About the Book:- The present book "Biodiversity Conservation in North East India" incorporates articles on plant biodiversity conservations, Bamboo ecosystems, floral and faunal diversity of North East India, forest resources, diversity in vertebrate wildlife in North East India. This is a compilation of the researches done in this exciting field by scientists, researchers, educationists, NGOs and the like. This volume contains chapters covering holistic information on biodiversity and its conservation with special reference to the North East India. Chapters on medicinal plants conservation, phyto chemical screening, synthesis of antimicrobial compound of plant extracts and endangered plants of North East India have added to the value of the book. A comprehensive account of biodiversity of vascular plants and ferns is also given to throw light on the importance of preservations of vanishing species from this planet. This book will definitely serve as an excellent reference material and practical guide for teachers, research workers, students and environmentalists.

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PREFACE

Biodiversity, “the repository of life” is the variety of all the genes, species and ecosystems which are found on our planet. The term encompasses all species of plants, animals and microorganisms, their genetic material and the ecosystems of which they are part- many of which have developed over millennia of evolutionary history.

The present day lives and future generation depend on “Biological diversity.” Scientists have described about million species on Earth, which is just tip of the ice burg; and so, the total is many times more. Global biodiversity is usually divided in to three fundamental categories, i.e. genetic diversity, species diversity and ecosystem diversity. The world’s biological diversity is a vast and undervalued resource. It comprises every form of life, from the tiniest microbe to the mightiest beast and the ecosystem of which they are a part. It provides humanity with a cornucopia of goods and services, from food, energy and material to the genes which protect our crops and cure our diseases.

Human being attached to biodiversity has many different values, separated here into three categories. Biodiversity as a means to an end, as a measure of environmental quality and as an end itself. The categories of value not only provide a variety of justifications for conserving biodiversity but they also suggest because of their distinct emphasis, that different component of species diversity may be more essential depending on which values are paramount. This component include species richness, heterogeneity and evenness, hence these three are the indices to measure biodiversity of an area.

Areas where high levels of species richness, threat and endemism coincide are termed as hot spots. There are 25 recognized hot spots in the world. These areas contain about 133,149 plant species (44% of the world)

and 9645 vertebrate species in 2.1 million square kilometers or 1.4% of the world land area. These hot spots also harbor many rare species. Any threat to these areas is more likely to result in species extinction.

India is the seventh largest country in the world with an area of 3287263 square kms and with a population of more than 1.21 billion as on 31st March 2011. India is one of the 12 mega diversity countries and has two biodiversity rich centres viz. Eastern Himalayas and Western ghats. India harbours over 125000 scientifically described and over 400000 undercribed species with substantial intraspecific genetic variations spread over its 3287 million hectres of land mass and 200 million hectres of excessive zone. There are 16 major types recognized in the Indian region and sub divided into 121 minor types. According to forest survey of India, the forest cover of India is about 19.27%, of this only a small fraction of about 4.5% is protected in the form of sanctuaries and national parks. India has 448 sanctuaries and 85 national parks, with an area of 112537.86 and 36171.80 square kilometers respectively. 7% of the world mangrove forests are also found in India.

The present book "Biodiversity Conservation in North East India" incorporates article on plant biodiversity conservation, medicinal plant diversity of Assam, diversity in wet land and forest ecosystems, plant resources of North-East India etc. This volume contains 18 chapters covering holistic information on biodiversity and its conservation with special reference to North-East India. Chapters on medicinal plants and their conservation, *invitro* micro propagation of ferns, extraction and analysis of alkaloids from medicinal plants, conservation of Dolphins, Hoolock Gibbons etc have added to the value of the book.

We are highly thankful to contributors for writing authoritative, thought provoking, informative and research articles for this volume. While dealing with such a voluminous work, errors are likely to occur despite our

best efforts; however the onus of technical contents rests with the contributors.

We wish to thank our family members for endurance during the compilation work of the text. We appreciate the cooperation and support of our friends and well wishers.

We are very thankful to LAP LAMBERT Academic Publishing GmbH & Co. KG Dudweiler Landstr. 99, 66123 Saarbrücken, Germany for publishing this book with patience, care and interest. We are confident that the book will be widely accepted by the students, teachers, scientists and researchers in the field of Botany, Zoology, Microbiology, Biotechnology and Environmental Sciences.

Taj Uddin Khan

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BIODIVERSITY CONSERVATION AND ITS FUTURE SCENARIO

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PROLOGUE

The CBD defines "Biological diversity" as the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. But in simple laical terms, "biological diversity" is broadly defined as the diversity of life on earth. Although the abbreviated term "biodiversity" was scarcely known prior to 1988, today it is ubiquitous-a popular, trendy phrase used by policy makers, citizens and mass media worldwide.

The Biodiversity: global dimension & crisis

The magnitude and pace of the current "extinction crisis" in biological diversity is unprecedented.

- To date, 1.4 million life forms have been named and described by science.
- Biologists estimate that there are at least 5 million, but perhaps as many as 50 million species existing today (McNeely *et al* 1990).
- At present, probably less than 5% of biological diversity is known to science (McNeely *et al* 1990).
- It is estimated that between 15,000 and 20,000 unknown species of flowering plants, exists only in tropics.
- Loss of diversity in plant genetic resources for food and agriculture has been substantial, and these resources are disappearing at an

unprecedented rate. No one knows how much diversity once existed in domesticated species, so it is not possible to say exactly how much has been lost historically.

- It is estimated that tropical forests alone support some 30 million insect species (Wilson 1990).
- It is estimated that between 50 – 100 species are being driven to extinction per day (Myers 1886 ;Wilson 1990)
- Tropical forests are falling at a rate of just under 1% per annum, or 29 hectares Per minute (CGIAR 1996)from 1980 to 1990, the loss was equivalent to an area the size of Ecuador andPeru combined i.e. 15, 20,114 sq. kms.
- Domestic animal breeds are disappearing at an annual rate of 5% or 6 breeds per month (FAO 1995). According to FAO, the status of almost one-third of all livestock breeds is endangered or critical.
- All of the world's main fishing grounds are being fished at or beyond their limits. About 70% of the world's conventional marine species are fully exploited, recovering from overfishing (FAO 1995).
- During the 20^{th} century, about 980 fish species became threatened (CGIAR 1998).
- Nearly 60% of the earth's coral reefs are threatened by human activity (Bryant & Burke 1998).
- According to a conservative estimate about 34,000 species of plants or 12.5% of the world's flora are facing extinction. At least one in every 8 known plants species on earth is threatened (Walter & Gillett 1997).
- For every plant that becomes extinct, 30 other species go with it-many of them are microorganisms.
- Loss of biodiversity threatens food security, especially for the poor, who rely on biological products for 80-90% of their livelihood needs

(i.e. food, medicine, fuel, fibre, clothing, shelter, energy, transportation, etc.).

- Biodiversity also have a role to play in the increasing threat to biological ware fare i.e. biodiversity is also strategically important for a century.

Biodiversity—value and measures

Humans attach to biodiversity many different values, separated here into three categories: biodiversity as a means to an end, as a measure of environmental quality, and as an end it itself.

In the first category, biodiversity is valued for its contribution to the sustainable production of goods and service. The discovery of new medicines is oft-cited example. Fransworth (1988) listed more tan 100 pure chemical substances extracted from plants and used worldwide for medicine. This category of values is, however, almost always very narrowly defined and does not include the subsistence value i.e. value of biodiversity to local human population that are consumed outside of a market economy. This is the root cause of conflict in all the biodiversity related programmes throughout the world.

The biodiversity provides useful services and supplies many amenities and commodities not only medicines and coping useful chemicals to synthetic ones, but food, wood products, natural fibres, natural dyes, recreation opportunities, aesthetic benefits, ecological filtering and many more. If the goal of biodiversity conservation is to keep intact the diverse service and the supply base in order to keep these goods and services flowing then clearly biodiversity is valued instrumentally as a means to this end.

Predicting the chemical and economic potential of a particular species is, of course, difficult. It is unlikely that every plant, animal or microbe will yield new products beneficial to humans. The implicit assumption in

arguments for saving biodiversity based on commodity production, than is that our lack of knowledge about the number of species, their potential uses, and the future economic value of those uses justifies preserving as many different species we can.

In the second category of values, biodiversity serves as an early warning system by indicating environmental damage. Biological indicators are organisms so closely tied to certain environmental conditions that their presence indicates the existence of those conditions. Pollution studies have used a wide range of organisms, from lichens to aquatic fly larvae to honey-bees, field mice and shrews, for biological monitoring. By allowing us assess pollution levels of environmentalist it becomes uninhabitable for all life, these indicators are like the proverbial canary in a coal mine. Moreover, there is a sense that biodiversity, in and of itself, may indicate a desirable environment. In other words, high biodiversity reflects a diversity of ecological options, the result of abundant opportunities for different organisms to acquire and use resources. As long as biodiversity is maintained, we have evidence that these opportunities are still available in our environment.

While conservation arguments based on its contributions to a better life for mankind are compelling, biodiversity is increasingly valued not for what it is this is the third category of biodiversity values. Whether the impetus is moral, religious, philosophical or historical, many view biodiversity as an end in itself, quite apart from the instrumental uses it may have in making human lives better. Philosophers and environmental ethicists ascribe “intrinsic valued” to entities that are valued as ends in them, rather than as the means to some other purpose. Unlike its value as a means to an end, the intrinsic value of a species is presumed to be to equal to that of many other species. The same is true for species value as part of our natural history.

The three categories of value not only provide a variety of justifications for conserving biodiversity but they also suggest, because of their distinct emphasis, that different components of species diversity may be more essential depending on which values are paramount. These components include species richness, heterogeneity, and evenness—hence these three are the indices to measure biodiversity of an area.

While assessing values we must keep in mind that not all of biodiversity can be valued materially or otherwise. Material value will not be found for many species, even in the distant future. Indirectly, countless "useless" species benefit humanities through their role in the web of ecological interdependences. Therefore, keeping the options open for future value addition to biodiversity, the BCSP (Biodiversity Conservation Strategy Programme) defined its guiding motto: "Understand it, defined it, and Use it widely and equitably".

Biodiversity-is our perception holistic?

Despite heightened appreciation and awareness of biodiversity during the final decade of the last century it is commonly perceived only as an environmental issue. Our mindsets have been oriented to accentuate biodiversity in terms of its ecological functions, including the maintenance and protection of watersheds and soils, the regulation of climate, habitats and so on. As a consequence our activities and programmes on biodiversity have been preoccupied from the viewpoint of environment and conservation. These tendencies provide boundaries of our thoughts to view biodiversity dispassionately. Individualistic or disciplinal mindsets inevitably narrowing down the full range of importance of biodiversity to humanity. This is not a problem *per se*, yet it can become one when narrowed mindsets constrain thinking about different aspects of biodiversity and relevant issues and problems associated with it.

Popular, but yet to be appreciated, biodiversity plays a profound role in our daily lives. In fact biodiversity is a function of both natural and social systems; it utilization and conservation involve interactions between species, populations, communities, landscape, and natural ecosystems, on the one hand, and culture, technology, indigenous knowledge, and commercialization on the other. Regions characterized by diverse ethnic groups with cultural diversity have been developed on par with the high level of biodiversity found in the regions. This is discernable in culturally rich parts of the world. In other words we can say that regions with rich cultural diversity are rich in biodiversity also and *vice versa.* The essential and long –standing relationships that humans have with biodiversity embrace cultural identity, spirituality, and subsistence practices that sustain communities and frequently contribute to the maintenance of biodiversity.

Human aspects of biodiversity

The human aspect of biodiversity is not confined to its ecological functions alone. Undoubtedly ecological functions have the highest social and economic priorities in terms of maintenance and protection of water and soil, regulation of climate and habitat.

But from a social or economic perspective, the subsistence values of biodiversity is also an important aspects, which has been either overlooked or received least attention from academic and applied research and in policy decisions. Subsistence values of biodiversity include provisions of foods, fibres, medicines and other products that are consumed outside of a market economy by the local communities. The subsistence uses of biodiversity plays almost no rule in the industrialized countries today, but large segments of the population in developing and undeveloped countries are dependent upon local biological resources for securing their survival.

The third aspect of biodiversity is the commercial value. It includes extractive products sold in local and regional markets, export goods such as resins, dyes, rattan and timber, and genetic resources used in agricultural and forestry crops. In facts, commercial value of biodiversity is almost always narrowly defined and does not take account of the importance of the extractive economy. The value of extractive products sold on local and regional markets play an important role in securing the livelihood of millions of local people. Even the commercial value of biodiversity are often reduced to a narrow range of goods by referring exclusively to their value in international market.

In assessing the economic values of biodiversity it is essential to analyze the full range of socio-economic aspects and widen the priorities ranging from ecological functions, subsistence uses and commercialization of biological diversity. In other words, a change in our perception about biodiversity is an absolute necessary to derive benefit out of it.

Biodiversity in N.E. India: an Overview

India with a total geographical area of 329 million hectares is a store house and treasure store of rich biological diversity both floral and faunal. The vast geographical area from Cape Comorin to Kashmir and Arunachal Pradesh to Punjab has a varied topography from the seas sweeping through the central plateaus and high lands and raising to the peaks of the Himalayas with varying temperature, humidity, rainfall, vegetation and consequent rich biodiversity. There are more than 45,000 plant species with about 7,000 endemics and 75,000 animal species found in this region. Hence, India is recognized as one of the "earth's biologically wealthiest nations" in the world. There are two biodiversity rich areas in India, termed as "Hot-spots"—the Western Ghats and the Eastern Himalayas.

The North-East Indian region of our country spread over 2, 62,179 sq. kms.encompasses eight states viz., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. These states fall under two well recognized biogeographic zones of India—The Eastern Himalayas (Arunachal Pradesh and Sikkim) and the Assam (all other states of N.E. region). The entire terrain in this region is predominantly hilly and mountainous starting from the plains with humid tropical conditions (river basin of the great Brahmaputra River) rising upto about 8000 m elevation in the Eastern Himalayas with temperate climate and snow covered peaks. The region experiences heavy to moderate rainfall, high humidity and cold winter. There are number of rivers and rivulets traversing through innumerable hill ranges treading through the rugged terrain, steep hills, valleys of the region—the Brahmaputra and Barak. All these factors have influenced the physiography and climate of the region (Table 1).

Table-1: Physiography and climate of N.E. Region

State	area(km^2) Sq.km	Forest cover%	Forest cover(m)	Range ofaltitude	Max. Annual rainfall	Term(^{0}C) Min/Max	Climate (mm)
Arunachal Pradesh	83743	68.847	61.54	146-7089	2000-4000	-20-28	Tropical to alpine
Assam	78438	23.688	39.15	42-1736	800-3000	6-36	Tropical to subtropical
Manipur	22327	17.384	67.87	205-2995	1400-4000	5-28	Tropical to

							temperate
Meghalaya	22429	15.633	42.34	90-1961	2000-12000	10-30	Tropical to temperate
Mizoram	21081	18.338	75.59	330-2140	2000-3200	12-30	Subtropical to temperate
Nagaland	6579	14.164	52.04	170-3100	1050-2000	3-27	Tropical to temperate
Sikkim	7096	3.118	37.34	200-9330	1200-6000	-04-23.3	Tropical to alpine
Tripura	10486	5.745	60.01	63-783	1200-2800	10-34	Tropical to subtropica
Total	2,62,179	1,66,917					

Such a diverse situation has favored the occurrence of varied vegetional types with rich flora and fauna. Further, the region also represents the transition zone between the Indian, Indo-Malayan, Indo-Chinese biogeographic gateway and meeting place of biotic elements of all these zones.

It is significant to note that out of nine important vegetational type of India, six of them are found in northeast region only. However, Champion & Seth (1968) classified as much as 51 distinct forest types in this region.

According to Forest Survey of India Report 1999 out of 2, 62,179 sq. kms area 1, 66,917 sq. kms area is covered by forest in N.E. region which accounts for 62.55% of the total geographical area as against the national average of 19.5% (Table 2)

Table-2: Change in forest cover in N.E. region (in Sq.km.)

State	Assessment			Total Change	
	1993	1995	1997	1999	
Arunachal Pradesh	68,661	68,621	68,602	68,847	+ 186
Assam	24,508	24,061	23,824	23,688	-840
Manipur	17,621	17,558	17,418	7,384	-237
Meghalaya	15,769	15,714	15,657	5,633	-136
Mizoram	18,697	18,576	18,775	18,338	-359
Nagaland	14,348	14,291	14,221	14,164	-184
Sikkim	--	--	--	3,118	--
Tripura	5,5386	5,538	5,546	5,746	+208
Net Change	--	--	--	--	-278

Biodiversity in Northeast India—a profile

- Out of 15,000 species of flowering plants in India 8,000 species are found in N.E. region only, which accounts for about 53%of total flora of our country.
- The region harbours 40 out of 64 species of Gymnosperms and 500 out of 1012 of Pteridophytes known in India.
- Distribution pattern of number of species of flowering plants in each state of N.E. India reveals that Arunachal Pradesh with about 5,000 species, followed by Sikkim with ±4,500 species, Meghalaya with ±3,500 species, Assam with ±3,010 species, Manipur with ±2,200 species and Tripura ±1,600 species respectively (Table 3).

Table-3: Distribution of species of flowering plants in each state of N.E. Region

State	Geographical Area (Sq.kms)	Population (Human)	No. of flowering plant species Recorded	Forest cover(%)
Arunachal Pradesh	83,743	8, 64,558	5000	61.54
Assam	78,438	22,294,562	3010	39.15
Manipur	22,327	1,826,114	2500	67.87
Meghalaya	22,429	1,760,626	3500	42.34
Mizoram	21,081	686,217	2,200	75.59

Nagaland	16,579	1,215,573	2,250	52.04
Sikkim	7,096	4,03,612	4,500	37.34
Tripura	10,486	2,744,827	1,600	60.01

- The region also experiences high concentration of some specific groups of plants; 500 out of 1145 species of Orchids; 80 out of 90 species of ***Rhododendrons***; 25 Canes out of 56 species; 95 out of 135 species of bamboos known in India.
- For many groups like ***Solanum, Zingibers, Aroids, Dioscorea,*** etc we are yet to assess their diversity, but definitely have rich diversity.
- This region is considered as one of the centre of origin of rice and citrus and secondary origin of maize; this region has more than 8,000 of rice and 15 of maize cultivers/land races; about 17 species and 52 varities with 7 natural hybrids of ***Citrus*** are available in this region.
- The genetic diversity of 132 species of wild relatives of cultivated crop like ***Prunus, Pyrus, Musa, Cucurbits, Brinjals, Legumes, Tea*** and many other grown in this region.
- Out of 3,000 species of medicinal plant known to occur in India about 2500 are recorded from N.E. India.
- Out of about 1,500 species of plants used in different systems of traditional medicine in India viz., Ayurveda, Siddha, Unani, Amchi,etc. more than 800 species are found in N.E. India.
- Out of 700 species known for their in modern medicinal systems in India viz., Allopathic, Homeopathic, etc. more than 300 species are found in N.E. India.
- Ethnic groups of N.E. India known to use about 4,500 (as against 7500 species in India) species for medicine in their indigenous systems; 2000 species(as against 3900 species in India) as edible

plants; about 250 species for fibre and cordage (as against 525species in India); about 400 species (as against 700 species in India) for material culture; about 200 species (as against 400 species in India) for fodder; about 200 species (as against 300 species in India) as pesticides, piscicides, etc; about 150 species (as against 300 species in India) for gum, resin & dye, an about 50 species (as against 100 species in India) for incense and perfume.

- In India at present 550 species are commonly employed in commercial preparation of about2000 herbal formulations; of these about 300 species are known to occur in N.E. region.
- Over 200 species of pants occurring in N.E. region are in the list of medicinal plants exported or offered for exported by Indian herbal exporters.
- Of 10 top medicinal plants required in bulk quantities (>10,000 matric tones) in ISM annually, seven species viz., ***Tinospora cordifolia*** (Saguni lota), ***Emblica officinalis*** (Amlokhi), ***Asparagus racemosus*** (Satmul), ***Centella asiatica*** (Manimuni), ***Terminalia chebula*** (Silikha), ***Andrographis paniculata*** (Kalamegh) and ***Withania somnifera*** (Ashwagandha) are occurring quite abundantly in N.E. region.
- Out of 700 endemic species of plants in India about 3000 alone are found in this region (Table 4).

Table -4: list of some important and unique plants of North East India

Species	**Family**	**Status**	**State**	**Remarks**
Nepenthes khasiana	Nepenthaceae	Endemic	Meghalaya	Insectivorous
Balanophora dioica	Balamophoraceae	Rare	Meghalaya	Parasite
Mirastemon yamamoti	Rafflessiaceae	Endemic	Meghalaya	Parasite

Amentotaxus assamica	Taxaceae	Endemic	Arunachal	Tree
Panax pseudoginseng	Araliaceae	Endemic	Arunachal	Medicinal herb
Sapria himalayana	Rafflessiaceae	Rare, Endemic	Arunachal	Root, parasite herb
Helwingia himalaica	Helwingiaceae	Rare	E. Himalaya	Shrub
Paphiopedilum insignis	Orchidaceae	Rare	Mizoram	Ladies slipper orchid
P. venustum	Orchidaceae	Rare	Meghalaya	Ladies slipper orchid
Elaeocarpus ganitus	Elacocarpaceae	Religious	Assam, Arunachal	Rudraksh
Platycerium alcicorne	Platyceraceae	Rare	Manipur	Staghorn fern
Ixonanthus khasianus	Ixnanthaceae	Rare	Meghalaya , Arunachal	Tree
Plectocomia assamica	Arecaceae	Rare	Arunachal	Giant cane
Gastrodia exilis	Orchidaceae	Rare	Meghalaya	Saprophytic
Podophyllum hexandrum	Podophyllaceae	Rare	Arunachal	Medicinal herb
Coptis teeta	Ranunculaceae	Endemic	Arunachal	Medicinal herb
Livistonia jenkinsiana	Arecaceae	Rare	Arunachal, Nagaland	Palm
Renanthera imschootiana	Orchidaceae	Rare	Nagaland	Red Venda
Dischidia rafflesiana	Dischidiaceae	Rare	Arunachal	Pitcher leaved
Cymbidium macrorhizon	Orchidaceae	Rare	Arunachal	Saprophytic

Etracentron sinensis	Tetracentraceae	Rare	Arunachal	Herb
Boschniakia himalaica	Orobanchaceae	Rare	Arunachal	Root parasite
Panax sikkimensis	Araliaceae	Rare	Arunachal	Medicinal herb
Edgeworthia gardeneri	Thymaeliaceae	Rare	Arunachal	Currency paper
Albizia arunachalensis	Mimosaceae	Endemic	Arunachal	Tree
Monotropa unifolia	Monotropaceae	Rare	Arunachal, Meghalaya	Saprophytic
Illicium griffithii	Illiciaceae	Rare	Arunachal, Nagaland	Star anise
Gnetum gnemon	Gnetaceae	Rare	Nagaland, Assam, Arunachal	Gymnosperm
Epipogon sessanum	Orchidaceae	Endemic	Arunachal	Saprophyte
Psilotum nudum	Plitosaceae	Rare	Arunachal	Fern
Sassaurea obvellata	Asteraceae	Rare	Arunachal	Brahma kamal
Rhododendron tawangensis	Ericaceae	Endemic	Arunachal	Tree
Vanda coerulea	Orchidaceae	Endemic	Meghalaya, Nagaland	Blue Vanda
Stylidium kunthii	Stylidiaceae	Endemic	Meghalaya	Herb
Meconopsis betonicifolia	Papaveraceae	Rare	Arunachal	Yellow poppy

This region is abounding with a number of primitive flowering plants and as such this region is considered as a cradle of flowering plants (Table 5).

