prerequisites to solve this problem is the reclamation of saline soil. This study was conducted to investigate the phytoextraction capability of leguminous dhaincha plant from saline soil. Dhaincha is a significant green manuring crop with a long historical importance which can grow in soil with an EC up to 10 dS/m. Three fields of varying degrees of salinity (non-saline soil, 1.36 dS/m; slightly saline soil, 3.91 dS/m; and saline soil, 6.89 dS/m) were selected to conduct the study. Each field was divided into bare land and land with dhaincha plant. Dhaincha plant was grown for 90 days after seed sowing (DAS). After harvest, in saline and slightly saline soil, EC of the land with dhaincha was reduced to 2.35 dS/m and 1.58 dS/m, respectively; exchangeable sodium was reduced to 937.5 ppm from 1562.5 ppm and to 468.75 ppm from 781.25 ppm, respectively. Amount of chloride ion at 90 DAS was reduced in saline and slightly saline soil and remained same in non-saline soil. SAR, ESP and sodium removal efficiency (RSE) was also calculated to estimate the salinity level and at 90 DAS, SAR and ESP in slightly saline soil reduced to 9.14 from 14.686 and to 14.82 from 31.19, respectively which indicate the transformation of slightly saline soil to non-saline soil. At the same time, SAR and ESP in saline soil were also reduced as compared to initial soil but it was transformed to sodic soil from saline-sodic soil. RSE by dhaincha plant was higher at 90 DAS than 45 DAS in both saline and slightly saline soils. Based on soil salinity removal efficiency, dhaincha performed better in slightly saline soil than that of saline soil.

Keywords: Problem soil, Soil salinity, Phytoremediation, Reclamation

**INVESTIGATION OF ANTIOXIDANT, ANTI-INFLAMMATORY,
ANTIHYPERGLYCEMIC, NEUROPHARMACOLOGICAL AND
ANTIMICROBIAL EFFECTS OF *Citrus macroptera* LEAVES- A RARE PLANT
FROM SYLHET, BANGLADESH WITH *in silico* ANALYSIS**

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Abstract

Citrus macroptera is an important plant from 'Rutaceae' family having many important uses in traditional medicine. This work was conducted on leaves of this plant to investigate its medicinal importance considering its local uses in a scientific process. Phytochemical investigation revealed the presence of different important secondary metabolites. In the TLC-based qualitative antioxidant assay using DPPH, the antioxidant active compounds of extract showed yellow spots. In the quantitative antioxidant activity, the extract showed positive activity in DPPH and hydrogen peroxide radical scavenging assays ($SC_{50} \sim 129.36$ and $176.38 \mu\text{g/ml}$, respectively) and also it showed FeCl_3 power assay ($RC_{50} \sim 41.49 \mu\text{g/ml}$). The total content of phenolic, flavonoid, tannin and antioxidants were 114.65 mg GAE/gm , 335.8 mg QE/gm , 48.684 mg GAE/mg and 173.84 mg AAE/gm of dried plant extract, respectively. In HPLC analysis, the *C. macroptera* extract revealed the presence of 8 polyphenolic compounds after conducting the HPLC spectrum with 16 standards. This extract significantly reduced the elevated blood glucose level in the oral glucose tolerance test and alloxan-induced diabetic test. In the acetic acid induced- writhing and tail immersion tests, this extract showed peripheral (40.75% and 66.7%) and central analgesic activity (28.83% and 41.52%) at 250 and 500 mg/kg doses, respectively. This extract also showed good anti-inflammatory effect in the formalin induced paw edema model by reducing the swelling. In Brewer's yeast induced pyrexia model, *C. macroptera* extract significantly reduced the elevated body temperature of mice. In evaluating the neuropharmacological behavior in open field model, this extract showed CNS depressive effect. However, this extract did not show promising antimicrobial effect in disk diffusion assay. Although it showed some retardation of bacterial growth for 2 gram negative and 2 gram positive bacteria, it failed to show any antifungal effect for *C. albicans*. In the *in silico* study, some of the reported compounds of this plant showed good binding affinities with the selected proteins.

Keywords: *C. macroptera*, HPLC analysis, Antioxidant, Pharmacological, *In silico* analysis

**ECO-FRIENDLY DISPOSAL OF ARSENIC CONTAINING SLUDGE (JAPAN)
USED FOR WATER TREATMENT PLANT**

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Abstract

Arsenic (As) contaminated sludge can be substantially generated from As contaminated groundwater treatment plants. Lack of proper management of this sludge can create further environmental problems due to mixing with soil and surrounding water bodies. The research was aimed to validate an eco-friendly disposal method through recycling of As sludge.