Table-5: Name of the dominant families with number of species in N.E. Region in comparison to India and world

Sl. No.	Name of family	N.E. Region Genus/Species	India Genus/Species	world Genus/Species
1.	Poaceae	160/1500	240/1100	620/10000
2.	Orchidaceae	145/825	167/1200	760/20000
3.	Fabaceae	50/200	100/750	482/12000
4.	Caesalpiniaceae	11/42	23/801	52/2800
5.	Mimosaceae	10/35	15/75	56/2800
6.	Asteraceae	25/70	137/75	900/13000
7.	Cyperaceae	14/175	21/350	90/4000
8.	Lamiaceae	30/95	65/380	80/3500
9.	Scrophulariaceae	15/35	60/350	220/3000
10.	Acanthaceae	25/125	70/340	250/25000
11.	Euphorbiaceae	55/160	65/340	300/5000
12.	Rubiaceae	50/170	80/280	500/6000
13.	Urticaceae	15/45	25/114	45/550
14.	Zingiberaceae	18/73	20/115	46/850

What about faunal diversity in N.E. region?

- The animals comprising a total of 11 order, 21 families, 86 genera, 148 species and 186 sub-species has been reported from this region (BHCP, 1993).
- About 50% of the mammalian species are endemic to this region (SAARC 1992).

- Out of 16 species of primates found in India, 11 species have been reported from this region.
- Out of 71 species of birds which are globally threatened and found in India as high as 55 species are found in N.E. India (Bhattacherjee 1996).
- Of the 36 feline species found the world over, India alone has 15 species and within India N.E. region have a representation of 9 cat species. Out of which 3 species viz., clouded leopard, marble cat and golden cat are endemic to this region.

Biodiversity as resource-need to broaden our mindset

Biodiversity has so far remained self-limited by holding to the view it is concerned only with ecological functions or environmental issue for the most of us. An accordingly we are preoccupied in formulating and implementing conservation programmes without analyzing the full range of socio-economic benefit that can be derived from biodiversity of an area.

Biodiversity such as is useless to the common people and to talk about the conservation for ecological functions alone is probably more ridiculous to them. If it is so, than what? A need in our approach to assess the entire range of socio-economic values of biodiversity is essential. Such programs in addition to ecological functions, much give priority to the subsistence uses and new schemes of commercialization of biodiversity for the international markets (also for the national market).

Even today most of us failed to perceive biodiversity beyond an environmental issue. A shift in our attitude from elemental analysis and ecological viewpoint to what they mean to the people of the region with rich biodiversity or to the human race is required, particularly in the present regime of globalization and privatization. This rests on the

assumption that by adding value to the biodiversity and transforming it to resources through programmes committed to develop new uses for biodiversity. Such a shift in our approach to the use of biodiversity will markedly increase the flow of benefits to people in the form of new jobs, local industry, substitution for imports, and new exports, and in so doing increase the rationale for maintaining, conserving and studying biodiversity.

Why we in N.E. India fail to harvest our rich biodiversity?

Except for quantifying economic value timber trees and other major forest products have we attempt to quantify economic value of other marketable and non marketable biodiversity? Do we elicit, retrieve, document and evaluate indigenous knowledge system relating to biodiversity? The positive answers to the above led us to consider our biodiversity the boon for northeast India.

Any wealth we possess becomes resource only when we use it or benefit out of it. Otherwise, it will remain as a useless wealth for us. Like gold in possession of someone, biodiversity in N.E. region still remain as a wealth with little or no initiative to transform it into resource. We all have to shoulder the responsibility and scientists, researchers, planner, policy makers have to play the pivotal role to transform biodiversity of this region into resource just like the goldsmiths shaping the gold usable form the ornaments.

Cultural diversity, Biodiversity and IK-*tria juncta in uno* in N.E. India

- Each ethnic groups has developed its own tradition and cultures based on the resources available in their surrounding environment—Root of all knowledge.

- Cultural/religious beliefs and practices, social norms and ethnics in respect of resource management and to maintain ecological balance—social ethnics towards biodiversity.
- Selection, domestication, cultivation and breeding of useful plants through traditional cultivation—Life supports systems.
- Indigenous technologies and use of local resource (food, medicine, other material culture)—Life sustain innovations.

All these forms the IK systems of the ethnic groups of N.E. region and the part of IK relating to biodiversity—need special attention to transform biodiversity of this region into resource in the present regime of IPR,TRIP and biopiracy.

EPILOGUE

Converting unknown or little-appreciated wealth of nature into biological resources that contribute the human well-being, local community self-reliance, and environmental protection is the only option for the northeast India for "using biodiversity". This requires research and development efforts to create new uses of bioresources. All attention, therefore, must directed to the factors that make a species a resource-a resource worthy of utilization and worthy of efforts for conservation. Once a species get known as a resource in any human society, the impact of this knowledge on expansion, distribution, threat to that species, and in cases even its extinction, play great role.

Several misleading assumptions may find place to create new uses of biological resources. Most of the communities that depend on intact nature are well aware of the importance of conserving natural diversity. In fact, such communities are far superior to modern industrial societies in terms of their relationship with nature, which is based on respect and a sense of community instead of just viewing it as resource.

In the face of existing uses by rural communities the call for a revolution in "increasing biodiversity" seems woefully misplaced in N.E. India. Where local communities have not already been displaced or dispossessed, they are often involved in intense and widespread resistance against the destruction of their resource base by outside economic forces. New export products cannot compensate for the destruction of existing subsistence economics. There is not so much a need to create jobs as to preserve existing livelihood—but to channelize the human resource and common people expertise into right direction.

Without a framework that addresses local rights, recognizes traditional knowledge and supports grassroots conservation, the emphasis on 'new' use for biodiversity could actually lessen the ability of local people to protect their lands and livelihoods. We should set as its goal the documentation of existing uses of biodiversity, helping legitimize these uses and making them the basis for policy decisions on the use of biodiversity.

In conservation programmes of biological diversity, there is, of course, a place for developing new methods of utilization. Unfortunately this aspect has been largely ignored by conservationists and other agencies advocating conservation of biodiversity in N.E. India. On the other hand a close attention must be paid to the fundamental issue of "who will use it, how will they use it and who will share the benefits'.

Finally, the analysis of above aspects of biodiversity in N.E. India on multifarious and almost indefinite human aspects convince us that the aim and emphasis in our approach on biodiversity must shift from what the elements of biodiversity in this region are, to what they mean to the people of the region or to the human race in general.

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ISOLATION AND CHARACTERIZATION OF*AZOTOBACTER VINELANDII* FROM RHIZOSPHERE OF FIELD-GROWN SUGARCANE IN BARAK VALLEY, ASSAM

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INTRODUCTION

Nitrogen is one of the most essential nutrients for the growth of sugarcane. Soil of Barak Valley is poor in nitrogen. Use of chemical N fertilizer can increase sugarcane yield. But the constant use of chemical fertilizer on soil brings adverse effects on soil metabolic processes and ultimately renders the soil into a less unproductive mass. In view of the above facts, attention has been given to the use of biofertilizesr which on one hand increase fertility of the soil and on the other hand do not cause any harmful effects on soil[1]. Research on biological nitrogen fixation (BNF) has increased significantly because of its potential importance to the economy and the environment. It has been especially interesting and important to find BNF in nonlegumes like sugarcane, rice, kallar grass and maize[2,3,4]. Nitrogen-fixing bacteria of the genera *Azotobacter*, *Enterobacter*, *Bacillus*, *Klebsiella*, *Azospirillum*, *Herbaspirillum*, *Gluconacetobacter*, *Burkholderia* and *Azoarcus* have been reported in association with a wide range of grasses [5,6,7]. Nitrogen-fixing micro-organisms have been reported living in the rhizosphere and as endophytes of sugarcane cultivars. The most common bacteria isolatedfrom sugarcane tissues are *Gluconacetobacter diazotrophicus*, *Herbaspirillum rubrisubalbicans* and *H. seropedicae*[8,9]. Other micro-organisms such as *Enterobacter cloacae* and *Klebsiella oxytoca* have also been reported to be found inside sugarcane [10]. Application of biofertilizers

provides equivalent output to 30-40 kg/ha N chemical fertilizer. Evidence for biological nitrogen fixation in sugarcane (*Saccharum spp*.) was reported in Brazilian sugarcane varieties. Studies on long-term N-balance and 15N isotope dilution technique [11] also have shown that some sugarcane varieties may actually obtain up to 70% of their N requirements by nitrogen fixation **.**Theaim of the work is to study the diversity of free living nitrogen fixing bacteria in sugarcane rhizosphere of Barak Valley, Assam.

MATERIALS AND METHODOLOGY

Collection of samples – Three sugarcane fields each from Cahar, Karimganj and Hailakandi districts were sampled during the study period in three different seasons *viz,* summer, rainy and winter. Samples from the rhizosphere soil, were collected, according to Muthukumarasamy *et al* (1999) [12] for the isolation of nitrogen fixing endophytes. Soils chemical and granulometric analyses were performed as described by Soil Conservation Service (1975) [13].

Isolation and culture of nitrogen fixing diazotrophs – Isolation and culture of nitrogen fixing diazotrophs was carried out by the dilution plate method of Waskman (1961) [14]**.**10g of soil sample was added with 100ml of sterile distilled water in a conical flask and shaken on horizontal shaker to form a homogenous soil suspension. Serial dilution upto 10^{-6} was made.1 ml from 10^{-6} dilution was inoculated aseptically into three sterilized petridishes containing 20 ml of melted Burk's medium. Upon solidification, the *plates* were incubated in inverted position for three days at 25^0C.The total number of colony forming units of diazotrophs per g of soil was counted. Discreate well developed and separated selected bacterial colonies were subcultured from each Burk's agar plate. Single colonies were restreaked on Burk's agar plate for further purification.

Characterization of aerobic diazotrophs- Pure isolates of the aerobic nitrogen-fixing bacteria from rhizosphere were characterized using the criteria of Bergey's Manual of Systematic Bacteriology (1994)[15] andBergey'sManual ofDeterminative Bacteriology (1984)[16] .The following morphological, physiological and biochemical tests were used: Colony morphology, size, Gram staining, production of diffusible and non-diffusible pigments were determined on Burk's solid medium after 2 and 5 days of incubation at 30 ◦C. Motility was determined in wet mounts and flagella arrangement was assessed by the technique of Rhodes(1958)[17].Encystment was induced by the method of Socolofsky and Wyss (1961)[18]. The cyst was stained by the method of Vela and Wyss(1964) [19] .Poly-β-hydroxybutyric acid (PHB) granules were examined according to the method described by Baker(1967) [20].Utilization of glucose, rhamnose, caproate, caprylate, meso-inositol, mannitol and malonate as carbon source was assayed on Burk's basal medium with a final concentration of 0.5% (w/v) of each substance.Starch hydrolysis was tested in cultures on Burk's solid medium containing 1% (w/v) potato starch by flooding with Lugol's iodine. Growth at different pH values was assessed by absorbance measurements (540 nm) after 48 h incubation on liquid Burk's medium with the pH adjusted to 4.0, 5.0, 6.0, 7.0, 8.0 or 9.0.

Nitrogenase activity -Nitrogenase activity of the isolated diazotrophs was assessed by acetylene reduction test .Isolates from Burk's N-free media were grown, for 48 h at 30^0C. Each vial was sealed with rubber stopper and the head space (5 mL) was injected with 10% (v/v) acetylene. Gas samples (0.2 mL) were removed after 1 h and assayed for ethylene production with a gas chromatograph using a hydrogen flame ionisation detector. Ethylene contamination of the acetylene was always known and accounted for final calculations. Values were expressed as nmoles C_2H_2 h^{-1} mg^{-1}

RESULTS AND DISCUSSION

The average rainfall of 72 mm, 461 mm and 1090 mm was recorded during winter, summer and rainy season respectively. The average (maximum and minimum) air temperature ranged from 15 -23^{0}C in winter, 26-36^{0}C in summer and 24-30^{0}C in rainy season during the study period. Average relative humidity of 76.5%, 80.14% and 91% was recorded in winter; summer and rainy seasons respectively. Soil of the study site was found to be clay- loamy type with low organic carbon, nitrogen, phosphorus and potassium contents. Highest soil temperature was recorded in summer 25^{0}C, which was followed by rainy 23^{0}C and winter season 18^{0}C respectively, while highest soil pH was recorded in rainy seasons (5.62), which was followed by summer (5.61) and winter season (5.60) respectively. Highest moisture content was recorded in rainy season 74% followed by summer (44%) and winter season (40%).*Azotobacter vinelandii* was isolated from sugarcane agroecosystem soil of Barak Valley, Assam. This study is supported by that of Graciolli *et al* (1983) [21] who found *Enterobacter cloacae*, *Bacillus polymyxa*, *Azotobacter vinelandii, Erwinia herbicala* and *Klebsiella pneumoniae* associated with root and rhizosphere of sugarcane.

The nitrogenase activity of *Azotobacter vinelandii* was found 403.05 nM C_2H_2 hr^{-1} mg-^{1}protein. This finding is supported by the study of Deb Roy *et al* (2009)[22].

An attempt was made to isolate and screen the nitrogen fixing bacteria from the sugarcane rhizosphere samples collected from three different districts of Barak Valley , Assam(Cachar,Karimganj,Hailakandi). *Azotobacter vinelandii* showed nitrogenase activity of 403.05nM C_2H_2 hr^{-1} mg-^{1} protein. Fixation of nitrogen to the soil by use of *Azotobacter* culture is a natural phenomenon and sufficient research work has been carried out on the role of *Azotobacter* culture in sugarcane cultivation at sugarcane Research Station, Padegaon.

The results,in general, indicates that application of *Azotobacter* at the rate of 5 kg/ha helps in reducing nitrogen dose by 50 kg/ha with increase in cane yield by 5 to 10 percent. However, it can help in reducing nitrogen dose even up to tune of 100 kg/ha without loss in yield. Thus inoculation of local sugarcane varieties with *Azotobacter vinelandii* may increase sugarcane yeild in Barak Valley, Assam without causing anyharmful effects on soil. Thus a future study is needed to assess the contribution of *Azotobacter vinelandii*as a reliable and effectivesugarcane inoculants

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Table -1

Physical, cultural and biochemical charecteristics of Azotobacter vinelandii

Properties	**Results**
Shape	Round rod
Size	2.3 X 4.0 µm
Flagella	Petrichous
Gram stain	-
Motility	+
Encystment	+ (after addition ob butanol)
PHB granules	+
Catalase	+
Oxidase	+
NO_3^- reductase	+

H_2S Production	+
Starch hydrolysis	-
P^H requirement	Higher than 6
Rhamnose utilization	+
Melonate utilization	+

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FUTURE OF THE ENDANGERED DOLPHIN FOUND IN THE RIVER BARAK

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INTRODUCTION

Altogether thirty six species of marine dolphins and four species of river dolphins, namely *Baiji* or the Chinese River Dolphin or the Yangtze River Dolphin (*Lipotes vexillifer*), *Boto* or the Amazon River Dolphin (*Inia geoffrensis*), *Franciscana* or La Plata River Dolphin (*Pontoporia blainvillei*) and *Susu* or the Gangetic and Indus River Dolphin (*Platanista gangetica*), are found in the world. Gangetic or Ganges River Dolphin (*Platanista gangetica gangetica* Roxburgh 1801) and the Indus River Dolphin (*Platanista gangetica minor* Owen 1853) are two sub-species of the river dolphin *Platanista gangetica* Roxburgh 1801 (Rice, 1998). They are very similar in appearance (Reeves *et al*., 2002). The Indus River Dolphin is found in the Indus River system and mainly in Pakistan. The Gangetic or Ganges River Dolphin (GRD)*Platanista gangetica gangetica* Roxburgh 1801 is distributed in the Ganges-Brahmaputra-Meghna (GBM) and Karnaphuli river systems of India, Nepal and Bangladesh (Anderson 1879, Kasua & Haque 1972, Jones 1982, Mohan 1989, Reeves & Brownell 1989, Shrestha 1989, Reeves *et al.* 1993, Wakid 2005). It is the State Aquatic Animal of Assam and the National Aquatic Animal of India. River dolphin lies at the apex of food chain in the river ecosystem.

In 1950-60s, dolphins were abundant in the river Barak (Biswas, 1995). Large scale hunting of dolphins in the river Barak took place in 1970-80s (Singha, 2009). Till 1970-80s GRD was common in the river Barak and some of its tributaries; but is now a rare animal in the same. The Barak which is an integral part of the GBM river system is the largest river of Manipur and of southern Assam and the second largest river of north-east India. GRD is known to the people of the Barak Valley as *Soonse* in Hindi, *Foo Maachh* or, *Hoohn* in the local dialect of Bengali, *Susuma* in Dimasa and *Nasubi* in Manipuri. It is placed in Schedule I of Indian Wildlife (Protection) Act, 1972, categorised 'Endangered' by IUCN (World Conservation Union, formerly International Union for Conservation of Nature and natural resources) and is included in Appendix I, i.e., at the highest level of restriction on trade on the animal, its body parts, oil etc., by CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora). Thus, the dolphin is a protected animal; its killing or trade is a punishable offence. A total of about 1200–1800 animals provide a reasonable lower range for the global population of the animal (Smith & Braulik, 2008). The legal protection of the animal in India so far is "completely ineffective" (Sinha, 2002). The range of distribution and population of the dolphin are diminishing day by day.

The present paper highlights the future of the Gangetic River Dolphin in the river Barak in view of its current population, habitat condition and conservation steps taken so for. As regards published works in this field and for that matter for the dolphin in the river Barak, except a few accounts on certain aspects by the present authors- Biswas (1995), Singha (2005), Singha & Biswas (2005), Singha *et al.* (2010), Dutta *et al.* (2011), Biswas *et al.*(2011) etc., only some brief notes and remarks by Choudhury (1997), Wakid (2007) etc., are available.

MATERIALS AND METHODS

A continuous stretch of 135 km from Narain Dahr (24°43′N, 93°04′E), situated near Assam-Manipur border in the hill course of the river Barak to Tiganga (24°52′ N, 92°29′ E), the bifurcation point of the same near Indo-Bangladesh border was studied for three years 2005-2008. However, dolphin counts of some previous years and habitat condition of 2010-2011 have also been included to appreciate the changing pattern. Dolphin surveys were done in dry months (December to February) following the modified line transact method as suggested by Smith & Reeves (2000).

To assess habitat condition, altogether 5 sampling sites (*Fig. 1*) were selected: (a) Site I, Dilkhush Dahr (24°47′N, 93°02′E), a past residential dolphin spot in the hill course of the Barak; (b) Site II, Lalmati Dahr (24°50′ N, 92°52′ E), a present dolphin congregation spot; (c) Site III, Gajambarer Dahr (24°51′N, 92°46′E), a past dolphin spot; (d) Site IV, Siddheshwar Ghat (24°53′N, 92°35′E), a Ferry Ghat and a past dolphin spot and (e) Site V, Malua Dahr (24°53′ N, 92°31′ E), a past dolphin spot at a meandering part of the Barak at about 1 km upstream from its bifurcation point.

Ten physico-chemical parameters of water, namely- surface water temperature, Secchi-disc transparency, conductivity, pH, dissolved oxygen, free carbon dioxide, alkalinity, total dissolved solids, total suspended solid and total solid content were measured every month using standard methods (APHA, 1980 & Trivedy *et al*., 1987).

Ganges river dolphin is mainly a piscivorous animal (Sinha,); so relative abundance of fish was estimated every month in terms of catch per unit effort (c.p.u.e.) i.e., the average hourly fish-catch (mass in gram) due to the effort of a single person, following the method as described by Biswas (1993).

Information on the presence or sighting of dolphins, their killings, entanglement in fishing gears and mortalities etc., was collected from riverside people, boatman, fisherman and others.

RESULTS AND DISCUSSION

Till the third quarter of 20th century Ganges River Dolphin was common and could be easily sighted throughout the year almost in all *dahr* i.e. riverine pool areas, upstream and downstream of islands and at and near confluences of the Barak and its tributaries. During rainy season (June-August) the animal had also been seen in wetlands like *beels* and *anuwas* (ox-bow lakes) which were well connected to the rivers. However, in the last ten years (2000-2010), dolphins were rarely seen in most of their past strongholds in the river Barak.

During dry months (December-February), the animals were found to congregate centred on only two spots: namely, Lalmati Dahr (24°50′ N, 92°52′ E), and Niyairgram Dahr (24°47′N, 92°50′ E) that lie at meandering parts and at 14 km apart from one another. During the rainy season, dolphins from their congregation sites migrated to other places and individual or mother-calf pair or loosely knit group of dolphins were often sighted at some confluences and meanders. Dolphins returned to their residential and congregation spots when south-west monsoon receded or water level in the river went down.

Lalmati Dahr and Niyairgram Dahr were found to possess geomorphologic and hydrological complexities- channel constrictions, abrupt widening, sharp point bars, large width at sharp meandering parts, deep water, long stretch of sandy bed, multiple deep pools or *dahrs*, areas of stagnant water, strong current, large eddy counter-currentsand other eddy counter-currents of varying sizes. Chirimukh, Sonaimukh, Madhuramukh,

Jatingamukh, Katakhalmukh and Dhaleshwarimukh etc., which once served as winter congregation spots to the dolphins, were found silted with no signs of pools and counter currents, worth the names, during lean seasons. Narain Dahr, Gajambarer Dahr, Masimpur Dahr, Malua Dahr etc., resembled Lalmati Dahr and Niyairgram Dahr in many respects of width, depth, presence of convergence areas, point bars, counter-currents and pools; but dolphins had stopped congregating at those spots decades back. Thus, apart from some specific geomorphologic and hydrological features, there are other conditions that help in the shaping of dolphin habitat.

Physico-chemical conditions of water at any time at the dolphin congregation and sampling site (Lalmati Dahr) were found intermediate or at an optimum (towards the lowest or highest) of those found at the other sampling sites. At the dolphin congregation site, surface water temperature ranged from 19-27.9 °C, Secchi-disc transparency 6-56 cm, conductivity 60 - 167 $\mu S\ cm^{-1}$, pH 7.1 - 8.1, dissolved O_2 6.4 - 8.5 mg L^{-1}, free CO_2 , 3 – 8 mg L^{-1}, alkalinity 40 - 88 mg L^{-1} (as $CaCO_3$), total dissolved solids 86 – 178 mg L^{-1}, total suspended solids 60 – 798 mg L^{-1} and total solids 192 - 884 mg L^{-1}.

Among the sampling sites, the relative abundance of fish was highest with the monthly average range of 0.060 - 0.275 kg per head per fishing hour at the dolphin congregation spot (Lalmati Dahr). It decreased as one rowed up or down. For the overall river Barak, the monthly average and the seasonal average ranged 0.040 - 0.275 and 0.051 - 0.192 kg per head per fishing hour respectively. Catch per unit effort (c.p.u.e.) at the sampling sites varied from month to month and season to season. Fish abundance peaked twice in a year in the Barak – first, a low peak after a few showers of pre monsoon rains in April-May and second, a high peak in post monsoon months (October-November). Dolphins started migrating outward from their congregation area when c.p.u.e. started dipping down with the start of monsoon rains and began

reaching congregation area when c.p.u.e. started soaring up there in post monsoon months. Dolphins frequently fled away from their congregation spot when fishing pressure became heavy there.

As the dolphin congregation spot (Lalmati Dahr) is characterised by having intermediate or the optimum physico-chemical conditions and also by having the highest availability of dolphins' food-fish among the sampling sites, it is clear that certain types of geomorphologic and hydrological features, definite ranges of physico-chemical characteristics and adequate availability of food–fish - all at a time are necessary for a dolphin congregation centre. Certainly, such spots are becoming more and more difficult for the dolphins to find in the Barak.

The population of the animal was found to be decreasing; it was 14 in 1999-2000, 12 in 2001, 10 in 2003, 9 in 2005, again 9 in 2006, 8 in 2007 and again 8 in 2008-2009. Collected information on 29 dolphin mortalities in the river Barak and its tributaries, including one adult dolphin in February 1999 and two juveniles in April 2000 and November 2000 at Lalmati Dahr area, indicates that 90% of the mortalities occurred due to fishing activities. Infant dolphins suffered maximum casualties (38%) followed by sub-adults (34%) and adults (28%).

Dolphins are still hunted in the river Barak. A group of fishermen mounting on boats and using fishing nets, oars etc., chase, surround, corner and net dolphins, specially small to medium sized ones. Dolphin while chasing fish often enters into creek formed by protruded sand bars (point bars), fishermen or others take the chance and kill the animal. There is a high demand of dolphin oil (cost not less than Rs 100 for 25 mL in 2008) in the Barak Valley. Presently, it is not available at any cost. Its use chiefly as folk-medicine for a host of ailments by a section of people and to some extent as fish attractant by some fisherman encourage dolphin killing.

Dolphin spots are also equally in danger. Channel migration and erosion are active at Lalmati Dahr and Niyairgram Dahr; further erosion of about 350-450m at the loop areas of meanders may shorten the river and throw out these spots as ox-bow-lakes. Both depth and width of the river as also the number and depth of pools decreased at these spots during the study period. River development programmes also threaten the dolphins. Availability of food-fish for dolphins is also decreasing day by day. Fish catch per unit effort (c.p.u.e.) in the river Barak is less than one-third of what is found in the river Brahmaputra. During 2005-2008 in the river Barak, the seasonal average ranged 0.051-0.192 kg per head per fishing hour. In the river Brahmaputra, near Dibru-Saikhowa National Park, the range of seasonal average value was 0.144 to 0.608 kg/hr (Wakid, 2004).

Almost every year, after a few showers of pre-monsoon rains, new born dolphin calves were seen at and near the two dolphin congregation spots. Individual dolphins or mother-calf dolphin pairs from downstream (the river Kushiyara and the river Surma, the two distributaries of the Barak) were observed to move upstream in the swelling water of the Barak during monsoon months lending chances of mixing of individuals and exchange of genetic materials of different stocks.

Some of the conservation measures that have already been adopted till date include (a) Exemption of two Barak River Fisheries (No. 4 and No. 5) in dolphin congregation area from leasing out for fishery purposes, (b) Clamping of 144 Cr.P.C. at Lalmati Dahr area for restraining any form of fishing there, (c) Submission of Feasibility Report of Dolphin Sanctuary from the DFO, Cachar to the Chief Conservator of Forests, Assam and (d) Issue of order for demarcating the proposed area of Dolphin Sanctuary. But unlawful fishing activities continue unabated at various parts of the River Barak, its tributaries and other water bodies throughout the Barak Valley in general and

the dolphin spots in particular jeopardising directly or indirectly the life and security of the few surviving dolphins of the Barak

CONCLUSION:

(i) Dolphin population in the river Barak is decreasing at an alarming rate and only about 8 individuals are now surviving in the river. Direct and indirect killings of the animal are still being continued in the Barak.

(ii) Out of so many dolphin spots of past, only two are left serving as the crucially important winter congregation spots for the entire population of dolphins of the Barak. The conditions of these spots are getting deteriorated and are feared to be lost as ox-bow-lakes or otherwise due to on going erosion, siltation etc.

(iii) Conservation steps taken so far have remained only on paper.

(iv) Unless protection laws are strictly enforced, maintenance and enhancement of dolphin habitat condition are carried out, high quality conservation measures are adopted, protection of life and habitat of dolphins are included in all plan, policies and projects for river development, dolphins of the Barak are bound to disappear from the Barak in no time and for all the time to come.

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DISTRIBUTION AND STATUS OF WESTERN HOOLOCK GIBBON IN PATHERIA RESERVE FOREST OF KARIMGANJ DISTRICT, ASSAM

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INTRODUCTION

The great ape Hoolock gibbon (Hoolock hoolock) is the only ape found in India. It was wide spread through India, Bangladesh, Mayanmar, China and adjoining areas. The range of the Western Hoolock gibbon is between Brahamaputra and Salween rivers, covering parts of north-east India eastern Bangladesh, north Mayanmar (Burma) and small area of southern China (Mc Cann 1933; Groves 1922, Choudhury 1987) In India, it is confined to the northeast, where it is restricted to the South Brahamaputra river and east of Dibang river (Parson 1941, Choudhury 1987). In the fragmented habitat Hoolock gibbon face severe problems due to large scale deforestation and timber logging. Some of the tribes of north-east India kill gibbon for its meat; also its bones are used in some oriental medicine. There are some taboos, which have helped in the conservation of some species in many areas (Choudhury, 2001).

Gibbons, the brachitors depend solely on the continuity of the forest canopy. Habitat loss in the form of breaking of the continuity of forest canopy have restricted and isolated the Hoolock gibbon population to small patches (sub-populations), even within a forest.

A fair amount of published information is now available on Hoolock gibbon in Assam and other areas of India (Mc cann 1933, Tilson1979; Choudhury1987, 1990, 1991, 1996, 1998, 2000, 2003, 2006; Chetri et al 2007) and there are number of synoptic works on primates or wild life in general. Choudhury (1993) provided information on the gibbon in karbi Anglong. Mention may be made in this connection that not many work has been done on gibbon in Karimganj district of Barak Valley particularly in the reserve forests bordering Bangladesh. In this paper attempts have been made to describe the status of western hoolock gibbon in Patheria reserve forest of Karimganj district of Assam (North East India).

Study area: The work was carried out in Patheria R.F of karimganj district. Patheria reserve forest covers a geographical area of about 7647.35 hectere which marks the western border of the district forming the international border with Bangladesh running from the south to the north. Its length is about 28 miles and breadth about 7 to 8 miles. This range is predominated by semievergreen forest.

METHODOLOGY

Methodology used for studying status and distribution of gibbonA. C**ensus technique: It involves both direct and indirect method**

Direct method

(i) Line transacts (ii)Fixed point count

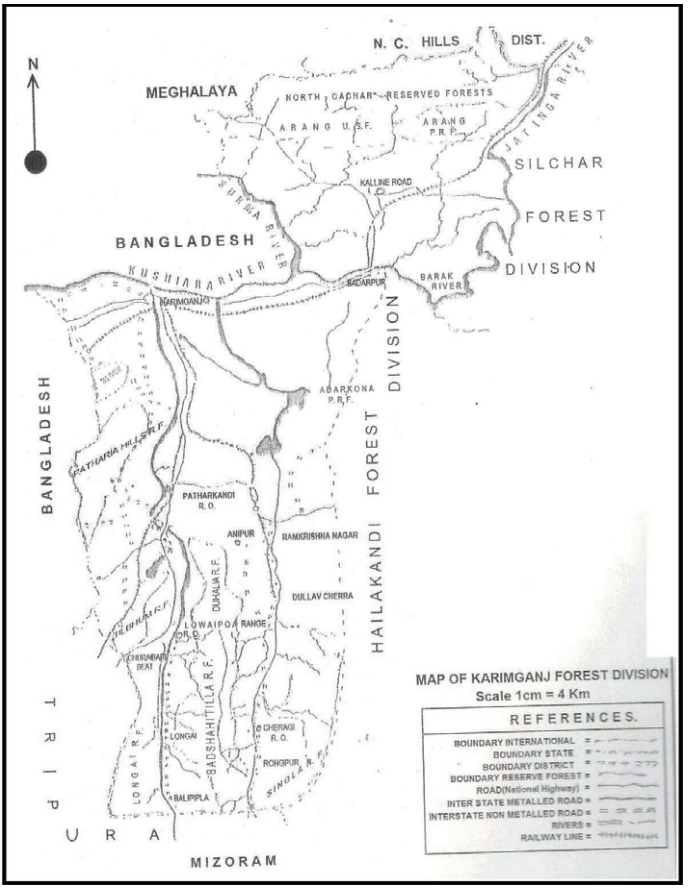
Indirect method

(ii) Gibbon call recording (ii)Auditory technique of surveying gibbon by Brockelmann and Ali (1987)

B. Threat analysis: Mainly anthropogenic threats were analyzed from both direct and indirect source

(i) **Direct source**: It includes surveying of habitat in the different gibbon habitats & observing the types of threats.

(ii) **Indirect source :**It include interviewing of local people & forest staff.



Map of Karimganj district, Assam

RESULTS

1. **Distribution of Hoolock in Patheria Reserve Forest**

(a) Census Methods: During the course of study in the patheria R.F. the presence of gibbon was ascertained by direct sighting or by hearing their calls and interviews with local forest staff, villagers and poachers using visual aids such as photos and drawings.

The data were collected during the extensive field study conducted from the period February 2010 to December 2011 in Patheria R.F. During the courseof field study number of methodswere used to obtain the actual picture. Various method includes-

1. Line transact
2. Fixed point count.
3. Gibbon call recording.
4. Auditory technique of surveying gibbon population by Brockelmann and Ali (1987)

The findings adopted following various techniques are summarized below;

1. Line transact

In this method encounter rate of gibbon is very rare and in only three occasion gibbon were observed. The transact were laid along the forest area at a distance of about 100 metre but this technique posed several problems because in the transact line there are number of terrain,water bodies,hill slopes etc (Plate- 1).

2. Fixed point count.

In the course of survey at least nine fixed points were lain in the survey area, in Patheria R.F. The points are selected on the basis of the information provided by the local people of the locality.The observing points were laid almost 200metre to 300 metre from the point of gibbon movement.Fixed point count was done on every Sunday from 5.30A.M to 2 P.M.In most of the point gibbon were found to observe moving in the forest from tree to tree in between 9 A.M to 12.30P.M.Only in two occasion photograph were possible.

3. Gibbon call recording.

Gibbon calls were recorded from twelve different location in Patheria R.F .The calls are recorded with the digital camera .The calls were of of 3-5 minute duration in many cases with few exception which excceds little more. Repeated calls were heard after 8-10 minutes and continued for 45-50 minutes at intervals. In some cases in Patheria, few groups were closer to each other and when one group started calling the other groups follow them and so on.

4. Auditory technique of surveying gibbon population byBrockelmann and Ali (1987)

It is one of the recent and reliable methods of gibbon estimation. With the help of this technique as many as six different location of gibbon occurrence were ascertained. Some of the locations as identified by call recording (3 above) was confirmed by this method.

(b) Threat Analysis

Present work reflect that fairly good number of western Hoolock gibbon are occurring in Patheria reserve forests but as per report of the local forest stuff and local people inhibiting in the nearby areas the number is declining day by day due to human interference.They are threatened towards the Indo-Bangla border. It is also reported that canopy destruction is the main cause of is decline mainly due to habitat loss. Destruction in habitat/canopy is due to some of the reasons like, a) Setting up of numbers of BSF outposts in the forest area, b) Construction of roads by the border security force along the border area within the premises of the forest in both the RFs, c) Illegal timber logging, d) Cutting of forest for timber and agriculture in the RF area (Plate-2)

Plate: 2. Timber logging in Adamtilla

During the tenure of work as many as 17 locations were identified as the habitat of western hoolock gibbon. The exact loation were recorded with the help of GPS. In the 17 different localities as many as 26 groups were identified with a total population of about 90-95 individual. In most of the groups it has been observed that the group consists of one male one female with 2-3 babies. They are mostly identified by their body colour. Some of the groups were assessed by applying auditory technique of Brokelmann and Ali (1987).The exact location of their occurrence are represented in a tabulated

form. Photographs of their habitat areas are given in Plate - 3.During the course of work presence of gibbon in their habitat & call recordings were also documented.

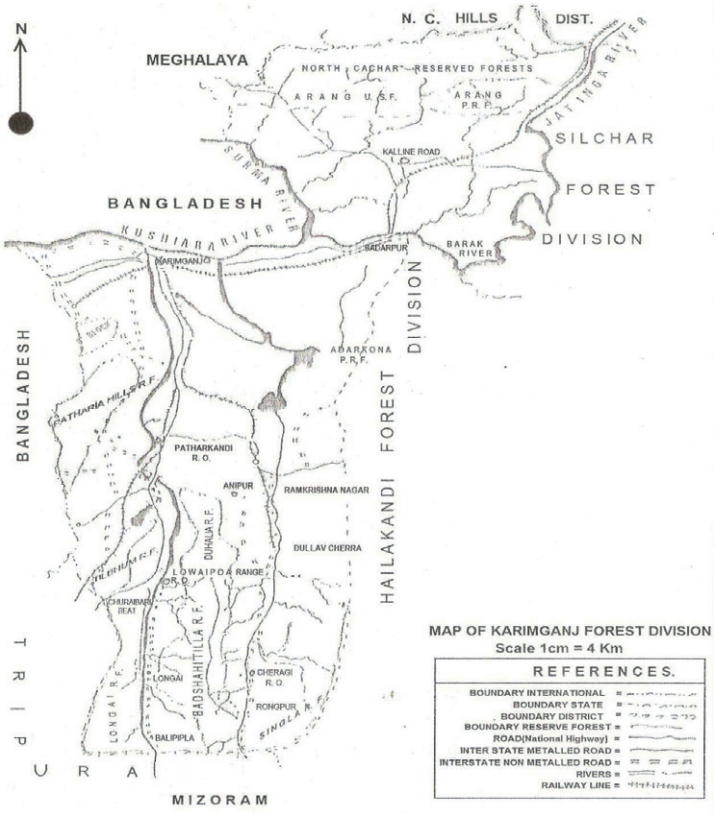
Cutting of forest for timber

Cutting of forest for agriculture

Table showing exact GPS location of Gibbon occurance in Patheria R.F

Sl no.	GPS reading	Name of R.F.	Location name
1	24° 43.160N 092°17.855E	Patharia	About 800m from Khasia Punjee,Bilbari west
2	24°43.978N 92°17.437E	Patharia	1Km from Bilbari toward west
3	24°42.429N 92°17.169E	Patharia	600m west of Bilbari-Sonatola road
4	24°41.906N 92°17.169E	Patharia	West of Bilbari towards Sonatola
5	24°41.654N 92°16.981E	Patharia	West Sonatola
6	24°39.156N 92°16.154E	Patharia	West Sonatola
7	24°39.328N 92°16.344E	Patharia	West Sonatola
8	24°37.231N 92°16.318E	Patharia	West Adamtilla towards Mohangul
9	24°37.915N	Patharia	400m west from Mukum

	92°16.117E		Tilla
10	26°36.492N 92°15.364E	Patharia	Adamtilla north – west
11	24°36.663N 92°14.534E	Patharia	West Mohangul
12	24°36.453N 92°14.376E	Patheria	300m west of Champabari
13	24°36.116N 92°14.995E	Patheria	700min the east west of Dumabari
14	24°36.654N 92°14.116E	Patheria	1Km west of Dumabari
15	24°36.372N 92°15.296E	Patheria	600m south –west of Dumabari
16	24°35.864N 92°15.921E	Patheria	800m south of Lakhipur
17	24°33.137N 92°14.117E	Patheria	1500m west of Patharkandi



Map showing distribution of Gibbon in Patheria R.F

Photographs of habitats of gibbon identified.

Habitat near Bilbari area

Habitat near Sonatola west

Habitat in west Mohangul

Habitat in west Dumabari

Call recordings in different location of Gibbon occurance in Patheria R.F.

Sl no.	GPS reading	Name of R.F.	Location name
1	24°43.978N 92°17.437E	Patharia	1Km from Bilbari toward west
2	24°42.429N 92°17.169E	Patharia	600m west of Bilbari-Sonatola road
3	24°41.906N 92°17.169E	Patharia	West of Bilbari towards Sonatola
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6	24°37.915N 92°16.117E	Patharia	400m west from Mukum Tilla
7	24°36.663N 92°14.534E	Patharia	West Mohangul
8	24°36.453N 92°14.376E	Patheria	300m west of Champabari
9	24°36.116N 92°14.995E	Patheria	700min the east west of Dumabari

10	24°36.654N 92°14.116E	Patheria	1Km west of Dumabari
11	24°36.372N 92°15.296E	Patheria	600m south –west of Dumabari
12	24°35.864N 92°15.921E	Patheria	800m south of Lakhipur

Photographs of Hoolock gibbon recorded in Patheria R.F

Photograph taken near Mukamtilla West

B Status of western hoolock gibbon in Patheria Reserve forest

The western hoolock gibbon in the above two reserve forest is endangered. The species is threatened by habitat loss, hunting for oriental medicine and human interference. Hunting for food is also an important reason for the decline of the gibbon in several region (near Khashia punjee near Bilbari).

Clearing of forest for timber & agriculture is the main factor leading to the destruction and fragmentation of gibbon habitat. Other factors include conversion of tropical forest to beetel leaf plantation and encroachment of forest land for settlement etc. Several other traditional use of forests for commercial purpose also contribute to habitat degradation, these include extracting fuel wood, extracting timber and live stock herbivory (Ashan, 1995).

In the Patheria R.F. much of the habitat is extremely fragmented; this makes hoolock gibbon particularly vulnerable to hunting & predation. Most population is very small, living in fragmented habitats and has a sharp declining trend. As per information of the local people of the area hoolock gibbon have disappeared from many pockets of Patheria R.F in recent past which may be due to their migration towards the Indo-Bangla border caused by disturbance of their habitat due to movement of B.S.F staff who are often engaged in patrolling duties within the dense forest area. On interactions withB.S.F.Personals, it has been learnt that the hoolock gibbons are occasionally seen in some forest pockets along the boundary lines of India and Bangladesh which falls under restricted area and for obvious reason public movement is restricted there.

DISCUSSION

Present work was undertaken as much work has not been done in the Barak Valley particularly in the reserve forests of karimganj district as per record.The presently the status of western Hoolock gibbon in the two forest area are fairly good, but seeing the trend of their population decline as reported by local forest staff and local people of the area, it is consider in the endanger category.The main cause behind their declining population trend as reflected from the work is mainly due to human interference in the form of

canopy destruction because of timber logging,construction of roads ,setting up of BSF out posts,clearance of forest for agriculture and silviculture(Islam and Feeroze,1992),collecting timber and firewood. Etc.

The present status is to some extent good because it has been speculated that still some close canopy structure exist and diversity of fruiting trees are perhaps the most important determinant of Hoolock gibbon population size in the site where they are present.Efforts are to be needed to conserve their habitat other wise they will not last long in this forests.

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BAMBOO RESOURCES, ITS DIVERSITY AND UTILIZATION: A CASE STUDY IN HAILAKANDI DISTRICT, BARAK VALLEY

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INTRODUCTION

The survival and progress of human beings depend on recognizing and exploiting natural resources, which are very much threatened at present. Wood is widely used and it is well-known that trees have long growth cycles. Unfortunately, the excessive timber harvest has turned out to be disastrous and every country has adopted protection measures to limit the utilization of wood material obtained from the forests. With this challenge, the utilization of bamboo resources has been highlighted. Bamboo belonging to the family *Gramineae* has about 90 genera with over 1200 species. Bamboo is naturally distributed in the tropical and subtropical belt between approximately 46° north and 47° south latitude, and is commonly found in Africa, Asia and Central and South America. Dwarf bamboo species grow to only a few centimeters (cm), while medium-sized bamboo species may reach a few meters (m) and giant bamboo species grow to about 30 m, with a diameter of up to 30 cm. Bamboo stems are generally hard and vigorous, and the plant can survive and recover after severe calamities, catastrophes and damage (Global Forest Resource Assessment ’2005; INBAR & FAO).

In Asia, the major bamboo producing countries are India (almost 11.4 million hectares) and China (over 5.4 million hectares), followed by Indonesia (2

million hectares) and the Lao People's Democratic Republic (1.6 million hectares). India accounts for roughly half the total area of bamboo reported for Asia, and together with China, approximately 70 percent. Over the last 15 years, the bamboo area in Asia has increased by 10 percent, primarily due to large-scale planting of bamboo in China and, to a lesser extent, in India (FRA'2005).

In India an estimated 8.96 million ha forest area of the country contains bamboo (Rai and Chauhan, 1998). According to the Forest Survey of India report, about 12.8 percent of total forest area is under bamboo cultivation, with the northeast region accounting for 66 percent of the country's bamboo resources in terms of value and 28 percent in terms of area (Indo-Asian News Service). India is very rich in bamboo diversity. There are 124 indigenous and exotic species, under 23 genera, found naturally and/or under cultivation (Naithani, 1993). Clump forming bamboo constitute over 67% of the total growing stock and *Melocanna baccifera*, a non-clump forming bamboo, accounts for 20% of the growing stock and is found in the north-eastern states.

The North East is called the home of Bamboo and this wonder plant is intimately interwoven with the socio-cultural fabric of the population of the area. While Bamboo forests in India occupy an extent of approximately 10.03 million hectares, about 28 percent of the area is located in North Eastern Region. The region has 67 per cent of the country's growing stock, spreading over 3, 50,000 hectares in forest alone. Inextricably woven in the tradition and culture of the North Eastern people, bamboo sustains 70 per cent of rural work force in the region.

Bamboos form an important component of the rural landscape of Barak Valley in southern Assam as also in other parts of northeastern India. Home gardens and bamboo groves of Barak valley are rich in bamboo

resources and *Bambusa cacharensis* R. Majumder ('betua'), *B. vulgaris* Schrad. ('Jai borua'), *B. balcooa* Roxb. (Sil borua'), form important bamboos prioritized by the rural people (Nath, 2001; Nath *et al*., 2004). *B. cacharensis* is endemic to Assam (Majumder, 1983; Barooah and Borthakur, 2003) and distributed abundantly within Brahmaputra and the Barak Valley and other two species (*B. vulgaris* and *B. balcooa*) are among the 14 Indian priority bamboo species (NMBA, 2004) and 38 priority bamboo species for international action (Rao *et al*., 1998).

Bamboo has received increasing attention over the last two decades for its economic and environmental values. In Africa, Asia and Latin America, it is closely associated with indigenous culture and knowledge and is widely used for housing, forestry, agro forestry, agricultural activities and utensils. In countries undergoing economic development, traditional bamboo culture gradually disappears. However, industrial development of bamboo is offering a newopportunity to younger generations to retain and continue developing cultural traditions related to the cultivation, harvesting and use of bamboo. The physical and environmental properties of bamboo make it an exceptional economic resource for a wide range of uses and for poverty reduction. It grows quickly and can be harvested annually without depletion and deterioration of the soil.

Bamboo is utilized for various purposes depending upon its properties. It plays an important role in the daily life of people; for house construction, agricultural tools and implements, as food material and weaponry etc. Besides being a convenient source of cellulose for paper manufacture and rayon, it supports a number of traditional cottage industries. Bamboo craft is one of the oldest of traditional cottage industries in India. The origin of this rural craft is traced from the beginning of the civilization when man started cultivation of food crops thousands of years back. Now bamboo craft is spread in all rural areas of the country and it feeds millions of

traditional workers. Bamboo is emerging as a major source of raw material for several processed products primarily due to its fast growth, wide spread occurrence and its multiple uses. The present study is to investigate the diversity, density, utilization and management of bamboo resources in the villages.

METHODOLOGY

The study was carried out in the villages under Hailakandi Block of Hailakandi District in Barak Valley of Assam, NE India. Hailakandi is situated at 24° 21′N latitude and 92° 32′E longitude. The district is bounded by River Barak & Cachar district in the North & East, Mizoram State in the South & East and Karimganj district in the west. The geographical area of the district is 1326.10sq.km. The district consists of plains and hilly areas and two reserve forests viz. Katakhal and innerline reserve forests.

The district experiences a warm and humid climate having a mean annual rainfall of 2660 mm, most of which is received during the south-west monsoon season (May - September). The mean maximum temperature ranges from 25.4° C to 32.6° C and the mean minimum temperature ranges from 11° C to 25° C. The dry season usually corresponds to the period from December to February. The soil is acidic, heavy clay to loams except river basin and hilly tracts, where sandy to clay loams can be observed. As per 2001 census the total population of the district is 542,978. Total rural population of the district is 501478 (92%) & urban population is 41500 (8%). Male-female ratio is 933 per 1000 males. According to 2011 census the total population of the district is 659,260. Total rural population of the district is 611,087 (92.69%) & urban population is 48,173 (7.31%). Male-female ratio is 946 per 1000 males.