A functional adsorbent 'JaPani' developed by JDC Corporation, Japan that removes As in groundwater was used in this experiment spiked with As-salt. Concrete hollow block (CHB) was made mixing As contaminated JaPani (0%, 2%, 4% and 6%, w/w) to the total mixture of the raw materials with 3 replications. The size of the CHB was 190mm × 390mm × 90mm and the weight was ≈10kg. The CHB was cured for 21 days. The curing waste water was collected and analyzed for As. The compressive strength test was carried out by using 'YES Series Compression Testing Machine'. Elution test was performed through tank leaching for 28 days and shaking by using deionized water for 6 hours. The As concentration was measured by using Shimadzu AA-7000 atomic absorption spectrophotometer.

The artificially contaminated JaPani contained 747.99 mg/kg and 13.26 mg/kg total and available As, respectively. Arsenic in curing waste water was found above the WHO recommended value (0.01 mg/l) for drinking water up to 11th day then decreased up to 21th day and was below 0.01 mg/l. The compressive strength of CHB decreased with increasing percentage of JaPani in the mixture except for 4%. However, the results were above the standard value (12 N/mm²) for strength of CHB. Tank leaching result revealed that up to 28 days the As concentration in the tank leaching water sample was below 0.01 mg/l for all the cases. The findings confirm that the As sludge can be used for making CHB without further polluting the environment.

Keywords: Arsenic, Slurry, Recycle, Management, Environment

FUTURE OF SUNDARBANS IN THE YEARS TO COME

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Sundarbans is located at 21.9497° N, 89.1833° E in the southern fringe of Ganges delta where 60% belongs to Bangladesh and 40% to India. The wrath of global warming has resulted in gradual increase in the sea level percentage in the last 10 years. Moreover, repeated disturbances have resulted in destruction of species of plants. Hence, Governments of both countries have taken measures of afforestation. We have discussed the future of Sundarbans 10 -20 years down the line. Land use land cover (LULC) change over 45 years was studied in the Sundarbans and maximum likelihood classification was applied. Accuracy assessment was done and the results showed that the dense forest cover was maximum in 1975 and gradually decreased over the years to 2005 in an inconsistent manner. The dense forest turned to moderate and sparse which eventually turned to barren land. These barren lands were mostly located near the boundary between the forest and human settlement and were more common in the Indian part of Sundarbans than the Bangladesh part. Paradigm shift study was done to synthesize the management intervention for Sundarbans and explore issues and challenges such as over-exploitation of resources, habitat degradation, change in vegetative pattern, poaching, wild life trafficking and many others which need immediate attention. A novel remote sensing analysis was performed to show the mangrove loss caused by various cyclone events and extreme weather conditions. The Sundarbans are also under threat from inundation and subsequent wetland loss caused by increasing sea levels, determined by remote and field measurements. An attempt was made to predict the direction of future change in mangrove species growing in the Sundarbans, Bangladesh. This not only indicated future mangrove assemblages, but also potential threats to environmental conditions and ecosystem services in the area. Patterns of mangrove species assemblage changes occurring in the Sundarbans were studied to predict the direction of future change in mangrove species by the Markov model which would indicate future mangrove assemblages, as well as the implicit environmental conditions and potential threats to ecosystem services in the area.

Keywords: LULC, accuracy assessment, paradigm shift, remote sensing, mangroves, Markov model, sea level rise

MICROBIAL REMEDIATION: A PROMISING TOOL TO ENCOUNTER HEAVY METAL TOXICITY AND PESTICIDE POLLUTION

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Abstract

Heavy metals and pesticide pollution have become an inevitable part of modern industrialized environment that find their way in all types of ecosystems. Environment as well as human beings are highly affected due to their persistent nature and high toxicity as they are entering in the food chain and resulting in Biomagnification that leads to severe malfunctioning of organ systems. Therefore, various efficient physico-chemical approaches have been taken to remediate heavy metals and pesticide contamination by taking care of environmental health policies in cost-effective ways. Such an eco-friendly and economic method is Microbial Remediation where microbes like bacteria, fungus and algae are used to take away heavy metals and pesticides from contaminated soils. Bacteria like *Pseudomonas aeruginosa*, *Bacillus cereus RC-1* are able to eliminate Hg and Cr respectively whereas fungi like *Saccharomyces cerevisiae* and algae *Spirogyra sp.* can encounter Pb from contaminated soil. Apart from heavy metal remediation bacterial, fungal and algal species have potential to eradicate baneful pesticides like Cypermethrin, Oxyfluorfen, DDT and many more. Microbes remediate heavy metals by their cell wall components or by metal binding intracellular proteins and peptides such as metallothioneins and phytochelatins as well as bacterial siderophores or by blocking metal uptake by altering biochemical pathways and many more. They are also able to biodegrade pesticides to prevent biomagnification by blocking their entry into the food chain. This study summarizes the uses of different microbes in maintaining environmental sustainability along with major detoxification mechanisms of Microbial Remediation like enzymatic detoxification, active export and intra/extracellular sequestration.