The study adopted was a descriptive survey method in which sampling was done from 30 villages, 10 homegardens in each village, which were selected randomly, under Hailakandi block. Information regarding the diversity, density, utilization and management of bamboo resources in the villages was gathered through field visits and interaction with bamboo growers through detailed and structured questionnaire. Species inventory and villagers' preference for bamboo species were assessed by surveying the selected homegardens and bamboo groves and enumerating the number of clumps per species. The relative importance value of a species is calculated by adding up the relative frequency and relative density of each to represent the dominant village bamboo species in the homegardens and bamboo groves.

RESULTS AND DISCUSSION

The survey revealed that there are 9 species of bamboo found to be cultivated in the villages. These are *Bambusa cacharensis* R. Majumder, (Betua), *Bambusa polymorpha.* (Jama betua), *B. vulgaris,*(Jai borua), *B. balcooa,*(Sil Borua), *B. nutans,*(Bakal), *Schizostachyum dullooa,*(Dolu), *Melocanna baccifera,* Kurz (Muli), *B. assamica.*(Mirthinga) and *B. pallida.*(Ketwa). The bamboos are distributed widely throughout the region.

The villages surveyed were grouped into 3 categories based on their location - viz., riverside villages, forest side villages and other villages (which do not fall under the aforesaid categories), for comparing the frequency, density and importance of the species in such areas.

Table:1-R.I.V of Bamboo species

	all villages			inriver-side villages			Inforest-side villages			in other villages		
Bamboo sp.	R.F	R.D	R.I.V culms	R.F	R.D	R.I.V culms	R.F	R.D	R.I.V culms	R.F	R.D	R.I.V culms
Betua	18.99	39.74	58.73	18.52	32.76	51.28	16.13	36.7	52.83	21.13	47.76	68.89
Jama betua	6.96	2.67	9.63	7.41	2.48	9.89	9.67	4.74	14.41	5.63	1.91	7.54
Sil Borua	18.35	10.37	28.72	18.52	7.79	26.31	16.13	11.91	28.04	18.31	12.08	30.39
Jai borua	18.99	25.72	44.71	18.52	36.66	55.18	16.13	12.54	28.67	19.72	21.55	41.27
Bakal	15.82	3.98	19.8	14.81	4.96	19.77	16.13	5.32	21.45	16.9	2.41	19.31
Mirthinga	13.29	15.23	28.52	14.81	13.88	28.69	12.9	26.24	39.14	12.68	11.31	23.99
Dolu	1.27	0.08	1.35	1.85	0.09	1.94	3.23	0.23	3.46	0	0	0
Ketwa	0.63	0.13	0.76	0	0	0	3.23	0.65	3.88	0	0	0
Muli	5.69	2.09	7.78	5.56	1.37	6.93	6.45	1.67	8.12	5.63	2.97	8.6

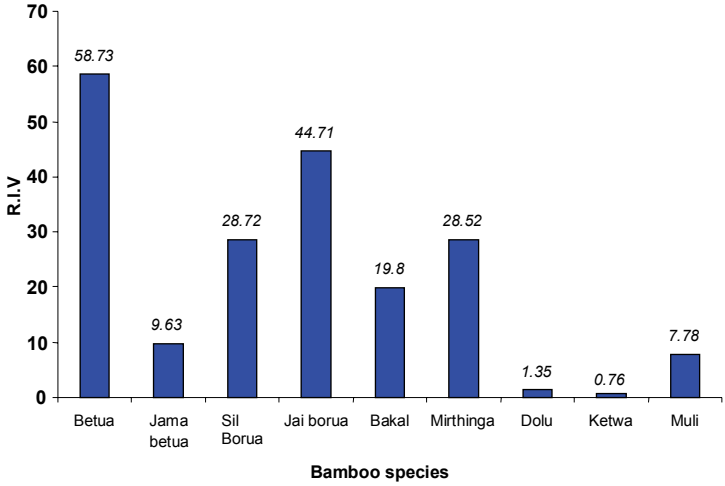


Figure: 1. R.I.V of bamboo species in all villages

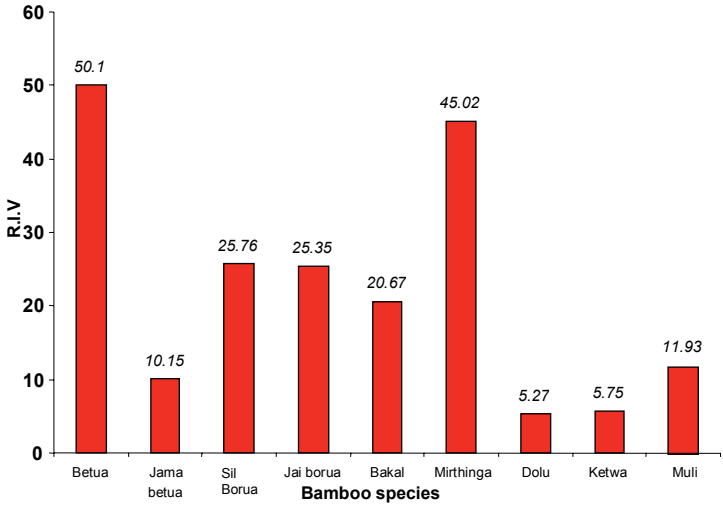
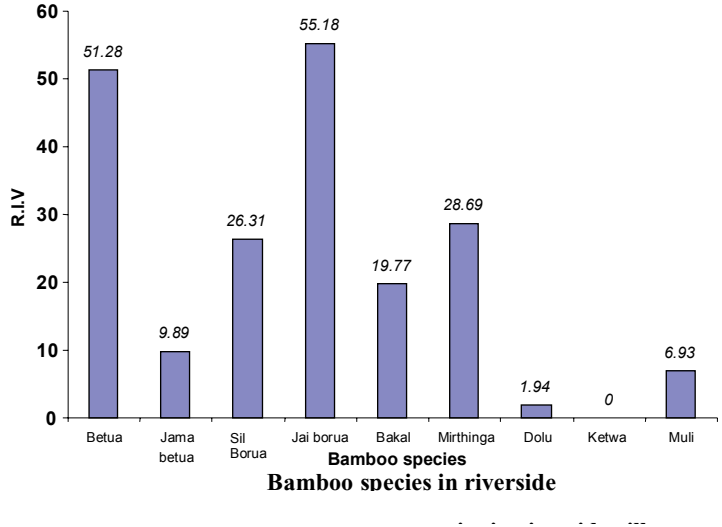


Figure:3. R.I.V of bamboo species in forestside villages



Bamboo species in riverside

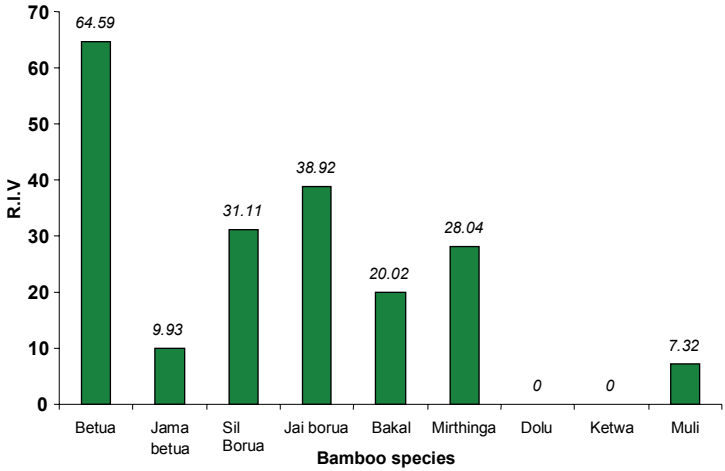


Figure: 4. R.I.V of bamboo species in other villages

Table: 2. Average number of clumps of bamboos per home garden in each village.

Village	Betua	Jama Betua	Sil Borua	Jai Borua	Bakal	Mirthinga	Dolu	Ketwa	Total
Narainpur-II	1.6	1.2	1.9	3.4	0.5	0.2	0.2	-	8.9±1.15
Narainpur-III	0.8	0.3	1.1	2.2	0.5	-	-	-	4.9±0.75
Itorkandi-II	1.1	0.1	0.8	0.8	0.3	-	-	-	3.1±0.41
Ujankupa-II	2.3	0.2	2.2	3.1	0.4	1.1	-	-	9.3±1.16
Rangauti-III	2.7	1.4	0.9	0.9	0.1	1.1	-	-	7.1±0.86

Vichincha-II	1.1	-	0.1	0.9	0.2	-	-	-	2.3±0.5
Bilpar Dhumkar	1.9	-	1.3	2.2	0.1	1.3	-	-	6.8±0.80
Bashbari Grant	2.7	-	0.8	0.7	0.1	2.3	0.2	-	7.7±1.10
Chandpur-I	1.9	0.1	0.7	1	0.1	0.1	-	-	3.9±0.72
Bhatirkupa-III	2.7	-	0.3	0.8	0.6	-	-	-	4.4±1.09
Gangpar Dhumkar-III	1.7	0.3	1.5	2.2	1.5	1.4	-	-	8.6±0.63
Gangpar Dhumkar-IV	1.3	-	0.8	1.3	0.8	0.2	-	-	4.4±0.45
Nitainagar-II	3.7	-	-	3.6	0.2	-	-	-	7.5±1.99
Nitainagar-I	3.2	-	0.8	1.7	0.1	-	-	-	5.8±1.34
Chepti Borjopur	2.7	0.1	1.7	2.3	0.1	1.2	-	-	9±1.09
Ujankupa-I	3.8	0.1	0.6	1.6	-	-	-	-	6.1±1.64
Borjurai	2.6	-	0.7	1.8	0.3	0.2	-	-	5.6±1.04
Lakhirbond-I	1.6	-	1.2	0.2	0.6	-	-	-	3.6±0.62
Boalipar-II	1.2	-	1.7	0.6	-	0.2	-	-	3.7±0.66
Purbosunapur	1.5	-	0.7	1.6	0.5	0.4	-	-	4.7±0.57
Kanchanpur-II	1.3	-	1.5	1.9	0.3	1.6	-	0.4	7±0.66
Bajantipur-I	1.6	-	0.9	3.7	-	0.6	-	-	6.8±1.4
Matijuri	0.4	-	1.2	1.8	0.2	0.5	-	-	4.1±0.66
Borjopur-I	1	-	1.1	0.4	0.2	0.7	-	-	3.4±0.38
Paikan	1.6	-	1.6	0.8	-	0.4	-	-	4.4±0.6

Boalipar-III	1.9	-	1.2	1.5	0.2	0.5	-	-	5.3±0.70
Bhatirkupa-II	3.6	0.8	1.3	4.4	1	1.8	-	-	12.9±1.5
Ratanpur-II	1.4	-	1.2	1.6	-	0.7	-	-	4.9±0.39
Rangauti-I	1.7	-	1	0.2	0.1	-	-	-	3±0.75
Kanchanpur-I	1.9	1.6	0.7	1.5	0.6	1.6	-	-	7.9±0.53

Considering all the villages it was found that the R.I.V of *Bambusa cacharensis* R. Majumder ('Betua') is 58.73, which is quite high and may be due to the high dominance of the species which is again due to the high preferences of these species by the villagers and also may be due to the high productivity of these species. More over the ecological and environmental conditions of the region may be favourable for the proper growth and productivity of these species. The species *B. vulgaris* Schrad.('Jai borua'), and *B. balcooa* Roxb. (Sil Borua) are also having a good R.I.V in the villages. Nath, 2001; Nath *et al*., 2004, quoted that the home gardens and bamboo groves of Barak valley are rich in bamboo resources and *Bambusa cacharensis* R. Majumder ('Betua'), *B. vulgaris* Schrad. ('Jai borua'), *B. balcooa* Roxb. (Sil Borua'), form important bamboos prioritized by the rural people. The species *B. cacharensis* is endemic to Assam (Majumder, 1983; Barooah and Borthakur, 2003) and distributed abundantly within Brahmaputra and the Barak Valley and other two species (*B. vulgaris* and *B. balcooa*) are among the 14 Indian priority bamboo species (NMBA, 2004) and 38 priority bamboo species for international action (Rao *et al*., 1998). The low R.I.V of *Schizostachyum dullooa,*(Dolu), *Bambusa pallida* (Ketwa), and *Melacanna baccifera* (Muli) may be due to less dominance and less preference of the species.

Again in the river-side villages, the R.I.V for *B. vulgaris* (Jai borua) was found to be highest (55.18), which may be due to the adaptability of the species to grow well in moist condition or in water logged condition. The species is thought to have adaptation to flooded condition and so is preferred the most in the riverside villages. In the river side villages the R.I.V of *Schizostachyum dullooa,*(Dolu) and *Melacanna baccifera* (Muli) are very low because these species are originally forest bamboos and have been planted in the villages. The ecological and environmental condition may not be favourable for their growth and productivity.

In the forest-side villages the R.I.V of *Bambusa cacharensis* (Betua) is highest (50.1), but here the high R.I.V of *B. assamica* (Mirthinga) (45.02) and the presence of *Bambusa pallida* (Ketwa), *Schizostachyum dullooa,*(Dolu) and *Melocanna baccifera* (Muli) marks the difference. The nearby forests have an impact on the diversity of the bamboos as well as in the growth and productivity of the various bamboo species. The low R.I.V of *B. vulgaris* (Jai borua) and *B. balcooa* (Sil Borua) reflects that the species have low frequency and density as because the ecological and environmental conditions are not suitable for their growth.

Again in the other villages which are in between the riverside and forest side villages, the R.I.V of *Bambusa cacharensis* (Betua) was found to be highest (64.59), but here the R.I.V of *Bambusa nutans* Wall. ('Bakal') was found to be 20.02 which is comparatively higher than the R.I.V of the species in the other regions. The high R.I.V of *Bambusa cacharensis* (betua) may be due to the high dominance and high preference of the species. The home gardens in all the villages reflect a good diversity of the bamboos and a diverse distribution of all the nine species through out the region. Species diversity in tropical home garden is reported to be very high due to species having different life forms, height and canopy structure (Babu *et al.* 1982; Soemarwoto & Conway (1991).

The average number of clumps of bamboos was found to be highest in Bhatirkupa-II with about 12.9 clumps per home garden followed by Ujankupa-II (9.3) and Chepti Borjopur (9). The lowest number of average clumps of bamboo per home garden was found in Vichincha-II (2.3).The average no of clumps of bamboo per home garden varies from village to village. This may be due to various topographic factors as well as climatic conditions in different areas. More over the size of the home garden, the interest of the villagers in planting bamboo and their socio-economic status may also play a great role in explaining the difference. Structure of home garden varies from place to place depending upon the socio-economic and ecological conditions (Soemarwoto 1987).

Among all the species *Bambusa cacharensis* (Betua), *B. vulgaris* (Jai borua) and *B. balcooa* (sil borua) are mostly preferred in the villages due to the various utility of these species and high productivity. *Bambusa cacharensis* (Betua) is preferred by about 45% of the villagers as because it can be utilized in all aspects of their day to day requirements as well as for commercial purpose. The species can be used for fencing, construction purpose, making various bamboo articles like baskets, mats, fishing articles, agricultural equipments etc. Betua has good elasticity and provides quality fibre ('beth') and hence can be utilized for various purposes. Moreover the species is endemic to the region (Majumder, 1983; Barooah and Borthakur, 2003) and grows well in such climatic conditions.

The trend of preference is same in forest side villages and in other villages, but in the riverside villages *B. vulgaris* (Jai borua) is preferred the most as it can adapt to flooded conditions and has good productivity. Jai borua can also be utilized in all aspects, from subsistence need to commercial need. Due to its high productivity and quick regeneration capacity it is harvested in every 4-5 years and sold to the market or in paper mill, which is practiced in many villages. *B. vulgaris* Jai borua can also be utilized for

making various agricultural equipments and rickshaw hoods and thus has a great commercial value.

In the villages, bamboos are utilized in two ways- for subsistence use and commercial use. Subsistence use refers to the uses in household, such as fencing the boundary of the house, fencing homegardens and crops for protection, construction of the houses, cattle shed, for burning in cooking, construction of barrier in water bodies, boundaries of ponds, etc. Bamboo is also used as a live fencing in the villages. Commercial use is again of two types- Large scale production of bamboo for selling in the market or in the Paper Mill and Production of small articles of bamboo used in day to day life.

Large scale production of bamboo was found only in few villages and only in a few families, due to lack of space. Some families in the villages like Bhatirkupa-III, Bhatirkupa-II, Bashbari Grant, Ujankupa-I and Chandpur-I often sell bamboos in the market or in the Paper Mill, after a gap of 5-6 years.

Production of small articles of bamboo, such as small and large baskets (Jhuri, Kholoi, Potaing, Tukri etc.), fishing articles (Dori, Chepa, Runga, Fufi etc.), agricultural implements, rickshaw hoods, etc. are produced only in two villages- Nitainagar-I and Nitainagar-II, under Hailakandi Block. These products are sold in the village market or in the nearby town.

The harvesting pattern of bamboos in the villages was found to be selective harvesting, i.e., harvesting the older or mature culms leaving behind the younger ones. But in some villages where bamboo is sold to the paper mill, clear cutting of the clumps leaving behind a few current year culms are seen.

A traditional system of bamboo management is prevalent in the region which involves yearly soiling mainly in the month of Chaitra (Mar-Apr), and

burning of the litter in the month of Falgun (Feb-Mar), thus enhancing the soil quality and the vegetation cover of the region.

Bamboo cover in the villages enhances the vegetation cover of the region. The bamboo-cover also plays a great role in the process of carbon sequestration, thus lessening the impact of global warming by acting as a carbon sink. Bamboo can act as a supplement of fuel wood thus lessening the burden on the near by forests. It also plays a great role in the conservation of soil quality by restricting soil erosion. Bamboos are used in live fencing and also in regeneration of degraded lands mainly due to flood.

CONCLUSION

Considering the potential of bamboo for socio-economic development, especially in rural areas, there is an immediate need to carry out their massive plantations in forests, farms and vacant community lands. It is also necessary to boost research and development activities for genetic improvement in bamboo, development of efficient methods for mass production of superior quality planting stock, and conservation of the genetic resources. Concerned international organizations and local governments should adopt useful policies to use bamboo resources, substitute bamboo for wood, in any possible industrial use and also to strictly limit cutting of wood and deforestation. This will be a significant contribution to the improvement of natural resources and solve many ecological problems. Rational plans should be developed and carried out to make use of bamboo resources, so that the existing bamboo forests would not be destroyed, as wood forests have been. At the same time, there are advantages of using cultivated bamboo with its short rotation period. With improved management practices there should be more bamboo wood for industries and edible shoots for human consumption. Thus there is an urgent need for the development of strategies and guidelines

for the proper management of the village bamboos in Barak Valley, N.E.India.

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STUDY OF THE TOTAL HARDNESS OF WATER NEAR THE MUNICIPALITY DUMPING SITE OF KARIMGANJ TOWN, ASSAM DURING RAINY SEASON

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INTRODUCTION:

Hardness is the traditional measure of the capacity of wate r to react with soap. Hardwater requiring considerably more soap to produce lather. Hard water often produces a noticeable deposit of precipitate (e.g. insoluble metals, soaps or salts) in containers, including “bathtub ring”. It is not caused by a single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations, although other cations (e.g. aluminium, barium, iron, manganese, strontium and zinc) also contribute. Hardness is most commonly expressed as milligrams of calcium carbonate equivalent per litre. Water containing calcium carbonate at concentrations below 60 mg/l is generally considered as soft; 60–120 mg/l, moderately hard; 120–180 mg/l, hard; and more than 180 mg/l, very hard (McGowan, 2000). Although hardness is caused by cations, it may also be discussed in terms of carbonate (temporary) and non-carbonate (permanent) hardness. Disposal of solid waste in to open dumps is the normal practices by municipalities of our country. During the rainy season leachate formation takes place from the wastes which enter near by water resources and penetrate deep down in to ground water. Leachates are composed of high concentration of organic substances, soluble salts and other constituents including toxic heavy metals etc (De, 1989, Dara, 1995, Kaushik et al. 2004, Obodo, 2001, Lark et al. 2002, Kudesia, 2000, and Waheed et al. 2007). It was reported by Dhere et

al.(2008) that the urban centers of India produce 120,000 t of solid per day and is almost all the cites , unscientific disposal of solid waste has created environmental pollution. Recently Rajkumar et.al (2010) has analyzed 43 ground water samples and 7 surface water samples from waste dumping sites at Erode city, tamilnadu and found that the analysed water samples are unsuitable for drinking due to contamination from leachates. Estimated daily intakes of magnesium from water of about 2.3 mg and 52.1 mg in soft-water and hard-water areas, respectively, have been reported, based on adults drinking 2 litres of water per day (Neri et al., 1985).

In this work authors have collected six water samples from Naughty Khal during the month of August 2011 and determined the total hardness of all the six water samples.

2. EXPERIMENTAL:

2.1 Study Area:

Karimganj town is the district head quarter of Karimganj district of Assam, a state in the north eastern region of India. The district is situated just on the Bangladesh border with the river Kushiara flowing in between. It is located approximately along 24^0 $52^/$ N latitude and 92^0 $49^/$ E longitude and has the area about 6.9 Km^2. According to the 2011 census report the total population of the district is 52,613. One prominent feature of the place is a wide canal meandering across the town. Earlier it used to be a connecting river way between Kushiara and Longai facilitating river communication and also balancing of water-levels between the two rivers. Although now, this canal has been blocked at several places through embankments and land-fills to pave way for road transport and construction works but still today Longai River is directly connected with the canal. The east side area near the embankment connecting Bonomali road and Hospital road of karimganj district was used by municipality for dumping the waste for several rears.

During rainy season, leachate from the municipality dumping site directly goes to the canal and ultimately pollutes the water quality of Longai river which is the main water resource used by Public health engineering of Karimganj district for domestic purpose.

2.2 **Sampling procedure:**

Water samples were collected from six different sites of Naughty khal at regular distance from the municipality waste dumping site of Karimganj district during the month of August, 2011. The descriptions of sampling sites are given in the table 1. The samples were collected from a depth of 1ft below the surface and kept in 1liter prewashed polythene containers. The water samples were analyzed for total hardness with in 24 hrs of the collection.

Table 1: **Description of sampling sites**

Sample	Site description
S_1	Nearest to the dumping site
S_2	Near the Bonomali embankment
S_3	Near the Betail embankment
S_4	Near the water supply plant of PHE where Naughty khal and Longai river joined
S_5	Opposite to Longai police out post in Longai river
S_6	Opposite to Satsangha Asram In Naughty khal

1.3 **Determination of total hardness:** Harris (2003)

Water hardness is an expression for the sum of the calcium and magnesium cation concentration in a water sample. These cations form insoluble salts with soap, decreasing

soap=s cleaning effectiveness. Water hardness is expressed in ppm $CaCO_3$ which has the formula weight of 100.1 g/mole. It is determined by performing a complexometric titration using a 0.01M ethylenediaminetetraacetic acid (EDTA) solution.

To do the titration, initially 25ml of the water sample has been taken in a conical flask and to it 4ml of NH_3 buffer was added. The colour of the reaction mixture has been turned to wine red when ~40mg of Solochrome black was added to it. The reaction mixture was the titrated against 0.01M EDTA solution till the colour of the solution has been turned from wine red to pure blue.

RESULTS AND DISCUSSIONS:

The values of the total hardness of the six different water samples are given in Table2

Table 2: Total hardness in mg/l

Sample	Total Hardness(mg/l)
S_1	70
S_2	37
S_3	50
S_4	53.3
S_5	30
S_6	65

It was found that S_1 has the highest hardness while S_5 has the lowest hardness value in comparison with the other samples. The variation of the hardness of all the six water samples is shown in the Figure 1. It is clear from the figure that S_1 and S_6, $S_2$and S_5, S_3 and S_4 have almost the equal value of hardness.