Keywords: Biomagnification, Microbial Remediation, Metallothioneins, Phytochelatins, Metal binding proteins (Metallothiones)

IMPACT OF WASTEWATER BIOREMEDIATION BY MANGROVE ECOSYSTEM ON CRAB ECOPHYSIOLOGY

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Abstract

Mangroves are tidal wetlands that, despite the myriad ecosystem services they offer, are frequently subject to significant anthropogenic stresses. One of these issues is pollution from urban runoff, however certain mangroves are employed as a bioremediation method to remediate wastewater (WW). Mangrove crabs, an essential species for the ecosystem's engineers, may be harmed by this method. This study sought to ascertain the effects of wastewater on the red mangrove crab *Neosarmatium africanum* from an ecological and ecotoxicological standpoint using an experimental region with controlled wastewater releases. A 3-week caging experiment was conducted while burrow density and salt levels (used as a proxy for dispersion) were measured. In the anterior and posterior gills of *N. africanum*, haemolymph osmolarity, gill Na⁺/K⁺-ATPase (NKA) activity, and gill redox balance were measured. As the salinity around the discharged area reduced, so did the density of the burrows. Despite the fact that gill NKA activity was unaffected, the osmoregulatory capacity of crabs from the affected area was decreased. The drop-in superoxide dismutase activity is a sign that redox metabolism is changing. Though increased in the posterior gills, oxidative damage and catalase activity were unchanged in both regions. These findings suggest that wastewater release may cause osmoregulatory and redox imbalances, which may help to explain why crab density has decreased. These findings lead us to the conclusion that as crabs are essential elements in the bioremediation process, wastewater discharge needs to be closely regulated.

Keywords: Anthropogenic, bioremediation, wastewater, caging experiment.

THERMOPHILES OF MEDICINAL IMPORTANCE FROM HOT SPRINGS

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Abstract

Like other organisms, thermophiles depend on proteins to maintain normal cell function. While our protein molecules break down under intense heat, a thermophile's proteins actually work more efficiently as they grow in very hot areas. Advantage is being taken of this property to better understand a group of proteins that exist in the cell's membranes. These proteins are the targets of a large number of today's medicines. Structure determination is difficult for membrane proteins, which becomes too floppy at room temperature to form the crystals of tightly packed protein copies. At first the genetics of thermophiles are manipulated to make them overproduce a protein and experimented with different environmental conditions until they find the best ones for encouraging these protein copies to form a crystal. This can find treatment of a range of diseases. The best-known application of a thermophilic enzyme in medicine, forensics and in biological research in general is DNA polymerase, isolated from thermophilic microorganisms for use in the PCR, which is employed to clone and amplify genes for diagnostic purposes. They aren't susceptible to proteolysis. Thermophilic bacteria in Moroccan hot springs, salt marshes and desert soils have also shown some medicinal value. All isolates were Gram positive, rod-shaped, spore forming and halotolerant. Asperjinone from *Aspergillus terreus* is also used to treat breast cancer. The therapeutic potential of antitumor drugs is seriously limited by the manifestation of serious side effects and drug resistance. An invention is disclosed, where a composition of bacteriocin derived from lactic acid bacteria and a carrier can be used for inhibiting proliferation of cancerous cells. *Streptococcus thermophilus* is also used to treat skin aging, skin cancer. In this investigation, we explore various properties of thermophiles and their potential applications.

Keywords: Thermophiles, Manipulation, Halotolerant, Bacteriocin.

GREEN SYNTHESIZED NANOPARTICLE-MEDIATED WASTEWATER TREATMENT: A REVIEW

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Ensuring water security is a major global challenge. The degradation of nature by human activities has contributed to a scarcity of water resources.