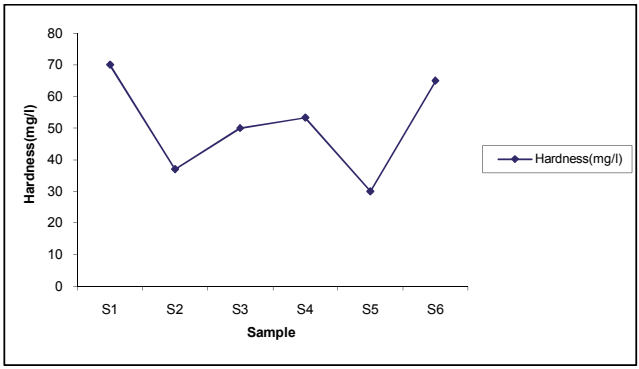

Figure.1: Variation of hardness of the water samples

Comparison of the variation of the results with the desirable and permissible limit of hardness of drinking water given by WHO shown that all the values well below the permissible limit even the desirable limit also.

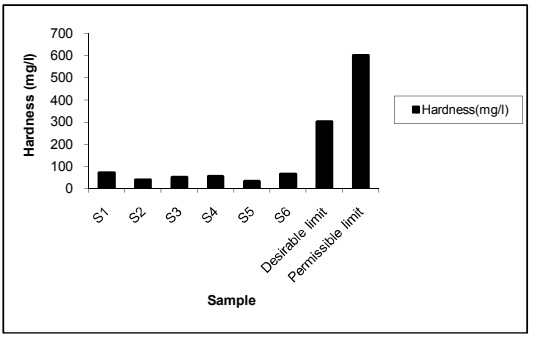

Figure.2: Comparative study of hardness of water samples collected with that of the desirable and Permissible limit of W.H.O

Authors have compared the results with the desirable and permissible limit of drinking water because S4 and S5 has collected from the area where Naughty Khal and Longai river has connected and moreover the villagers of the surrounding area use water of Naughty khal and Longai river for their their drinking as well as irrigation purpose may be because of their ignorance of knowledge of dissolve pollutants in water.

CONCLUSION

From the analytical data it can be concluded that the water sample tested were no longer hard. But still further analysis for other physico chemical parameters and heavy metals, wll be required for the detection of the extent of pollution of the water of Naughty khal and Longai river by the pollutants from the open municipality dumping site of Karimganj Town.

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VERMICOMPOSTING AS A SYSTEM FOR RECYCLING ORGANICWASTE: AN OVERVIEW

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INTRODUCTION:

Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product. Vermicomposting differs from composting in several ways. It is a mesophilic process, utilizing microorganisms and earthworms that are active at 10–32°C (not ambient temperature but temperature within the pile of moist organic material). The process is faster than composting; as the material passes through the earthworm gut, a significant transformation takes place (Butt *et al*., 2005). The resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators, and fortified with pest repellence attributes as well. In short, earthworms, through a type of biological alchemy, are capable of transforming garbage into valuable components (Vermi Co 2001, Tara Crescent 2003).

TYPES OF EARTHWORMS:

Earthworms are invertebrates. There are nearly 3600 types of earthworms in the world and they are mainly divided into two types: (1) burrowing; and (2) non-burrowing. The burrowing types *Pertimaelongata* and *Pertima asiatica* live deep in the soil. On the other hand, the non-burrowing types *Eisenia fetida* and *Eudrilus eugenae* live in the upper layer of soil surface. The burrowing types are pale, 20 to 30 cm long and live for 15 years. The non-

burrowing types are red or purple and 10 to 15 cm long but their life span is only 28 months.

The non-burrowing earthworms eat 10% soil and 90% organic waste materials; these convert the organic waste into vermicompost faster than the burrowing earthworms. They can tolerate temperatures ranging from 0 to 40°C but the regeneration capacity is more at 25 to 30°C and 40–45% moisture level in the pile (Carpenter *et al.,* 2008). The burrowing types of earthworms come onto the soil surface only at night. These make holes in the soil up to a depth of 3.5 m and produce 5.6 kg casts by ingesting 90% soil and 10% organic waste.

MATERIALS REQUIRED FOR VERMICOMPOSTING

A range of agricultural residues, all dry wastes, for example, sorghum straw and rice straw (after feeding cattle), dry leaves of crops and trees, pigeon pea (*Cajanus cajan*) stalks, groundnut (*Arachis hypogaea*) husk, soybean residues, vegetable wastes, weed (*Parthenium* sp) plants before flowering, fibre from coconut (*Cocos nucifera*) trees and sugarcane (*Saccharum officinarum*) wastes can be converted into vermicompost. In addition, animal manures, dairy and poultry wastes, food industry wastes, municipal solid wastes, biogas sludge and bagasse from sugarcane factories also serve as good raw materials for vermicomposting.

The quantity of raw materials required using a cement ring of 90 cm in diameter and 30 cm in height or a pit or tank measuring 1.5 m × 1 m × 1 m is given below:

Dry organic wastes (DOW) 50 kg
Dung slurry (DS) 15 kg
Rock phosphate (RP) 2 kg
Earthworms (EW) 500–700

Water (W) 5 L every three days

The various ingredients are used in the ratio of 5:1.5:0.2:50–75:0.5 of DOW: DS: RP: EW: W. In the tank or pit system 100 kg of raw material and 15–20 kg of cow dung are needed for each cubic meter of the bed.

METHODS OF VERMICOMPOSTING

- **Pits below the ground**

Pits made for vermicomposting are 1 m deep and 1.5 m wide. The length varies as required.

- **Heaping above the ground**

The waste material is spread on a polythene sheet placed on the ground and then covered with cattle dung. The heap method of preparing vermicompost was better than the pit method. Earthworm population was high in the heap method, with a 21-fold increase.

- **Tanks above the ground**

Tanks made up of different materials such as normal bricks, hollow bricks, shabaz stones, asbestos sheets and locally available rocks were evaluated for vermicompost preparation.

- **Cement ring**

Vermicompost can also be prepared above the ground by using cement rings.

EARTHWORM MULTIPLICATION

Numerous organic materials have been evaluated for growth and reproduction of earthworms as these materials directly affect the efficacy of vermicompost. Nogales et al. (1999) evaluated the suitability of dry olive cake, municipal bio-solids and cattle manure as substrates for vermicomposting. They reported that larger weights of newly hatched earthworms were obtained in substrate containing dry olive cake. In another study, maize straw was found to be the most suitable feed material compared

to soybean (*Glycine max*) straw, wheat straw, chickpea (*Cicer arientinum*) straw and city refuse for the tropical epigeic earthworm, *Perionyx excavates* (Manna *et al*. 1997). Zajonc and Sidor (1990) evaluated and compared various non-standard materials for the preparation of vermicompost. A mixture of cotton waste with cattle manure in the ratio of 1:5 was found to be the best. The use of grape cake alone increased earthworm weight slightly. Tobacco (*Nicotiana tabacum*) waste, used as substrate, increased earthworm weight but the earthworms failed to reproduce. A mixture of tobacco waste with rabbit manure in the ratio of 1:5 was found to be lethal to the earthworms.

BENEFITS OF VERMICOMPOST

a) **Soil**

- Improves physical structure of soil.
- Enriches soil with micro-organisms (adding enzymes such as phosphatase and cellulase)

- Microbial activity in worm castings is 10 to 20 times higher than in the soil
- Attracts deep-burrowing earthworms already present in the soil
- Improves water holding capacity

b) **Plant growth**

- Enhances germination, plant growth, and crop yield
- Improves root growth and structure
- Enriches soil with micro-organisms (adding plant hormones such as auxins and gibberellic acid)

c) **Economic aspects**

- Biowastes conversion reduces waste flow to landfills
- Creates low-skill jobs at local level
- Low capital investment and relatively simple technologies make vermicomposting practical for less-developed agricultural regions

d) **Environmental aspects**

- Helps to close the "metabolic gap" through recycling waste on-site
- Creates an eco-friendly environment.
- Production reduces greenhouse gas emissions such as methane and nitric oxide (produced in landfills or incinerators)
-

PRECAUTIONS DURING THE PROCESS

Only plant-based materials such as grass, leaves or vegetable peelings should be utilized in preparing vermicompost.

Materials of animal origin such as egg shells, meat, bone, chicken droppings, etc are not suitable for preparing vermicompost.

The earthworms should be protected against birds, termites, ants and rats.

Adequate moisture should be maintained during the process.

Stagnant water or lack of moisture may kill the earthworms.

The vermicompost should be removed from the bed at regular intervals

METHODS FOR APPLYING VERMICOMPOST

Vermicompost can be used for all crops: agricultural, horticultural, ornamental and vegetables at any stage of the crop.

For general field crops

Vermicompost is used by mixing with seed at the time of sowing . Normal irrigation is followed.

For fruit trees:

- The amount of vermicompost ranges from 5 to 10 kg per tree.
- For efficient application, a ring (15–18 cm deep) is made around the plant.
- A thin layer of dry cow dung and bone meal is spread along with 2–5 kg of vermicompost.
- Water is sprayed on the surface after covering with soil.

For vegetables:

- For raising seedlings, vermicompost is applied in the nursery bed.
- This results in healthy and vigorous seedlings

For flowers:

- Vermicompost is applied around the base of the plant.
- It is then covered with soil and watered regularly

IMPROVED CROP GROWTH AND YIELD

Vermicompost plays a major role in improving growth and yield of different field crops, vegetables, flowering plants and fruit crops (Channabasanagouda *et al.,* 2008). The application of vermicompost gives higher germination of mung bean (*Vigna radiata*) compared to the control. Further, the growth and yield of mung bean has also been found to be significantly higher with vermicompost application. Likewise, the fresh and dry matter yields of cowpea (*Vigna unguiculata*) were higher when soil was amended with vermicompost (Karmegam and Daniel 2000).Growth promoting activity of vermicompost may be tested using a plant bioassay method.. The marked difference in plumule length of maize seedlings

indicated that plant growth promoting hormones are present in vermicompost.

CONCLUSION

The production of degradable organic waste and its safe disposal becomes the current global problem. By reducing the time of humification process and by evolving the methods to minimize the loss of nutrients during the course of decomposition, the fantasy becomes a fact (Maheswarappa *et al.,*1999). Earthworms can serve as tools to facilitate these functions. They serve as "nature's ploughman" and form nature's gift to produce good humus, which is the most precious material to fulfil the nutritional needs of crops. The utilization of vermicompost results in several benefits to farmers, industries, environment and overall national economy.

Table 1. Nutrient composition of vermicompost and garden compost.

Nutrient element	Vermicompost (%)	Garden compost (%)
Organic carbon	9.8–13.4	12.2
Nitrogen	0.51–1.61	0.8
Phosphorus	0.19–1.02	0.35
Potassium	0.15–0.73	0.48
Calcium	1.18–7.61	2.27
Magnesium	0.093–0.568	0.57
Sodium	0.058–0.158	<0.01
Zinc	0.0042–0.110	0.0012
Copper	0.0026–0.0048	0.0017
Iron	0.2050–1.3313	1.1690
Manganese	0.0105–0.2038	0.0414

Table 2. Plumule length of maize seedlings.

Treatment	Initial length (cm)	Final length (cm)
Tank water	16.5	16.6
Vermicompost water	17.6	18.6

Table 3. Multiplication trial of earthworm species at ICRISAT, Patancheru, India in 2000[1].

Earthworm species	Initial population	Final population	Increase (%)
Mixed culture	900	15950	1612 (27)[2]
Eisenia fetida	90	1036	1051 (12)
Eudrilus eugenae	55	1007	1731 (18)
Perionyx excavatus	85	1192	1302 (14)

1. Mixture of legume tree leaves and cow dung was used as substrate.
2. Values in parentheses indicate increase in number of times at 90 days after incubation.

Table 4. Multiplication trials of earthworms using different organic materials at ICRISAT, Patancheru, India during 2000–02.

		Initial		Final[1]	
Earthworm species	Feed material	Population	Weight (g)	Population	Weight (g)
Eisenia fetida	Tree leaves (15 kg)	345	20	2510	207
	Cattle manure (15 kg)	510	207	1159	207
	Cattle manure (3 kg) + *Gliricidia* stem (6 kg)	1255	101	1000	50
Eudrilus eugenae	Tree leaves (15 kg)	311	21	2986	334
	Cattle manure (15 kg)	2986	334	1522	216
	Cattle manure (3 kg) + *Gliricidia* stem (6 kg)	2707	230	2249	100
Perionyx excavatus	Tree leaves (15 kg)	409	29	2707	230
	Cattle manure (15 kg)	2707	230	2650	187
	Cattle manure (3 kg) + *Gliricidia* stem (6 kg)	3356	365	1000	50

1. At 90 days after incubation.

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SOME ASPECTS OF ENVIRONMENTAL ECOLOGY AS REFLECTED IN THE VEDAS

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INTRODUCTION

We all know that Ecology is the science that deals with the interrelations of plants and animals together with their environment. Environment includes its surroundings and atmosphere.

Many a Verses from **Rigveda** tells about the physical factors of the present day Ecology e.g. Fire (Agni), Light (Surya), Water (Jal) and Precipitation or Rains (Varsha/Vristi), Air (Vayu), Rivers and the flow of water.

ECOLOGY

Here we shall discuss **some of the ecological factors** such as **Light,Air, Water, Agni** and **some other aspects of ecology** such as **water cycle, sustainability** etc. which are reflected in the Vedic verses.

Philosophical and scientific expositions of some of the Physical Factors of ecology:

Light/Sun (Surya):

RV.X.37.4:

yena surya jyotisā vādhase tamo jagachcha vishvamudiyarsi bhānunā |

tenāsmadvishvāmanirāmanāhutimapāmivāmapa dusvapnyam suva ||

If we go through the English translation of this hymn (RV.X.37.4) it is stated as that the whole world is illuminated bythe Sun/Surya, and the Sun dispels the darkness with his light and the sun is the source of all energy. (The same exposition is also found from the Sayana's Commentary on the above verse.)

In the present day ecology i.e. from modern ecological point of view it is stated that the sun is the ultimate source of energy inan ecosystem that sustains all sorts of life.

Air/Vayu:

RV VII.87.2:

atmā te vāto raja ā navĪnotpashurna bhūrniryavase sasavān |
antarmatĪ vrhatĪ rodasĪme vishvā te dhāma varuna priyāni ||

This hymn of**Rigveda. VII.87.2** clearly tells the role of **air** by which all living world is survived.It indicates that the survival of living world is through air (that is oxygen).

(Based on the commentary of Pt. Satvalekar (1985),)

The facts are scientifically correct in the modern science.

And we all know that without air we cannot even think of our existence.

If we watch Yogashana of swami Ramdevji in the morning you would see the importance of air as he is doing almost all the **'asanas'** using air and it really does work.

Water :

RV.VII.87.1:

radatpatho varunah sūryūya prārn āmsi samudriy ā nadinām |
sargo na srsto arvatirrtāyanchakāra mahiravanirahabhyah ||

RV VII.101.4:

yasmin vishvāni bhuvanāni tasthustisro dyāvastredhā sasrurāpah |trayah koshāsa upasechanāso madhvah shchotantyabhito virapsham ||

RV VII.101.5:

idam vachah parjanyāya svarāje hrdo astvantaram tajjujosat |
mayobhuvo vrstayah santvasme supippatā osadhĪrdevagopāh ||

RV.I.23.19:

apsvantaramrtamapsu bhesajamapāmuta prashastaye |
deva bhavata vājinah ||

RV.I.23.20:

apsu me somo avravidantarvishvāni bhesajā |
agnim cha vishvasambhuvamā pashcha vishvabhesajih ||

The above mentioned hymns of Rig Veda viz. **RigvedaVII.87.1; Rig Veda VII.101.4 ,Rig VedaVII.101.5,and Rigveda** I. **23.19-20 clearly reflect the d**ependency on water.

If we go into the details of these hymns we find that:

People from veryancient times were aware of the importance of water.

The Rig Veda identifies the Waters as the first residence or **ayana of Nara**, the Eternal Being and therefore water is said to be **pratishtha**, the underlying principle, or the very foundation of this universe.

Based on the commentary of the above verses by Sayanacharya and Pt. DamodarSatvalekar they may be stated as :

*All living beings are dependent on water. The water which comes in the form of rain goes to wells, pond and rivers.

*Water is nectar which sustains all sorts of life, and the food grains are also grown by this water.

From scientific point of view i.e. in the present day ecology it is found that Water is one of the most essential factors for life in this world which is available in the form of humidity and precipitation. It is available from rain, underground water from digging well, and fountains, stored water from **step wells** and streams etc.

There is a very nice Interpretation of Water cycle in the hymn RV.VII.101.3:

Water Cycle:

satrĪru tvadbhavati sūta u tvadyathāvashani tanvani chakra esah |
pituh payah prati grabhnāti mātā tena pita vardhate tena putrah ||

The above Rig Vedic hymn VII.101.3, clearly states the concept of **Water cycle** in the present day ecology.

The English translation of the above hymns is like this:

Here, the father is the sky, earth the mother, who receives the rain from the father, which, producing the means of offering libations and oblations, returns again to the parent sky(heaven), as well as supports his offspring – all living creatures.

So this is nothing but the concept of present day's water cycle which refers to the continuous movement of earth's water from earth's surface into the atmosphere and back to the surface.

Agni/Fire:

Next comes fire. The hymn is

RV.VI.6.3:

vi te visvagvātajūtāso agne bhāmāsah shuche shuchayashcharanti |
tuvimraksāso divyā navagvā vanā vananti dhrsatā rujantah ||

This hymn**Rigveda. VI.6.3.**clearly reflects the role of Fire/Agni. There are several many instances/hymns of the physical factor Agni/Fire in the Vedas.

The commentary of Pt. Satvalekar and Sayanacharya is that'Flames of fire are expanding all sides **flickering by air bright**, fire-flames bring destroying darkness and **devours forest**……etc.'

In the present day ecology, fire is mentioned as one of the physical factors that influence life. We find that the devastating flames destroy the forest by burning and afterwards the land becomes **arable** and promotes congenial growth of vegetation. So this is scientifically correct.

Interpretation on Sustainability:

Finally if we go into the sholka of **Yajurveda 40.1**we find **Interpretation on Sustainability. The hymn is as**

Yajurveda 40.1:

Ishā vāsyamidam sarvam yatkincha jagatyām jagat |

Tena tyaktena bhunj Īthā mā grdhah kasyasviddhanam ||

This sholka states that the whole universe together with its creatures belongs to the Nature. One can enjoy bounties of nature by giving up all greed. Implicit in this statement is that no creature is superior to the others and human being should not have absolute power over nature. Let no one species encroach on the rights and privileges of any other species.

Thus, the element of sustainability is i**ngrained** in it because the emphasis is to use nature without greed. Once an element of greed enters, exploitation starts and we cease to utilize nature for the good, the benefit and welfare of our fellow human beings.

CONCLUSION:

Thus whatever Physical factors like water or precipitation, fire, Light etc. that affect the life of organisms in one way or other found in the present

day environmental ecology, all these factors are mentioned in many verses of Vedas thousands of years back.

So after a thorough study of some aspects environmental ecology and some of the verses of the Vedas (**RV.I.23.19-20,** RV.X.37.4; RV.**VII.87.1-2;** RV.VII**.101.3;** RV.VII**.101.4;** RV.VII**.101.5;** RV.VI**.6.3; YV40.1)** we may come to the conclusion that there is a convergence or a parallel trend of the two schools of thoughts namely the ancient Indian Philosophy and the Modern Science (ecology). Thus, if we want to know more about our modern research, we should relearn the philosophical aspects of the Vedas thoroughly.

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BIODIVERSITY AND ITS CONSERVATION STRATEGY: ROLE OF MEDIA

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INTRODUCTION:

Today, everyone is concerned about the deteriorating quality of environment surrounding him. It is as much a cause concern to highly developed industrialized rich nations because of their chemical pollutions of air, soil and water as of poor, densely populated people from filth, water polluted by organic wasters that harbour pathogenic microbes, poor sanitations and overall poverty. In fact, all the components of environment like-surface water, underground water other water bodies, air, upper atmosphere, ozone layer, rivers, costal shift and oceanic belts, forests and other vegetal covers etc. all under severe stresses created by men through their social and economic activities.Rising human population and increasing its demands on natural resources are primarily responsible for the overall environmental degradation. Exhaustion of natural resources, depletion of vegetal cover, loss of biodiversity and rapid extinction of wildlife are some of the examples of the result of environmental degradation. 'Why did mankind not foresee or kept a blind eye to such a massive environmental degradation all over the world. Much because of greed of rich people to become richer and lack of holistic vision of environment to developmental activities. Not almost every successful story of our industrial development found to major reason of decrease in environmental status. Never, any technocrat, planner, developer of our society has seen or provide any kind of reference to his kind

of disastrous future of our planet. Only ecological perspective can provide a holistic look of negative effects, which creations of our civilization said to either see or pretend to have not foresees.The international communities are well aware and are seized of the global environmental and ecological problems and various efforts have been initiated to control global warming and halt probable climatic change.

There are several organization, government agencies, intergovernmental agencies, non-government organization (NGO) that have undertaken various action plans and projects to study the relationships between man and environment, interactions between man and nature, the environmental problems resulting wherefrom and remedial measures thereafter.

It is heartening to note that international co-operations are forthcoming for the amelioration of the environmental and ecological problems. Efforts are being made to control Ozone depletion and greenhouse effects at global level. The signing of Montreal protocol in sept., 1987 under the leadership of UNO's UNEP, the international conference on 'depletion of Ozone layer, in London, held from march 5 to 7, 1989, wherein government officials, scientists and industrialists of 180 countries participated, earth summits in Rio De Janeiro (June 3 to 14, 1992) and New York (June 23 to 27, 1997) ,Kyoto Protocol(1997) that came into force on 16 February 2005 are a few examples of international community's efforts to protect environment, but, unfortunately all exercises have gone without remarkable impact in term of satisfactory up gradation of the environmental conditions.

Therefore, lots of efforts are to be made at international and national level. Normally media always pay attention and support these kinds of cause and concerns. Indian media also support policies, programmes, approaches adopted by government to improve the quality of environment. Medha Pateker, Sundar Lal Bahuguna, Rajendra Singh, Vandana Shiva, F.C. Mehta, Sunita Rao, R.K. Pachauri and other individuals, NGO's, working for

environmental protection have supported by the media. Media provide sufficient coverage to environmental news i.e. World Environment Day (June, 5) programmes, plantation, awareness programmes, etc. Newspapers, Magazines and other print media provide regular materials on the issue and give proper coverage. Many articles, news, features, comments etc. can be identified in these publications. Radio also pays a great attention to the issue. A number of Radio programmes i.e. features, weekly diary, play, discussions, speeches etc. regularly broadcasted into air. Environment received a regular space on T.V. screen also. Infotainment news channels with their number of programmes focusing on these issues and contribute in educating the masses. Many of our folk dancers, singers, and musicians and other folk performers (artists) accepted it as a major social problem and have created scripts, programmes, songs, slogans on environmental issues.

Media is a powerful agent of social change. It has a great impact on human behaviour and their way of thinking. Information is now flowing fast to the people through various media. The media are known to be playing an effective role not only in informing the people but also in influencing their thinking and shaping their attitudes. In India as part of sovereign national system, the media are used to serve the people and the nation according to new visions and rational goals, policies and targets set by the architects of the nation, the media managers and experts. Since independence, Indian media reflects their responsibility to the national issues i.e. health, education, population control, secularism, national security, terrorism and environmental protection etc.

Media are considered as the catalyst of change and development and expected to accelerate the process of social welfare and empowerment of all. Through the process of communication creation of informed citizenry and playing the role of gatekeeper media has contributed in people's empowerment, diffusion of innovations and ideology of progress and modernity. In a democratic society like India media has perceived as the

friend and voice of mass against the odds of power, capital and exploitations. Media are expected to set the agenda of development and progress for everyone, create a pressure on system to work constantly for people's welfare and provide communication functionality between all stakeholders of development; government, local leadership, donors, field workers, local population and civil society. Thus it can be said that the perception and diffusion both media jobs are critical for environmental protection because people's perception is highly dependent on such messages.

BIODIVERSITY AND CONERVATION STRATEGY:

Biodiversity is the contracted form of Biological Diversity and coined in1985.Generally, biodiversity refers to the sum total of living organisms that inhabit at a particular ecosystem. It includes various plants and animals in a particular area. Biodiversity is a unique creation of God and variegations display the greatness of the God .Therefore, "Biodiversity is all about understanding Nature and being part of it (Ramakrishnan, 2010)."India has a rich and diverse population of plants and animals. With about 2.5 per cent of the land area, the Indian region has 7.8 per cent of the globally recorded biodiversity (Myers et al., 2000).Among the 25-mega biodiversity hotspots of the world, India got the share of 3-mega hotspots and Indo-Burma Mega Biodiversity hot spot zone cover the whole north-east of India. Moreover, our country has ten distinct biodiversity zones. Today , the issue for the conservation of biodiversity has more relevance due to rapidly increasing environmental uncertainties such as climate change ,global warming, changes pattern of land use and land cover, biological invasion by exotics ,biological depletion etc. In this regard, the Ministry of Environment and Forest, government of India formulated a National Conservation Strategy and Policy Statement on Environment and Development on June 1992.Besides, the government of India has enforced National Biodiversity

Act, 2002 which is an important step towards conserving and sustainably managing biodiversity for the well welfare of its citizens.

ENVIRONMENTAL DEGRADATION AND MEDIA:

Our father of nation, M.K.Gandhi rightly said "Nature has enough to satisfy everyone's need but not everyone's greed."Therefore, the greedy nature of human being is the main cause behind environmental degradation. Every day, all over the world men are making decisions, which are responsible for the changing in the earth's environment. Unfortunately, every decision of human kind deteriorates the quality of environment on the earth. It is true that individual decisions are not confirming too much of damage but after the social acceptance these decisions seriously affects the quality of environment. These decisions are making with the help of images of the world. People take their decisions not so much on the world as it is but rather on the world as they perceive it. The image of the world to the mind of people based upon the communication or messages provided by the media.

Media is a powerful organ of modern society. It has a great influence over mind of people. Media is a means of effecting or conveying something; A channel or system of communication, information, or entertainment. The term media used both in singular and plural. The singular media and its plural media seem to have originated in the field of advertising over 50 yrs ago; they are apparently still so used without stigma in that specialized field. In most other applications media has used as a plural of medium. The great popularity of the word in references to the agencies of mass communication is leading to the formation of a mass noun, constructed as a singular. According to Webster's dictionary— media are "means of disseminating information, entertainment, etc., such as books, news papers, radio, television, motion pictures and magazines".

Oxford dictionary defines media as—"Television, radio, and newspapers as the means to mass communication".

In his book Mass Communication Theory Denis McQuail has included 'Print Media: the book & the library, Print Media: the newspaper, Other Media; these includes plays, songs, tracts, serial stories, poems, pamphlets, comics, reports prospectuses, maps, posters, music, handbills, wall newspapers....periodical (weekly or monthly) magazines, Film, Radio & Television, Recorded Music, New Media, ICT, Personal Video Recorded, CD-ROM, Compact Disc, DVD etc., The Internet', into mass media.

In this context, the term media used as a plural of medium or short form of mass media, which have included the print (newspapers, magazines, posters, banners, handbills etc.), Radio, Television, Cinema, Internet or Folk media (dances, music and other performing & population folk forms) in its frame. Television, Radio, Newspapers, Magazines, Internet, Folk Songs, Exhibitions, Public Gatherings, Seminars, Slogans, and Events have covered as a mass media.

'Media have the tools and technologies that facilitate dissemination of information and entertainment to a large number of people'. These tools mediate the message. Media is a powerful cross-cultural, cross-national institution effectively influencing people.

MASS MEDIA AND BIODIVERSITY:

Lopsided progress has been manifested in the form of ravaged ecology of our earth. Consequently, the situation leads towards the depletion of biodiversity of our planet. India's ancient literatures talked about the good ecological consciousness of our ancestors. Interestingly, the global circumstances in the last few decades have forced India and kept in such a situation where it is hard enough to practice a traditional life style. It forces

us to accept a life style to push our planet towards doom. Interestingly, it is heartening to note that there is sign of gratifying resurgence of a good environmental consciousness in India during the last three decades. The most important factor for the raising environmental consciousness in our country is the active participation at the institutional as well as people's level. Therefore, it is the need of the hour to make our people pre-occupied with environmental consciousness .Because, addressing an issue is not the sole responsibility of the government but it needs every individual's contribution. Besides, our judiciary, legislative and bureaucratic institutions need strong commitment towards the protection of our environment. In order to have a practical environmental culture, a concerted effort is required by the established institutions as well as the people.

MEDIA APPROACH IN ENVIRONMENTAL AND BIODIVERSITY PROTECTION

Today, environmental issues have drawn the attention of all kind of media. Issues such as environmental degradation, pollution and related problem have assumed global dimension and threaten the very existence and survival of mankind. Ever-increasing environmental problems such as green house effect, ozone layer depletion, rapid decrease in global greenery, heavy loss in bio-diversity, increase in slums & solid waste, recycling of plastic and more other problems have cautioned the media attention.

With the passage of the time, as natural man converted into 'economic man', the process of agricultural extension, urbanization, industrialization, increase in settlement pattern etc have created necessity to evaluate man-environment relationship. Later on, it became required to manage things with environmental perspective. Pollution checking and reducing programmes, environmental assessment programmes, concept of environmental

management became necessary in changing global circumstances. These issues always get high attention in media. As a watchdog of society it is required that media should cover these kind of issues.

Modern mass media have treated environmental issues as a social problem. Environmental pieces have been covered to fulfil variety aspects of the content. Environmental elements are necessarily linked with human survival, therefore, degradation, pollution, planning, management, preventive and precautionary measures to environmental concerns received attention of all kind of media i. e. traditional to modern mass media.

Media are very important democratic organ and an effective pressure group. Most of media are controlled by elite and capitalist section of the society who controls the political system and economy. These mass media organization are tool of opinion formation and owners always hold a look on the media production. Therefore, such organ's point of view is very crucial in environmental protection.

In the developing countries like India where rapid transformation is taking place, media plays an important role. Surveillance of the environment related information or 'news' about what is happening in the society, Role of media is of great importance in the field of environmental issues where the process needs to be accelerated quickly and effectively to keep pace with the fast changing scenario. Media play an important role in raising the environmental issues due to its functional roles, via information, education and to create stage for discussions and debates of various events or issues including environmental awareness. They play a key role in promoting awareness and for understanding the problems of vital environmental issues all over the world. As the watchdog of the society, media have to educate the people and keep them informed on various aspects of environmental degradation. It can aware the people on the call of the environmental issues.

CONCLUSION

The report on National Conservation Strategy and Policy Statement on Environment and Development (Ministry of environment and forest, government of India,1992) has emphasized that mass media should play a vital role in raising public awareness. Further it has been acknowledged that media have good potentials such as raising the awareness level of the public on environmental issues, promotion of people's participation in environmental activities and conservation of natural resources.

To conclude with, it can be suggested that environment must be a part of regular mainstream media practices. An integrated media policy is the need of the hour. Media should be used as a provocative tool and attract the attention of the opinion leaders. People are well awaked to the existing environmental condition and they have potential to pay some contribution for it. Perception about environmental situation among common mass is high but they don't take any pain for it. That is the point where attention is required. The thing is we have to devote to convert this common perception into specific conservation oriented habits; by this we will be able to protect our environment, our green planet and our beautiful universe.

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STATUS OF BIRD DIVERSITY OF BAUWAA BEEL: A THREATENED ECOSYSTEM

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INTRODUCTION

Located at the district of Southern Assam, Hailakandi a small *beel* called *Bauwwa beel (24° 37' 60" N, 92° 34' 60" E).* This *beel* is recognized as one of the IBA *(Important Bird Area)* of Assam (Islam and Rahmani, 2004). It covers an area of 70 ha. of land which varies to 150 ha. during monsoon, surrounded by four villages viz., *Kuchilla*, *Zadukuna*, *Borbond* (pt-II), *Borbond* , however the lion's share goes with *Kuchilla (about 90%).* Annual rainfall stars with a month of June which generally ranges from 1000mm to 3000mm. Climatic condition of the wetland is largely tropical "Monsoon" type with a hot summer (max. 35 °C) and a cool winter (min. 7°C).

Previous records indicates the occurrence of more than 90 species of birds (Choudhury,2000) which includes four threatened species- One critically endangered species viz., Oriental white backed vulture *Gyps bengalensis* ; two vulnerable species viz., Lesser adjutant stork *Leptoptilos javanicus* and Greater spotted eagle *Aquila clanga* and one near threatened category viz., Spot billed pelican *Pelecanus philippensis* . Besides Swamp Flancolin *Francolinus gularies,* European Golden Plover *Pluvialis apricaria* and Eastern or Great Knot *Calidris tenuivostris* are some are common but noteworthy species also reported from this beel. However, it is also admit - able that this beel has not been surveyed for about eight years until last year..

METHODOLOGY

The survey was mostly conducted on foot during winter as it become dry and confined except for monsoon season, when water-level rises in that case a boat was used. After preliminary survey from all the villages, a particular zone was selected for intensive fieldwork. In addition, photographs were taken for identification later and estimation of birds. Binocular (8x32) was also used in the field.

RESULT

Being located in the far southern part of Assam, it remains unknown to the many. However as the *beel* is located near the main town of the district i.e., 10 km away from Hailakandi town, so assessing is not so difficult as proper travelling facility is available .

During my survey, I encounter 40 species of birds with large number of Lesser Whistling Duck *Dendrocygna javanica* often exceeding a thousand plus besides frequent occurrence of vulnerable species viz.; Lesser Adjutant Stork *Leptoptilos javanicus* is also noted.

Other than the bird the beel is found to harbor species like Golden Jackal *Canis aureus*, SmallIndian Mongoose *Harpactes javanicus,* and snakes like checkered keelback Watersnake *Xenochrophis piscator* and various turtles and frogs.

DISCUSSION

Threat- This drastic loss in bird's number is due to constant pressure of land reclamation and siltation. Land reclamation is due to agricultural expansion and in addition to this siltation also plays a very vital role by reducing its area further. Also flood on the other hand causing the breaking of embankment of the land, which in turn leads to filling up the *beel* costing more reduction of the area of the *beel*, its future consequence is lethal.

Besides over fishing, cattle grazing, hunting for fun and also pollution are some other threats.

For this group of bird's that are mostly affected are Cormorants, Darter, Herons, Egrets, Bittern, Stork, Duck, Lapwing, Plover, Sandpiper, Kingfisher and Wagtail.

Measure proposed - *Bauwwa beel* has full potential to be a good birding spot but if proper conservation measure like initiation of awareness programmes, encouragement of eco-tourism and research works, frequent checking for traps in form of large nets by forest officials as it support many rare and threatened species of birds.

Although, the *beel* is small but remain as significant one in entire NE, as it has full potential to become a good birding spot if proper conservation measures are taken before it is too late as India has already lost 38 percent of fresh water wetland (since 1991).

TABLE-1.1: List of commonly available birds

NAMES	2011	2012
Northern lapwing *Vanellus vanellus*	+	-
Common kingfisher *Alcedo meninting*	+	+
White breasted kingfisher *Halcyon smyrnensis*	+	+
Little egret *Egretta garzetta*	+	+
Cattle egret *Bubulcus ibis*	+	+
Lesser whistling duck *Dendrocygna javanica*	+	+
Indian pond heron *Ardeola grayii*	+	+
Common sandpiper *Actitis hypoleucos*	+	+
Little ringed plover *Charadrius dubius*	+	+
White wagtail *Motachilla alba dukhunensis*	+	+
Grey backed shrike *Lanius tephronotus*	+	+

Little cormorant *Phalacrocorax niger*	+	+
Brown shrike *Lanius cristatus*	+	+
Black drongo *Dicrurus macrocerus*	+	+
Broad billed crow *Corvus corone*	+	+
Common myna *Acridotheres tristis*	+	+
Spotted dove *Streptopelia orientalis*	+	+
Lesser adjutant stork *Leptoptilos javanicus* VULNERABLE	+	+
Pariah kite *Milvus migrans*	+	-
Rose ringed parakeet *Psittacula krameri*	+	+
Asian koel *Eudynamys scolopacea*	+	+
Magpie robin *Copsychus saularis*	+	+
Pied myna or Asian Pied Starling *Sturnus contra*	+	+
Cinnamon bittern *Ixobrychus cinnamomeus*	+	-
European golden plover *Pluvialis apricaria*	-	+
Hoopoe *Upupa epops*	-	+
Bay backed shrike *Lanius vittatus*	-	+
Common Swift *Apus apus*	+	+
Stork billed kingfisher *Halcyon capensis*	-	+
Black Hooded oriole *Oriolus xanthornus*	+	-

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MICROPROPAGATION OF *ASPLENIUM NIDUS* L. A NEAR-THREATENED EPIPHYTIC MEDICINAL FERN OF NORTH EAST INDIA AND ITS CONSERVATION.

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INTRODUCTION

Asplenium nidus L. also called as Bird Nest Fern is a beautiful epiphytic species, often seen to grow in lithophytic conditions, is a well distributed species of North East India. The plant loves moist environment and grows well in trunks of old angiospermic trees and tree ferns, on moss covered wet rocks etc. It has been found that the basket-shaped rosette of long fronds trap falling twigs and leaf litter and large ferns can contain substantial quantities of organic matter. These baskets act as an abode for different arthropods and lower groups of animals (Ellwood and Foster; 2002, 2004).Amphibians, reptiles and small mammals have also been recorded from them. Reports suggest that a single large fern rosette may contain as much invertebrate biomass (the weight of all the invertebrates) as found in the whole of the rest of the tree crown in which the fern grows (http://www.nhm.ac.uk/nature-online/species-of-the-day/collections/collecting/asplenium-nidus/canopy/index.html).

The plant possesses medicinal uses as well. In Hawaii, the juice of *A. nidus* leaf and shoots was mixed with other plants to treat general weakness

and mouth sores in children. In old Hawaii the leaves of the plant adorned traditional altars and were used in canoe tree cutting ceremonies. The black midrib was used to decorate *Pandanus* mats. (Emerson, 1909; Bornhorst, 1996; https: //ntbg.org/plants/plant_details.php?plantid=1304; Akana, 1922).The plant has been reported as depurative, contraceptive and used in general weakness (Koh *et al.*; 2009). The decoction of the plant is drunk to cure Jaundice in North east India (Sen and Ghosh, 2011). In Southern India, it is used in fever, elephantiasis and a host of other ailments (Benjamin & Manickam, 2007). In Tahiti, it is used in treating chest pain (Baltrushes, 2006). Its other ethno medicinal usages are reported as well (Defilipps, 1988; Bourdy *et al.*, 1996; Singh, 2001; Gogoi, 2002).

Other than the above uses, the plant is also famous as indoor and greenhouse plant (Gilman, 2011; http: //en.wikipedia.org/wiki/*Asplenium*.; Mott, 2008). Thus from ecological, medicinal and horticultural point of view this plant is very important and needs prime attention to save it from elimination. This is because due to wanton felling of trees and clearing of forestlands, the plant has been facing acute danger of becoming extinct in near future. Moreover, due to some unknown reasons, the plant has been found to propagate very slowly in nature. No plantlets were found in near periphery of the last few surviving populations of the plant in Barak valley, Southern Assam. This might be due to the scarcity of old trees in close periphery of the plants. So, the present work was selected to propagate the plant in laboratory condition so as to put forward a successful *ex situ* conservation protocol to protect the plant from becoming extinct.

REVIEW OF LITERATURE

Tissue culture of *Asplenium nidus* L. has been previously tried in various laboratories. Fernández *et al.* (1991) tried the regeneration capacity of *A. nidus-avis* leaves in liquid medium. Khan *et al*. (2008) experimented the

in vitro propagation of bird's nest fern from spores. Zhang *et al.* (2010) conducted experiment to study the regeneration capacity of different explants of *A. nidus.* But no such work could be found on micro propagation of the plant involving intact sori or on its *in vitro* conservation in and around the studied zone could be found.

MATERIALS AND METHOD

Mature spores and fertile leaves containing young sori of *A. nidus* L. were collected from Madanmohon area of Karimganj District and stored at 4ºC. On the date of inoculation, first the spores were rinsed with a drop of Tween-20 in 50 ml autoclaved distilled water followed by several consequent wash in autoclaved distilled water. Surface sterilization of spores were done with 35% (w/v) solution of Sodium hypochlorite (4% active chlorine) for 15 minutes and filtered through autoclaved filter paper. The spores were consequently washed several times with autoclaved distilled water to remove any traces of the chemical used and inoculated in medium in wet conditions. All steps were performed by taking the spores inside 1ml sterile microtip blocked both sides with cotton. The washing was achieved by a 1ml micropipette. The fertile leaves containing young sori were cut into small pieces and sterilized in 150ml conical flasks in the same way as above. The explants were blotted dry by sterilized blotting papers before inoculation

Different media were used for the experiment. The standard Murashige & Skoog medium (MS), Parker and Thompson`s Basic Fern medium (PNT), White`s medium, B5 medium etc., were used along with their different strengths and combinations (Table: 1).

The spores and sori were transferred in aseptic conditions in Laminar Air Flow hood and incubated in Growth Chamber of the Tissue culture laboratory at 25ºC±1ºC under 16 hrs photo period at 2500-3000 Lux. The

germinated spores and sori were sub cultured until macroscopic gametophytes were developed. After germination, the cultured materials were transferred into fresh medium after every three weeks for better growth of plants.

RESULTS AND DISCUSSION

It was seen that both the spores as well as sori germinated well in the present experiment. It took about three to four weeks for germination of spores while the sori started producing masses of gametophytes in about six to seven week from the time of inoculation. It was seen that individual spores developed into individual gametophyte, which when cultured in hormone supplemented media grew vigorously. But, culture of sori was beneficial from the fact that, one sori gave rise to mass of gametophytes, which further proliferated into many sporophytes. Moreover in the present experiment, it was found that, MS media without any sucrose and hormonal supplements supported the germination of plants from both spores and sori. PNT media also supported the growth, but the main problem with it was infection from fungus. Bevistin was added as antifungal agent, but it proved to be detrimental towards the growth of the plant though bevistin proved to be good in our other experiments (Majumder *et al.* 2011; a, b).

Proliferation of the gametophytes took place in IAA supplemented media. Thus it can be said that auxin is needed by this particular species for its development *in vitro*. In fact, the beneficial effect of auxin in plant tissue culture has been depicted as well by different authors (Zhong, 2009; Majumder *et al.*, 2011a, b). A little deviating from our other works (unpublished), it was seen that MS media proved to be better for germination of the spores and sori of *A. nidus*, though we obtained best results by using PNT media in micropropagation of other ferns. Khan (2008) and Zong (2009) also obtained better results by using MS media in their work. Though

Bevistin proved to be a good antifungal agent in our other works (unpublished), it did not go well with *A. nidus.*

When the gametophytes were transferred in the freshly prepared respective supplemented media, small sporophytes began to develop from these. It took about nine months from the time of germination of gametophytes to produce the sporophytes. The growths of the sporophytes have been noticed to be very slow and various modifications of the medium (data not shown) are being tried for standardizing a successful sporophyte development protocol from the gametophytes.

CONCLUSION

Thus from the above, it can be concluded that, a successful germination and culture protocol for the spore and sori culture of *A. nidus* has been put forwarded in this paper. It was seen that spores and sori germinated well and developed into macroscopic gametophytic structures in MS and PNT media without sucrose or hormonal supplements. The germination percentage was higher in MS media than in PNT media. Germination took about three to seven weeks in controlled condition. The germinated prothallus developed into macroscopic structures when transferred to hormone supplemented media. It was found that auxin induced proliferation of the gametophytes. Bevistin, an antifungal agent was used. But it did not proved to be good in the present case. Sucrose was avoided as it did not support growth and caused infection to the culture media. The plants are still in gametophytic stage and various combinations of hormones and other supplements are being tried to induce sporophytes from the culture.

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LINKING CLIMATE CHANGE SCENARIOS TO BIODIVERSITY SPECIES DATA IN ORDER TO PROTECT FUTURE DISTRIBUTIONS

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INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) states that "projected impacts on biodiversity are significant and of key relevance, since global losses in biodiversity are irreversible" (IPCC, 2007). Many facets of society are concerned about the future of biodiversity because it provides a foundation of goods and services to allow for a healthy functional biosphere (IPCC 2007, Gayton, 2008). In order to protect species diversity, Canada became a member of the Convention on Biodiversity in 1992 and is committed to protecting and managing biodiversity. Canada is therefore required to address any threats to biodiversity such as climate change (Duro et al., 2007). The use of climate models to predict future biodiversity is a relatively new field of research. Previously scientists did not have the capacity to accurately model climate and its impact on ecosystems but advances in technology have allowed researchers to accurately map future scenarios of biodiversity and climate change (Duro et al., 2007; Nagendra, 2001; Kerr and Ostrovsky, 2003). Methods to research climate and biodiversity vary depending on the scale of the research, landscape structure, time, resources, and desired detail (Kerr and Ostrovsky, 2003). Remote sensing and field data are commonly used as inputs along with climate models to predict long term forecasts of future biodiversity (Xiaoyang *et al.* 2004). Reviewing the range of research in the field of biodiversity and

climate change will consolidate information and aid in the improvement of future research methodologies. In this paper, we provide a literature review of large area, spatially explicit studies that investigate the link between species distributions or biodiversity and climate change.