Plants, bacteria, actinomycetes, algae, fungi and yeasts are used as the basis for the green synthesis of nanoparticles (NPs). These nanoparticles serve as a stabilising and reducing agent as well as being environmentally friendly, non-toxic, efficient and cost effective in comparison to traditional methods. Green synthesized nanoparticles are highly consistent and bioabsorbable, which makes them quintessential for wastewater treatment. Their capability of removing and degrading a wide range of organic pollutants from wastewater without affecting their own stability, makes them reusable and recyclable, thereby solving various water quality problems throughout the world.

Currently, very few studies have investigated the use of green synthesised NPs for wastewater treatment. This poster will provide a run-through of recent advancements in nanotechnology for effluent treatment, with a emphasis on nanobased materials such as nanometals, nanoadsorbents, nanomembranes, and photocatalysts and also provide a brief discussion of the advantages, disadvantages and critical issues involved in deploying these nanomaterials for removing hazardous materials and contaminants from water, owing to their mechanical properties, enhanced surface area, and significant chemical reactivities with low energy consumption. Further, challenges and issues related to the use of green synthesised NPs in wastewater treatment, especially technology transfer from laboratory scale to commercial applications. will also be discussed.

Keywords: wastewater; non-toxic; nanoparticles; nanotechnology; photocatalysts;

PROJECT UTHAAN: RESCUING THE INHABITANTS OF THE SINKING ISLAND OF GHORAMARA

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Abstract

Ghoramara Island (21.9133°N, 88.1297°E) in the Indian Sunderban Delta, often faces the wrath of nature in the form of cyclones like "Amphan" and "Yaas", soil erosion caused by rising groundwater levels, infrequent rainfall and lack of clean drinking water along with frequent droughts. To uplift the affected families, Enactus St. Xavier's College, Kolkata has been taking special measures. Since its inception in 2015, Enactus SXC has been working towards the upliftment of rural communities. This recent venture of Project Uthaan, launched on February 25th, 2022, aimed to generate employment for the islanders through *Spirulina* cultivation. *Spirulina* is a Filamentous *Cyanobacteria*, which is farmed with the aid of a mixture of fish water and a nutrient-rich solution. An in-house biofertilizer, curated from *bacterial consortia*, is being developed to improve the cultivability of the saline-infested coastal area and to restore the degraded farmlands. Through a collaboration with St. Xavier's College's Microbiology Department, *Spirulina* culture was developed which would help to produce and supply *Spirulina* to pharmaceutical companies to manufacture *Spirulina* tablets, having immense health benefits. The volatile weather dynamics of the island have disrupted the staple occupation pattern, resulting in immigration to states like Tamil Nadu and Kerala, for employment. Attempts to revitalise the island using horticulture methods have been futile because of lack of capital, submerged farmlands, minimal government support and increasing poverty. Currently, about 44.64% of the families earn a meager income of INR 1,500- 2,500 per month. Through Project Uthaan, the islanders would be able to grow 150–180 kg of *Spirulina* per month for INR 170-200 per kg, with the selling price ranging from INR 1,000-1,500 per kg of yield. Thus the project would achieve United Nations Sustainable Development Goals 11, 1, 8, 3, 13 and 12 (2015). The youth have limited options for education beyond the secondary level, in addition to other widespread issues such as lack of infrastructure, housing, and healthcare facilities. Project Uthaan also attempts to socially uplift the islanders by increasing their income and bettering their standard of living, while providing them with the basic necessities for a socially plausible living.

FACTORS CONTRIBUTING TO THE DEGRADATION OF CORAL REEF AND THEIR MITIGATION.Alypia Daimari^{1*}, Prof. Debjani Dutta²

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Abstract

Corals are among the richest, most distinct, and productive ecosystems on the world, but one of the most exposed and negatively affected territories as they've sustained tremendous losses due to anthropogenic disruptions and climate change stipulations. Coral reef structures are formed by huge deposits of calcium carbonate produced by hermatypic coral that lives in symbiosis with zooxanthellae. The coralmicro-biome includes dinoflagellates, viruses, fungi, archaea, and bacteria. Corals are microbially driven ecosystems that depend on the effective capture, retention, and recycling of nutrients to flourish in oligotrophic waters. They're the typical mutually salutary symbiotic organism with various symbiotic microorganisms that play important parts in keeping up holobiont wellness and ecosystem flexibility under environmental stress and also in positive feedback circles that heighten coral reef decline, with balancing effects on biogeochemical cycles and marine food webs. Ecologically, coral reefs are the feeding, breeding ground, and begetting places for numerous marine organisms. They're of three types – hard, soft, and deep- ocean corals. The extent for loss associated with the degradation of coral reef systems is economically, biologically, physically, and culturally immense. The universal dangers that bring about severe deterioration of corals are- climate change; greenhouse gases leading to coral bleaching and ocean acidification, coral diseases, and microplastics. Hence, the acclimations and mitigations that should be adopted to save the corals are- reduction andre-usage of plastics, reduction in carbon emission, and coral restoration. There's a critical need to develop a basic understanding of the complicated microbial relations within coral reefs and their task in ecosystem adaptation, and it's important to include microorganisms in reef conservation to secure a future for these unique surroundings. Researchers must do widespread investigation to assess the uses of microbial shifts for host health and coral reefprocesses.

Keywords: Coral reef, coralmicro-biome, hermatypic, algal endosymbionts, zooxanthellae, holobiont, biogeochemical cycle, carbon emission, climate change, coral conditions,micro-plastics, ocean acidification.

A FOLDING VEHICLE AND BIOMEDICAL DEVICE FOR THE ASTRONAUT

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Abstract

It is a smart portable foldable light weighted car with a digital environmental sensing laboratory and biomedical sensors to check the astronaut's health while he/she rides the car on the surface of mars. This folding smart car can be controlled through gesture, or on a button click, or by voice command, as well as it carries a full environmental studying laboratory and a biomedical sensor which constantly study the astronaut's heart rate, blood oxygen level, blood pressure, PPG and body temperature and all the reading can be observed from our Android Application. Interestingly this car will be expanded from single seater to multi-seater vehicle. It occupies very little space for storing and every part is detachable. Its digital environmental sensing laboratory can survey the weather condition, soil condition, any bio-organism's presence in the environment and its biomedical device monitors the astronaut's health at all time it can be also used on earth as an e-vehicle. All of the above comes at a cost much cheaper than any conversational space vehicle mission now known till date. Even though it can be used on earth as a normal e-vehicle which will monitor the rider's health to avoid major or minor accidents on road.

Keywords: Folding-vehicle, Cluster of Sensors, Bio-medical Sensor, Observatory App.

MANGROVE RESTORATION THROUGH ADMINISTRATION OF RESIDUAL HALOPHILES

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Abstract

To the untrained eye, mangroves might appear to be mundane lookalikes of inland forests but they have immense roles in biodiversity conservation. They provide carbon storage, breeding grounds for fish and protection against ingress of salt laden seawater during floods. Hence, mangrove growth enhancement and protection are essential measures in biodiversity conservation. In this project, we isolated two bacteria after screening six potential salt tolerant isolates. The two identified bacterial isolates [A3-*Bacillus subtilis* and A7-*Priestia sp*- NOVEL STRAIN] were found to be salt tolerant nitrogen fixers, phosphate and potassium solubilizers and de novo auxin producers. Since they were found to possess plant growth promoting properties, we went on to test their ability to enhance the growth of mangrove plants, namely *Avicennia officinalis* and *Excoecaria agallocha*. Both isolates A3 and A7 enhanced the growth of experimental setups in comparison to the control. Their combined action is currently under experimentation, after which final comments can be made. However, at the outset, both isolates have shown extremely promising mangrove growth enhancing capabilities. Hence, we propose the use of these two isolates as a biofertilizer (Trade Name- MANGROBACT) in the domain of mangrove protection.

SOUND INDUCED SCP (SINGLE CELL PROTEIN: SOUNDS GOOD!)

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Abstract

Spirulina is a cyanobacteria which is cultivated worldwide for its miraculous Nutritional quotient. It is also termed as a Superfood due to its high protein content. It also serves as a rich source of vitamins as well. In this investigation, a strategy has been devised using tools of physics , more specifically sound, to enhance the growth of Spirulina keeping in mind it's incredible potential as a good supplement. Physico-stimulant like audible sound frequency is one of the new promising for enhancing spirulina growth rate. Spirulina was cultivated at specific frequency and specific amplitude under maintained temperature and light intensity. The objective of the experiment is to study the effect of sound frequency on Spirulina. The sound frequency was fed 5 hrs for 21 days. The result showed increased in Spirulina growth by 19.7 % compared to Control Setup where no sound frequency was applied. In conclusion, the audible sound frequency enhances the growth rate of spirulina. A futuristic view point will trigger further investigation that can be done for a range of different frequencies and more efforts can be used to make the setup more feasible and cost-effective.

Key words: Spirulina, growth enhancement, sound frequency, nutrition supplement.

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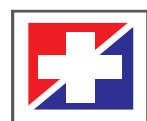
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