METHODS AND DATA

Our interests are in large area biodiversity which requires a great amount of species spatial data. Most spatial biodiversity research falls into three categories: field based data, remote sensing based data, or a combination of the both (Nagendra, 2001). Field plot data are used by many researches such as Iverson, Thuiller, and Hamman and Wang (Iverson and Prasad, 1998; Iverson et al., 2008; Thuiller, 2003; Guisan and Thiller, 2005; Hamman and Wang, 2006). Field data requires a massive amount of input data that involves physically sampling the vegetation structure of tens of thousands of plots (Hamman and Wang, 2006; Iverson and Prasad, 1998). The spatial and species data are then put through a number of statistical models. Common models include: regression tree analysis (RTA), random forests, bagging, linear models, generalized boosting models (GBM), multivariate adaptive regression splines, and artificial neural networks (Moisen and Frescino, 2002; Prasad et al., 2006; Iverson et al., 2008; Thuiller, 2003; Thuiller and Morin, 2009). There is no one model that prevails at this time. RTA is the most widely used, but even this model has literature that conflicts with its dominance as the best species distribution modeling technique (Moisen and Frescino, 2002). RTA has a non additive behavior because it separates predictor variables making RTA a valuable model in large diverse environments (Iverson and Prasad, 1998). Researchers commonly use a variety of statistical models and or hybrid / ensemble of models. Thuiller and Morin chose the GBM niche based model and the Phenofit process based model, but also suggest that a hybrid model would better reflect reality and therefore improve the accuracy of the results

(Thuiller and Morin, 2009). Field plot data provides a detailed and ground truthed look at species interactions and diversity. The drawback to this type of data gathering is that it dates itself in the short to medium term which will require re-sampling every few years (Condes and Milan, 2010). Furthermore, this is an intensive and costly way to research biodiversity (Condes and Millan, 2010; Guisan and Thuiller, 2005). The field plots must represent all bioregions since the data will need to be interpolated; this is difficult in diverse and remote study areas. Field data research is recommended for limited uniform landscapes at the regional to sub regional level with adequate resources (Nagendra, 2001). Remote sensing is used by biogeographers such as Foody, Duro, and Xiaoyang; to quickly and cheaply research biodiversity (Foody, 2008; Gillispie et al., 2008; Duro et al., 2007; Xiaoyang et al., 2004). Remotely sensed data can be gathered by a number of passive sensor satellites such as the moderate-resolution imaging spectroradiometer (MODIS), Landsat, and SPOT; as well as active sensor satellites such as Radarsat, SRTM, and ASAR (Gillespie et al., 2008; Turner et al., 2003). This satellite data can provide massive amounts of data such as the fraction of light absorbed by vegetation values (fPAR values), digital elevation models, disturbance, land cover, and fragmentation (Ritters et al., 2002, Running et al., 2004;). This data are provided in a continuous raster format and can cover all scales of research from local to global scales (Duro et al., 2007). Species richness and diversity can be found using the normalized difference vegetation index (NDVI) which is gathered using passive satellite data (Xiaoyang et al., 2004). Although a large amount of information about biodiversity can be gathered quickly, this type of input data can have limited resolution and currently has limited utility at the species level (Gillespie et al., 2008). At this time only a generalized view of biodiversity is attained from these data sets (e.g., Hamann and Wang, 2006). Innovative research is now being conducted that will refine methods for using remote sensing data. Researchers are using derivatives of satellite data such as fragmentation, land

cover, disturbance, productivity, and topography to enhance the accuracy and scope of biodiversity research (Foody, 2008; Hamman and Wang, 2006). Future work will use higher resolution data, integrate a variety of biodiversity data sets, and link field data to ground truth results. Remote sensing is currently recommended for regional to global biodiversity analysis that requires repeatable quantitative analysis (Turner et al., 2003). Although field data are being overtaken by remote sensing as a data source, it is important to sustain both types of research to continuously improve and calibrate methodologies (Gillespie et al., 2008). Climate models and emission scenarios are constantly being updated. Most research is being conducted on IPCC approved models and emission scenarios that give a variety of outcomes from worst case to best case. Common models include the Hadley CM3, GCM, CGCM, and PCM (Iverson et al., 2008; IPCC,
2007; Flato et al., 2000). Emission scenarios are used in climate models to compare possible future CO2 levels in the atmosphere. The most common emission scenarios used are the A series (high C02), B series (low C02) and an averaged scenario. Most researchers use a variety of models and scenarios to allow individual interpretation of the data since no one model or scenario can accurately predict the future of these complex systems (Thuiller, 2007; Iverson and Prasad, 1998; Iverson et al., 2008). Some common goals for biodiversity and climate change forecasting is to find conservation gaps, species niches, invasive species movements, modeling species distributions, and habitat analysis (Hamann et al., 2005; Guisan and Thuiller, 2005; Hannah et al., 2005). There are many applications for this research that will help resource managers make informative decisions; for example: Hamann et al. used geographic information systems to layer biodiversity models with protected areas data to find conservation gaps for particular forest types (Hamann et al., 2005). The fates of many species can be determined by analyzing future species distribution, the climactic stresses put on them, and the amount of conservation efforts existing for those species (Willis et al.,

2008; Foody, 2008). Although the methods to create future biodiversity models differ the value of the data are the same.

RESULTS AND DISCUSSION

GIS is an excellent tool to research shifting biodiversity due to climate change in large complex environments (Duro et al., 2007; McDermid et al., 2005). Field plot data are valuable for species specific relationships, but is not practical for large diverse environments. Remote sensing is valuable for regional to global analysis, but until recently has not been applicable to research at the species level.

Biodiversity and climate research has a number of common opportunities and challenges. For instance, the assumption that climate is the main variable for species survival may be problematic (Currie, 2001; Turner et al., 2003). All researchers used climate scenario models and species distribution data in a GIS to predict future biodiversity. There is a consensus that temperature and precipitation are the most important factors in climate models and biodiversity; however, other variables may be important as well (Hamann and Wang 2006; Turner et al., 2003; Negendra, 2001; Iverson et al., 2008; Hannah et al., 2002). Nagendra stated in 2001 that species diversity research in remote sensing was confusing and contradictory. Current literature shows a more directed approach to this type of research (Nagendra, 2001; Hannah et al., 2002, Barnard and Thuiller, 2008). Output data can be linked with parks and protected areas. Studies use biodiversity models to make suggestions about migration corridors, non climactic stressors to ecosystems, and ecosystems where protected areas should be placed (Ritters et al., 2002; Turner et al., 2003; Lemieux and Scott, 2005; Willis et al., 2008). Although biodiversity research has shown to be useful, there are many opportunities that are not being explored. Within the literature there seems to be a lack of integration between data sets, traditional knowledge, and policies perspective that would help synergize conservation efforts into the future.

CONCLUSION

We looked at common biodiversity and climate research to find the methodologies used to map biodiversity, choose climate models, and address conservation gaps. Biodiversity research can be done using field data, remote sensing, or both. Given the spatial nature of predicting future geographical distribution of biodiversity, GIS and remote sensing are important technologies to employ in addressing research questions. Biodiversity and climate mapping has limitations but it provides valuable data to make informed decisions about the impact climate change will have on the biosphere.

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BIODIVERSITY AND SUSTAINABLE DEVELOPMENT

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INTRODUCTION

Biological diversity simply means the diversity, or variety, of plants and animals and other living things in a particular area or region.Biodiversity also means the number, or abundance of different species living within a particular region. Scientists sometimes refer to the biodiversity of an ecosystem, a natural area made up of a community of plants, animals, and other living things in a particular physical and chemical environment. In practice, "biodiversity" suggests sustaining the diversity of species in each ecosystem as we plan human activities that affect the use of the land and natural resources.

Biodiversity is being viewed in the context of sustainable development offers opportunities for poverty eradication, human well-being and the livelihood and socio-cultural integrity of people, and in particular, in developing countries which are rich in biodiversity but are poor and struggling to catch up with the globalisation challenge.

Biodiversity constitutes the living natural resources that are found inhabiting our aquatic (including marine and fresh water) and terrestrial (including all the major biomes like forests) ecological systems.

Environment is a general term that refers to “the external conditions in which an organism lives. It is used to describe everything that surrounds an organism. The term environment includes the earth, the surface, air, water, sunshine, rivers, mountain, seashore and forest etc. It is defined as sum

of all social, biological, physical and chemical factors, which comprise the surrounding of man.

.Environmental problems have become a matter of great concern in recent times, which is largely brought on by the coincidence of high income and high density of population. With the increase in income and population production process initiated to meet the increasing demands for consumption started to generate more pollution. The economic development of the society depends on the utilization of resources offered by the environment.

Economics studies the cost of exploiting resources in the environment and the resultant benefit arises to the society at large. For instance, when the population increases and at the same time there is a scientific and technological improvement but the environmental quality slowly degraded. This intern will lead to imbalance in the ecosystem. The environmental pollution ultimately leads more of ill fare rather than welfare. Preservation of environment and the promise of economic development are the twin objectives of environmental economics. There can be no conservation of environment without the promise of development as there cannot be sustained development with the preservation of environment. It is in this context the subject economics entered into the realm of environment.

NEED FOR STUDYING BIODIVERSITY AND ENVIRONMENT

Everything that lives in an ecosystem is part of the web of life, including humans. Each species of vegetation and each creature has a place on the earth and plays a vital role in the circle of life. Plant, animal, and insect species interact and depend upon one another for what each offers, such as food, shelter, oxygen, and soil enrichment. Maintaining a wide

diversity of species in each ecosystem is necessary to preserve the web of life that sustains all living things. In his 1992 best-seller, "The Diversity of Life," famed Harvard University biologist Edward O. Wilson -- known as the "father of biodiversity," -- said, "It is reckless to suppose that biodiversity can be diminished indefinitely without threatening humanity itself."

We study the environment for two main reasons. Our first objective is to understand some basic facts about the environment and how natural ecological systems function. Our second objective is to suggest some long-lasting, successful solutions of environmental problems. Environmentalists believe that the world would be destroyed if people do not understand environmental problems and try to solve them. To these environmentalists, ecological and social development means the destruction of the environment and therefore, ultimately, the end of civilization, the extinction of many species and probably the extinction of human beings.

A final word about environmental education, i.e. educational programmes designed to increase public awareness of environmental issues. Environmental education seeks to give us an understanding of environmental issues and the skills to solve environmental problems such as the problem of population, loss of ecological balance, climatic change, loss of biological diversity, ozone depletion, environmental degradation, acid rain and greenhouse efforts. Since environmental pollution is a global problem there is need for international efforts to solve various environmental problems**.**

ECONOMIC DEVELOPMENT AND ENVIRONMENT

Environment economics is partly a study of economics which deals with the interrelationship between “environment” and “economic development’. It studies the ways and means through which the environment is not disturbed. Environmental economics is that branch of economics, which discuss about

problems relating to the interactions of economic activity of society with the harmony between natural and humanity. It is a subject, which studies how best the economic growth of the community could be maintained without damaging environment.

There is a close relation between natural resources and economic development. And environment is also a natural resource. With economic development more and more resources are consumed. This may lead to depletion of resource base with development. If this happens the performance of resource-rich developing countries would be even worse.

Environment is helpful for development, but development is harmful for environment. Because most of the environmental problems, pollution problems, environmental imbalances, overuse of environmental resources, acid rain and global warming etc. are result of development process. As economic development process goes on, these problems also on simultaneously. With the industrial/economic activities, waste and pollution problems are also increases. With the starting of developmental transfer process, agriculture-rural based economy converted into industrial and urban-based economy. This would result very fast industrialization and urbanization. Industrialization and urbanization resulted in air, water and land pollution and very badly damaged the environmental system.

Thus development process damages the environment system through over use of environmental resources and pollution problems. It badly damaged on sustainable development. It has also created problems for existences of human beings because of seasonal unnatural charges / various, acid rains and global warming. Pollution has created very serious problem of global warming. The volume of CO_2 mixing with atmosphere has increased about 25% during the last century. Stuvier has estimated the CO_2 1.2 billion tons per year during 1850 to 1950. Mohnen estimated the total human made emission of CO_2 in atmosphere is about 22.4 million tons per year. The

National Academy of Science (USA) has forecasted that mixing of CO_2 in atmosphere will result in global warming of 1.5 degree C to 4.5 degree C. There would be serious effects of global warming. Seasonal cycles would be badly changed. Droughts and floods would be increased. Sea level would raise. Drought prone areas would be victimized. Poverty is also one important reason for over use of natural resources. Poors are over using land, forests, fisheries and other important natural resources. In underdeveloped countries, natural resources are over used in development process. Thus in underdeveloped country like India, over using of environmental resources is due to poverty, population and underdevelopment. This would create problems of pollution, environmental balance and sustainable development.

SUSTAINABLE DEVELOPMENT

Sustainable development, according to the Brundtland Report of 1987, is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Put in the new globalised order, sustainable development is the integration of economic, social and environmental development considered as the inter-dependent and mutually reinforcing pillars which operate at the local, national, regional and global levels. Poverty eradication, the change in unsustainable patterns of production and consumption, and the protection and management of natural resources base of economic and social development, are constantly cited as the over-arching objectives and essential requirements for sustainable development.

One would question why these issues should be at the centre of all discussion on sustainable development. The reasons are easy to find:

1. there is a division of the human society into the rich and the poor, and there is an ever-increasing gap between the developed and the developing worlds

2. the global environment is presently under stress because,

   (a) There is high population growth rates acting in concert with other human induced factors as underlying causes for habitat degradation and destruction

   (b) There is continuing loss of biodiversity at rates much higher than can be replenished

   (c) With the use of modern harvesting and other new technologies essential biodiversity stocks continue to be depleted

   (d) As a result of our own actions and inactions, desertification has claimed more and more fertile lands

   (e) Adverse effects of climate change are being witnessed every day

   (f) Natural disasters have become more frequent and more devastating

   (g) Several developing countries have become more vulnerable to economic hardships and have several compelling reasons to mortgage their natural resources for debt relief, and

   (h) Air, water and marine environments continue to be polluted through our industrial activities

3. The benefits and costs of globalisation are unevenly distributed, and these have presented a new set of difficulties to developing countries to meet the globalisation challenge.If nothing is done to reverse these global trends, the disparities will become entrenched, and sustainable development as a final goal for the global order will not be achieved.

The World Summit on Sustainable Development from which emerged the Johannesburg Plan of Implementation and the United Nations Millennium

Development Goals (MDGs) was meant to avert a global disorder. The focus of the Summit was to find consensus through dialogue on targets, time tables and partnerships to speedily increase access to such basic requirements of humanity as clean water, sanitation, adequate shelter, energy, health care, food security and the protection of biodiversity without compromising on environmental sustainability. These were aptly summed up in the UN Secretary-General's WEHAB Initiative of water, energy, health, agriculture and biodiversity.

These basic requirements of humanity as well as access to financial resources and other provisions to developing countries were agreed at the summit.

The result is highlighted in the eight MDGs which embrace all the three pillars of sustainable development with implementation targets, schedules and time lines.

The eight MDGs are summarized as follows:

(1) Eradicate extreme poverty and hunger
(2) Achieve universal primary education
(3) Promote gender equality and empower women
(4) Reduce child mortality
(5) Improve maternal health
(6) Combat HIV/AIDS, malaria and other diseases
(7) Ensure environmental sustainability
(8) Develop a global partnership for development

All the 8 MDGs are inter-linked to the WEHAB initiative. Water, Energy, Health and Agriculture are so well entrenched in cross-sectoral development plans and agenda of both developed and developing countries and their

absence at any development process is immediately noticed. It is not so with biodiversity. Biodiversity as a political term, emerged just a little over a decade, and its assimilation into sustainable development agenda has been slow. The situation is different with the WEHAB initiative, whereby biodiversity is being looked at in the same way as the others, as integral part of any plans for sustainable development. The assembly of use indicators for biodiversity point to both sustainable and unsustainable use categories. The direction of the pendulum to sustainable use is now considered the only guarantee to ensure the integrity of economic, social and environmental development which are the essential re-enforcing pillars of sustainable development. Sustainable use of biodiversity is therefore a process to achieve the continual use of biodiversity for economic, social and environmental development for sustainable development.

Sustainable use is defined as the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining the potential to meet the needs and aspirations of present and future generations.

ENVIRONMENTAL PROBLEMS

There are many comprehensive assessments of the state of the world's environment. We focus on four main categories of environmental problems: air pollution, water pollution, toxic emissions and ecosystem health.

1. Air Pollution:

Air pollution in urban areas has become a matter of great concern in India. Motor vehicles are the major contributors to this air pollution. These are the ground level source of air pollution and have the most damaging

impact on the general public. Air pollutants damage crops. Acid rain is a regional problem in many parts of the world.

2. Water Pollution:

Water becomes polluted when chemicals and other waste materials dumped into it. Domestic sewage and industrial waste are the major sources of water pollution in India. If pollution is very high the water level can no longer support human and non-human life. Almost one billion people are without access to safe drinking water, a sixth of the world's population. Several stomach diseases are caused by the use of polluted water. According to World Health Organisation (WHO), 11% diseases in India are caused by contaminated water. The child mortality is less correlated with income than with the population's access to safe drinking water and to proper sanitation services. Water contamination is one main environmental threat in many parts of the world.

3. Toxic Chemicals:

Toxic chemicals in the environment have been a problem for decades. Serious toxic problem from the perspective of human health is lead. Lead cause serious health problems. Lead is a major air pollutant because it is mixed with petrol in automobile performance. Most of the developed world now significantly restricts or bans the use of lead in automobile fuel**.**

4. Ecosystem, Health:

Ecosystem health in many parts of the world has deteriorated. This is largely due to the loss of habitat from an ever-expanding world population. Virgin forests are being cleared for the purpose of selling timber as well as providing farmland. Wetlands are drained to obtain more land for agriculture and housing. The number of endangered species of plants and animals grows

every year. The world has yet to find solutions to these problems and thus protect important ecosystem.

GOVERNMENT MEASURES FOR ENVIRONMENT PROTECTION

The Government of India has undertaken several legal and administrative measures to protect the environment from further degradation and pollution. A brief account of these measures is given below:

(I) The Environment (Protection) Act:

This Act provides for control of hazardous substances. It drafts rules prepared for notification of hazardous, chemicals and control of manufacture, storage and transportation and disposable of substances and wastes.

(II) The Forests (Conservation) Act 1980:

This Act has strict provisions for checking the diversion of forest land for any other purpose. During 1951-80, the rate of diversification of forest land was about 1,50,000 ha per annum. but, after 1980, it has been reduced to just 6,500 ha per annum. In order to promote afforestation, tree planting, ecological restoration and economic development activities in the country, the National Afforstation and Eco-development Board NAEB) was set up in August 1992.

(III) Pollution Control Boards:

Central Pollution Control Board was set up in 1974. Similar boards were set up at state levels to address environmental issues in India. These boards specify the permissible limit of effluent and emissions. They are also bringing awareness among the people about the possible

danger of environmental pollution. Further, they also provide technical assistance for the improvement of the environment.

(IV) Wildlife Protection:

For the protection of wildlife an Act named The Wildlife Protection Act 1972 was passed. National Wildlife Plan was adopted in 1983. The Indian Board of Wildlife is the apex statutory body with Prime Minister as Chairman.

(V) Environmental Education and Awareness:

To bring environmental awareness among the people, a schemed named National Environmental Awareness Programme was launched in 1986. A centre for environmental education was established at Ahmedabad in 1984 to frame educational materials and curricula.

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

1. Use of Non Conventional Sources of Energy

   India is heavily depends on thermal and hydro power plants to meet its power needs. Both these types of plants pollute the environment. Wind power and solar energy can be effectively used to replace thermal and hydro power.

2. Use of Gases

   Rural Households in India generally use wood, dung cake (upla) and other biomass as fuel. This practice has led to several problems like deforestation reduction in green cover wastage of animal's dung and air pollution. To meet this situation, subsidized LPG is being provided by the government. Besides it, gobar gas plants are being encouraged through easy loans and subsidy. In cities, the use of Compressed

Natural Gas (CNG) as fuel in public transport system has substantially reduced the level of air pollution.

3. Establishment of Mini Hydel Plants

   Hilly areas have streams everywhere. Most of such streams are perennial. Mini hydel plants can be set up to use the energy of such streams to move small turbines. The electricity so generated can be used locally. Mini hydel plants are environment friendly as they do not change the land use pattern, More over, large scale transmission towers and cables are not required in such plants.

4. Adoption of Old Practices

   In the past, all of our practices (e.g. agriculture system, health care system, housing, transpoooort etc.) were environment friendly. But in recent years, we have been moving away from these practices. This has caused large scale damage to our environment. We can go back to these traditional practices. For example, Ayurveda and Unani systems of treatment are environment friendly. Now-a-days we can see so many cosmetic products such as hair oil, tooth paste, face cream, body lotion etc. all are herbal in composition.

5. Use of Bio-compost

   As we know that Indian farmers have switch over to the use of chemical fertilizers particularly since mid 1960s. They have neglected the use of bio-compost fertilizers. The reckless use of chemical fertilizers has adversely affected the fertility of land and water bodies including ground water system. In recent years, the demand for organic food is on a rise. Therefore, farmers again have started using organic manure.

6. Bio Pest Control

When Indian agriculture experienced green revolution , the use of more and more chemicals pesticides have become a common feature. It soon began to show adverse impacts on food products, soil and water bodies. To meet this challenge, we are now using pesticides based on plant products. Several types of pest controlling chemicals are being obtained form neem trees. In addition, we have also adopted mixed cropping for pest controlling. Growing different crops in consecutive years on the same piece of land has also helped farmers in this direction.

The following tools are needed for success in target-oriented biodiversity actions.

Communication, education and public awareness of the targets and the related MDGs to involve all stakeholders including the many organisations and initiatives, both national and international, public and private, individuals and communities

- Use of selected, appropriate indicators that are
  - specific, measurable, achievable, realistic and time-related (SMART)
  - relevant and meaningful to diverse stakeholders
  - developed through a consultative process to ensure wide ownership
  - tested for their utility at different scales
  - formulated to take account of different timescalescost effective and affordable
  - timely, both in terms of currency and sensitivity to change over appropriate timescales
  - related to country-specific objectives including poverty reduction and meeting the MDGs

- integrated, constituting a set (or nested series) of increasingly aggregated indicators

- Use of existing mandates and processes to continue the collection of data but reporting and management of information should be harmonised and streamlined in order to reduce duplications and to identify and promote synergies.
- Capacity building efforts and technology transfer and co-operation should be vigorously pursued. The necessary capacities, supported by the appropriate technologies, must be available at the national level to develop and implement the required strategies, including a focus on ecosystem services, assessment of progress in achieving the target, and communication of biodiversity values to all sectors. The latter includes demonstrating the benefits of monitoring, assessment and reporting. The need to apply biosafety conditions in biotechnology to ensure food security and human and environmental health is also to be emphasised.
- Commitment on the part of a state party in ensuring that biodiversity-related issues are enshrined in all cross-sectoral programmes and that there is implementation of the national biodiversity strategy and action plans with the provision of the necessary resources including finance.
- Partnership is necessary and should be encouraged to bring on board all stakeholders of biodiversity. This will constitute a useful tool to build co-ordination and synergy in achieving the target.

  Through partnerships, duplication of efforts will be reduced and resources will be properly utilised.

CONCLUSION

In the foregoing, an attempt has been made to relate biodiversity to the global millennium goals in order to achieve sustainable development. The long term perspective for sustainable development requires the broad-based participation of various stakeholders in policy formulation, decision-making and implementation at all levels in particular of issues of biological diversity and this must be encouraged. The Botanic Gardens Conservation International, and other similar institutions, areconsidered as having major roles to play including to inform and educate their constituents on the tenets of biological diversity to sustainable development.

If development process continues with greater tempo, it may lead to premature old age and the degeneration of environmental system, adversely affecting thereby the quality of human life. Deforestation, soil erosion, salutation etc. have decreased soil fertility and caused the degradation of land and biotic life, increasing the intensity and frequency of floods and brought, enhancing pollution of air, water, soil and even the development of slums. Consequent unplanned urban-industrial nexus presents an unhappy and alarming environment. It is high time therefore, to take necessary steps to protect environment and to promote real development.

It is certain that merely making laws and legislation in the parliament is not enough to safeguard the environment. Strict vigilance and enforcement of safety and anti-pollution measures are equally necessary. People's participation, environmental education and perception will certainly work as additional safeguards for ensuing protection of environment and accelerating the balanced development.

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THE SOIL MICROBES AND GROUND VEGETATION OF BOTANICAL GARDEN, G.C. COLLEGE, SILCHAR, SOUTH ASSAM

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INTRODUCTION

At present there is a particular interest in the study of biodiversity including the soil microbes. Such studies will be helpful to understand and manipulate the working of the ecosystems. Soil is a structured, heterogeneous and discontinuous system, generally poor in nutrients and energy sources with microorganisms living in discrete microhabitats (Stotzky, 1997). Human activity has greatly accelerated the rate at which species have disappeared from the Earth (May *et al*. 1995). The loss of plant species directly alters the remaining community by lowering its diversity, (Loreau *et al*. 2001). Researchers have investigated the influence of plant diversity on soil microorganisms (Bargett and Shine 1999, Wardle *et al*. 1999, Stephan *et al*. 2000). Because plant species differ in their biochemical composition, changes in plant diversity could alter the production, as well as the range, of organic compounds in detritus that limit, and thus control, the composition and function of heterotrophic microbial communities. The ground floor vegetation plays an important role in nutrient cycling, habitat conservation and regeneration of tree shrubs. The herbaceous floor vegetation has been reported to show high nutrient content and rapid turnover rates as influenced by climatic conditions (Spain 1984) and vegetation characteristics (Vogt and Vogt 1986). However, extensive studies are lacking on the soil microbes and the herbaceous floor vegetation of protected areas like botanical gardens in

South Assam. The present study was aimed to analyze the soil mycoflora and floristic composition of the herbaceous floor of Botanical Garden, G.C. College, Silchar, South Assam. Further, this study would provide a glimpse of the biological diversity helpful to understand the prevailing ecological system.

MATERIALS AND METHODS

The present study was carried out at botanical garden, G.C. College (24°49′ 0″ N latitude and 92°48′ 0″ E longitude) of Silchar, Cachar district, located in south Assam. The study site is a protected area of around 0.13 ha within the College campus. The ground vegetation is dominated by herbs and grasses. The climate of the region is tropical humid type with extended monsoon. Monsoon or rainy season is characterized by excessive rainfall and high humidity. The year is divided into three distinct seasons viz. short summer (March – April), rainy (May – October) and winter (November – February). Total annual rainfall during the study period was 2081 mm. The mean maximum temperature ranges from 25°C in January to 32°C in August and the mean minimum temperature ranges from 11°C in January to 25.1°C in August. The soil of the region varies from alluvial to laterite, texture usually varies from sandy loam to sandy clay loam. Laterite soils are usually found in hill slopes and hillocks. Soil pH lies within the range of 4.5 to 6. The study site covered an area of 0.12 ha, fenced along the edges, the botanical garden under the department of Botany within the College campus. The garden was established with an objective to cultivate economically important plant species as well as plants of necessity to fulfill the need of the curriculum. The ground vegetation comprised of herbaceous species and grasses. Management of the garden involved annual clipping of the unwanted plants preferably during the month of February.

For soil mycoflora, a modified soil dilution plate method (1, 2) was adopted. Soil was collected randomly from the study site. The temperature during the time of soil collection ranged from 25.3 °C to 31.9 °C. 10 gm of soil was taken from a composite soil sample in 100 ml sterilized distilled water and was shaken for 20 minutes. The dilution was then made 1: 10000. 1 ml soil suspension per plate was aseptically pipetted in sterilized plates. Molten Czapek's Dox agar medium was then poured in the plates and rotated gently. The plates when solidified were incubated at 25 ± 1 °C for five days. Total fungal population and percentage of occurrence of specific groups of fungi were then calculated. Observations were taken by performing the experiment repeatedly for three times. Bacteria were isolated from the soil by non selective methods and were classified into different morphological and physiological groups employing methods of the Society of American Bacteriologists (1957).

Field sampling of plant communities was carried out using the quadrat method during the last week of peak growing season. Ten quadrats with a optimum size of 50 cm x 50 cm were taken randomly and the constituent species were recorded. The flora was studied by segregating the plants into different species and latter to their respective genera and families. Further, species were grouped into various growth forms viz. grasses, sedges, leguminous, non-leguminous forbs, annuals and perennials. Life forms of different species in the study site were determined after detailed floristic studies (Gupta and Kachroo 1983). The morphological characters of each species were taken into consideration to ascertain different life-form classes in the field. The biological spectrum for the plant communities were compared with normal biological spectrum of Raunkiaer (1934).

RESULTS AND DISCUSSION

The present study revealed a rich population of microorganisms predominantly fungi in the garden soil of College campus. A total of 21 species of soil fungi was recorded in the study site. The most dominant fungi includes species of *Aspergillus*,*Alterneria*, *Penicillium*, *Fusarium* and *Trichoderma* (Table 1). These species interact among themselves and occasionally exhibited inhibitory effects on the other. The inhibitory phenomena present in all types of soil capable of supporting microbial growth (Deb *et al.* 1999). Gram negative bacteria exceeded that of Gram positive bacteria in the garden soil (Fig.1). Plant growth promoting rhizo bacteria (PGPR) and plant growth promoting bacteria (PGPB) help in synthesizing particular compounds for plants, facilitating antagonism and uptake of nutrients from the soil.

Macrophytes of the studied vegetation revealed 24 families including 41 genera and 43 species (Table 2). Asteraceae dominated as family in the study site followed by Poaceae. The former comprised of 6 species while the latter 5 species. The angiosperms of the studied vegetation were segregated into 34 dicot species and 7 monocot species (Fig.2). Dominance of dicotyledons might be an indication of better adaptation of these species than the others. 25 species were annuals and the rest were perennials indicating that majority of the species were evaders avoiding the dry conditions in a year (Table 2). Plant communities were distributed into various ecological groups' viz. grasses, sedge, non leguminous forbs, leguminous forbs and ferns (Table 3). The vegetation reflected enormous number of non leguminous forbs as compared to legumes. There were 33 species assigned to non leguminous forbs with only 2 legumes. 2 fern species was also recorded from the study site (Fig.3). Grass diversity was not as high although field observations revealed vigorous growth of *Eleusine indica* covering the whole ground surface. Species enumerated in the study area was categorized into

various life forms viz. phanerophyte, therophyte, cryptophyte, hemi-cryptophyte and chamaephyte (Table 1). Observations revealed that there were 23 therophytes, 9 phanerophytes, 7 cryptophytes, 1 hemicryptophyte and 3 chamaephytes. The life form pattern of the study site showed dominance of therophytes with more than four times increases over normal biological spectrum (Fig.4). The preponderance of therophytes are indicative of strong seasonal regulation by climate as they are adapted to complete their life cycle within rainy season and survive the unfavorable period of growth through seeds (Singh and Krishnamurthy 1981). Cryptophytes, showed an increase (almost three-fold) in the studied vegetation over normal spectrum. Considerable presence of cryptophytes was indicative of biotic interferences and survival of unfavorable growth period by the plant species in the form of perennating buds (Paulsamy *et al*., 1997). Hemi-cryptophyte and chamaephytes were inconspicuous in their representation in the study site (Fig.4). The study site thus, showed over expression of therophytes and cryptophytes in relation to normal biological spectrum and based on Raunkiaer's terminology, displayed a thero-cryptophytic habitat.

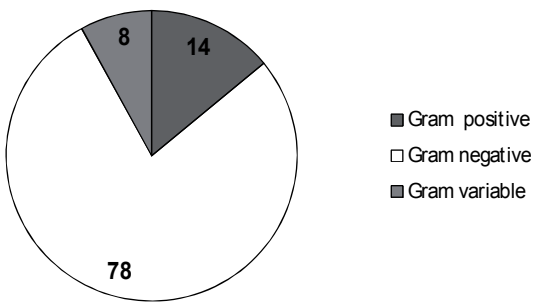

Fig. 1.Percentage occurrence of physiological and morphological forms of bacteria in garden soil.

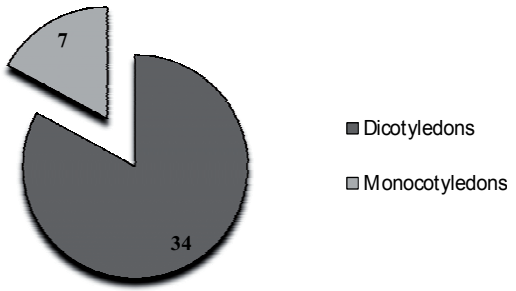

Fig. 2. Distribution of angiosperms into dicotyledons and monocotyledons.

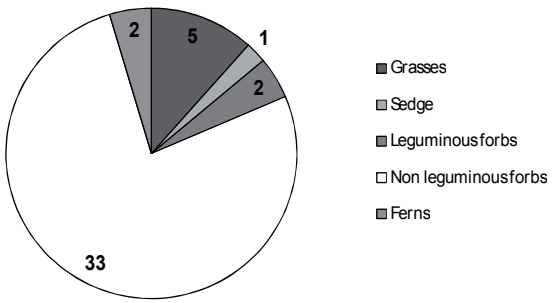

Fig. 3. Plant species assigned to various Ecological Groups.

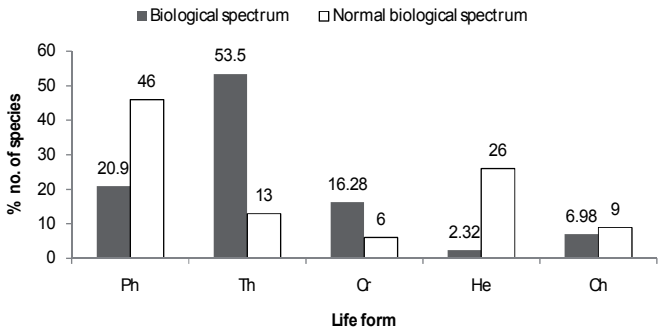

Fig. 4. Comparison of biological spectrum of the study site with the Raunkiaer's normal biological spectrum.

Table 1: Incidence of different species of fungi in garden soil and their percentage of relative abundance.

Sl. No.	Species of Fungi	Relative abundance (%)
1	*Absidia sp.*	17%
2	*Alternaria sp*	38%
3	*Aspergillus candidus*	52%
4	*A. flavus*	7%
5	*A. fumigatus*	26%
6	*A. japonicas*	39%
7	*A. niger*	25%
8	*A. ustus*	4%
9	*A. versicolor*	56%
10	*Fusarium sp.*	37%
11	*Gliocladium sp.*	30%
12	*Heterosporium sp.*	5%

13	*Humicola sp.*	8%
14	*Mucor racemosus*	28%
15	*Penicillum sp.*	26%
16	*P. oxalicum*	2%
17	*P.. rubrum*	3%
18	*Streptomyces sp.*	18%
19	*Trichoderma harzianum*	11%
20	*T. viride*	23%
21	*Yeast*	5%

Table 2 : Family wise distribution of species, growth form and their life form in the study site.

Family	Name of Species	Growth form	Life form
Acanthaceae	*Justicia japonica*	annual	therophyte
Amaranthaceae	*Achyranthes aspera*	annual	therophyte
	Alternanthera sessilis	perennial	phanerophyte
	Amaranthus spinosus	annual	therophyte
Apiaceae	*Centella asiatica*	perennial	chamaephyte
Araceae	*Colocasia esculenta*	perennial	cryptophyte
Asteraceae	*Ageratum conyzoides*	perennial	phanerophyte
	Chromolaena odorata	perennial	phanerophyte

	Eclipta alba	annual	therophyte
	Mikantha micrantha	perennial	phanerophyte
	Spilanthes paniculata	annual	therophyte
	Synedrella nodiflora	annual	therophyte
Caesalpinaceae	*Cassia sophera*	annual	therophyte
	Cassia tora	annual	therophyte
Commelinaceae	*Commelina benghalensis*	Annual	therophyte
	Floscopca scandens	Perennial	cryptophyte
Convolvulaceae	*Evolovulus nummularius*	annual	therophyte
	Ipomoea palmata	perennial	phanerophyte
	Murdania nudiflora	annual	therophyte
Cyperaceae	*Cyperus brevifolius*	perennial	cryptophyte
Dryopteridaceae	*Diplazium esculentum*	perennial	crytophyte
Euphorbiaceae	*Croton bonplandianum*	annual	therophyte
	Euphorbia hirta	annual	therophyte
	Phyllanthus niruri	annual	therophyte
Fabaceae	*Desmodium triflorum*	annual	chamaephyte
Lamiaceae	*Leucas aspera*	annual	therophyte
Lygodiaceae	*Lygodium japonicum*	perennial	cryptophyte
Malvaceae	*Urena lobata*	perennial	phanerophyte

Mimosaceae	*Mimosa pudica*	perennial	cryptophyte
Oxalidaceae	*Oxalis corniculata*	annual	chamaephyte
Piperaceae	*Peperomia pellucida*	annual	therophyte
Poaceae	*Crysopogon aciculatus*	perennial	hemicryptophyte
	Cynodon dactylon	perennial	cryptophyte
	Digitaria longiflora	annual	therophyte
	Digitaria pruriens	annual	therophyte
	Eleusine indica	annual	therophyte
Rubiaceae	*Oldenlandia corymbosa*	annual	therophyte
	Spermacoce hispida	annual	therophyte
Scrophulariaceae	*Lindernia crustacea*	annual	therophyte
	Scoparia dulcis	annual	therophyte
Solanaceae	*Solanum torvum*	perennial	phanerophyte
Tiliaceae	*Triumfetta rhomboidea*	perennial	phanerophyte
Verbenaceae	*Clerodendron viscosum*	perennial	phanerophyte

Table 3: Species enlisted to different Ecological Groups.

Ecological Groups	Name of Species
Grasses	*Crysopogon aciculatus*

	Cynodon dactylon
	Digitaria longiflora
	Digitaria pruriens
	Eleusine indica
Sedge	*Cyperus brevifolius*
Leguminous forbs	*Desmodium triflorum*
	Mimosa pudica
Non Leguminous forbs	*Achyranthes aspera*
	Ageratum conyzoides
	Alternanthera sessilis
	Amaranthus spinosus
	Cassia sophera
	Cassia tora
	Centella asiatica
	Chromolaena odorata
	Clerodendron viscosum
	Colocasia esculenta
	Commelina benghalensis
	Croton bonplandianum
	Eclipta alba

	Euphorbia hirta
	Evolovulus nummularius
	Floscopca scandens
	Ipomoea palmata
	Justicia japonica
	Leucas aspera
	Lindernia crustacea
	Mikantha micrantha
	Murdania nudiflora
	Oldenlandia corymbosa
	Oxalis corniculata
	Peperomia pellucida
	Phyllanthus niruri
	Scoparia dulcis
	Solanum torvum
	Spermacoce hispida
	Spilanthes paniculata
	Synedrella nodiflora
	Triumfetta rhomboidea
	Urena lobata
Ferns	*Diplazium esculentum*

Lygodium japonicum

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A STUDY ON ANTIMICROBIAL AND INSECTICIDAL EFFECT OF ISOLATED COMPOUND AND CRUDE METHANOLIC EXTRACT FROM THE LEAF OF *CLERODENDRUM VISCOSUM* VENT.

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INTRODUCTION

Plants, microorganisms, vertebrates and invertebrates are fine biochemical factories for the biosynthesis of both primary and secondary metabolites. Their ingenuity in creating diverse structures with generous sprinkling of functionalities and delicacies is thrilling. This is the outcome of evolution through millions of years during which they have been withstanding many tough tests of survival **[1].**

Studies on the extracts of different species of the genus *Clerodendron* have been carried out by a number of researchers round the globe **[2]**. Roots and leaf extracts of *C. indicum*, *C. phlomidis*, *C. serratum*, *C. trichotomum*, *C. chinense* and *C. petasites* have been used for the treatment of rheumatism, asthma and other inflammatory diseases **[3-7]**. Plant species such as *C. indicum* and *C. inerme* were used to treat coughs, serofulous infection, buboes problem, venereal infections, skin diseases and as a vermifuge, febrifuge and also to treat Beriberi disease **[8]**.

The plant *Clerodendron viscosum* Vent. is an indigenous medicinal plant widely distributed in various parts of India, Ceylon, Malaya and Bangladesh **[9]**. In Bangladesh, among the shrubs, the highest density (53.57 plants/100 m^2) and frequency (35.71%) were found in *Clerodendrum viscosum* **[10]**,Repellent response of *Clerodendron viscosum* to the larvae and adults of

flour Beetle, *Tribolium confusum* was studied by Husain and Hasan. They observed that both the larvae and adults were repelled by contact with different food media when mixed with leaf dusts of the plant **[11]**. The commonly reported useful parts of the plant for therapeutic uses are Root and Leaves **[12]**.

Anwar *et al.***[13]**, reported the antifungal activity of the ethanolic extract of leaf of *C. viscosum*, against *Botryodiplodia* The free radical scavenging potential of the roots of *C. viscosum* was studied by Shirwaikar and his co-workers **[14]** using different antioxidant models of screening. The ethanolic extract of the root (1000 µg/ml concentration) showed maximum scavenging of the radical cation, 2,2-azinobis-(3-ethylbenzothiazoline-6-sulphonate)(ABTS) observed upto 98.92% followed by scavenging of nitric oxide radical (96.75%), ferric ion radical (94.43%), 1,1- diphenyl, 2-picryl hydrazyl (DPPH) (92.25%) and antilipid peroxidation potential (81.13%). The aqueous extract showed only moderate activity. They commented that this finding justifies the therapeutic application of the plant in the indigenous system of medicine, augmenting its therapeutic value.

DESCRIPTION OF THE PLANT

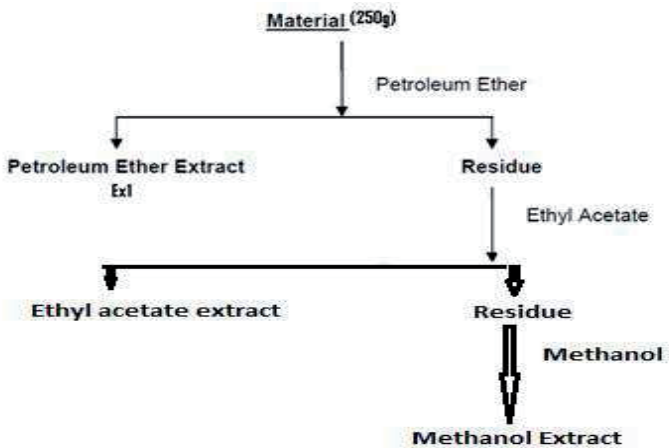
Clerodendrum viscosum, Vent. (Local name *Bhant*) is a perennial shrub with bluntly 4-angled stem. Leaves in whorls, sessile, narrow lanceolate, sub-entire, glabrous, rather hard. Flowers bluish-purple often white in pyramid shaped terminal panicles. The plant is slightly woody shrub with bluntly quadrangular stems and branches, leaves usually three at a node, sometimes opposite oblong or elliptic, serrate; flowers blue, many in long cylindrical thyrsus; fruits 4 lobed purple durpe, somewhat succulent with one pyrene in each lobe [**12, 15**].

For the present work, green leaves of the plant were collected from several growing areas in Barak Valley during March-April, 2011. The plant material was air dried at ambient temperature (~25^{0}C) and than powdered. The powdered material was used for further experimentations.

ISOLATION OF BIOACTIVE COMPONENTS

The extraction of the desiccated and grinded aerial parts was macerated consecutively with petroleum ether , ethyl acetate and methanol at room temperature & by soxhlet.

Uniformity is tested by TLC & the extraction in large scale was performed by soxhlet apparatus.



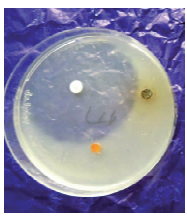
METHANOL EXTRACT

The methanol extract was fractionized by column chromatography using petroleum ether: ethyl acetate in the ratio 9.5:05 ratio as eluent

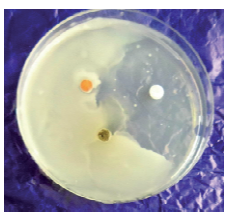
- The first fraction was collected on the basis of TLC analysis.
- The isolated fraction after purification with PTLC was screened for antimicrobial and anti-toxicity analysis.

ANTIMICROBIAL ANALYSIS

Four pathogenic stain of bacteria were collected from Silchar Medical College, Hospital viz: - *Klebsilla pneumoni, E. coli, S. Aurus, Bacillus sp*. And were tested with crude methanolic extract of leaf, Isolated compound from leaf using methanol as solvent and standard antibiotic (Ciprofloxacin) using the standard disc diffusion method. The results obtained are: -

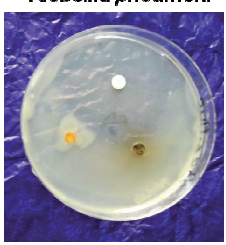


E.coli



Klebsilla pneumoni

S. Aurus



Bacillus sp

Disc diffusion method was used to determine the zone of inhibition

	Crude Extract	Isolated Compound	Standard (Ciprofloxacin)
Bacillus	0	0	6cm
Klebsilla	0	0	7cm
S. Aurus	0	0	5cm
E. coli	0	0	8cm

TOXICITY ANALYSIS

Direct toxicity analysis with *P. americana* was carried out following the method described by Talukdar and Howse and Rahman et.al. Insects were chilled at 40C for a period of 10minutes. The immobilized insects were individually picked up and 1 ml each of Crude Methanolic extract, Isolated Compound from methanolic extract and Methanol as standard were applied to the dorsal surface of the thorax of each insect by using a micro-capillary tube. 12 insects were taken for this experiments. 4 insects were kept in each Petridis. In Petridis 1, the insects were treated with Methanol as standard, In Petridis 2, the insects were treated with crude methanolic extract and in the third Petridis, the insects were treated with isolated compound. The experiment was carried out in qualitative mode and the concentration of the sample were not studied. The results obtained are:-

Substance Used	**Time**	**No of *P. americana* taken**	**Mortality**
Methanol	After 30 minutes	4	0
	After 60 minutes	4	0
	After 90 minutes	4	0
Crude Extract	After 30 minutes	4	0
	After 60 minutes	4	1
	After 90 minutes	4	1
Isolated Compound using methanol	After 30 minutes	4	0
	After 60 minutes	4	2
	After 90 minutes	4	2

CONCLUSION

From the study, it is found that both the crude extract and isolated compound from the methanolic leaf extract from C. viscosum were inactive at least against the bacteria under observation.

It is also found that the isolated methanolic compound is more toxic *to P. americana* than the crude methanolic leaf extract of *C. viscosum*.

The structural elucidation of the isolated compound is under investigation.

ACKNOWLEDGEMENT

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ENDANGERED PLANTS OF INDIA WITH SPECIAL REFERENCE TO ASSAM

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INTRODUCTION

An endangered species is a population of organisms which is at risk of becoming extinct because it is either few in numbers, or threatened due to changing environmental conditions. An **endangered** species may be defined as "taxa in danger of extinction and whose survival is unlikely, if the causal factors continue to operate." The International Union for Conservation of Nature and Natural Resources (IUCN) has calculated the percentage of endangered species as 40% of all organisms based on the sample of species that have been evaluated since 2006.Such species may decline in numbers due to threats such as habitat destruction, climate change or pressure from invasive species. The term "endangered "can be used either in general or legal context. When used in general sense, the term describes a species that faces a risk of extinction but does not necessarily indicate that the species is protected under any law. When used in a legal context, the term refers specifically to a species defined legally as an animal or plant species in danger of extinction throughout all or a significant portion of its range.

Threatened species are those species which don't fall under the endangered or vulnerable categories but indication are available that such plants may come under any of these two categories, if appropriate measures are not taken to protect them.

India is one of the twelve mega biodiversity countries of the world and it has four hot spots. These are North- East, Eastern Himalayas, Western Ghats and Andaman & Nicobar island2s. Assam is a northeastern state of India. It is part of the

Eastern Himalayan biodiversity Region and considered one of two biodiversity hotspots in India. It is the land of enchanting aesthetic beauty with lush green hills, pastures, tea gardens river plains and wilderness all around situated between $24^0 44^/$ N and $27^0 45^/$ latitude and $89^0 41^/$ E and $96^0 02^/$ longitude, the state is surrounded by Arunachal Pradesh, Nagaland, Mizoram and Meghalaya .It has also common international boundary of 500 km with Bhutan and 200 km with Bangladesh .It has an area of over 78,438 sq.km. 17.68 % of state geographical area is under reserved forests cover Over 350 plants are listed in Assam's endangered, rare, vulnerable or threatened species list. Assam is one of the richest biodiversity zones in the world and consists of tropical rain forests, deciduous forest, riverine grass lands, bamboo, orchards and numerous wetland eco systems

CAUSES OF ENDANGERED OR THREATENED SPECIES

The causes of threatened species may be of two types ---Natural and Artificial.

The natural causes responsible for endangering plants are landslides, draughts, floods, storm, earthquakes, disease etc. Other threats include invasion of exotic and other aggressive weeds air, water pollution and lack of pollinators.

Artificial or Man made threats include grazing, commercial exploitation, industrialization forestry, urbanization, scientific and

educational research, roads, dams, increasing townships, international tourism, mining and pressure of introduced plants. Over exploitation of plants, commercial purpose leads to destruction of habitat. Supply of raw material to the forest based industries is also a major cause of forest destruction in the hills. The other cause of forest destruction is due to increase in cattle population.

LIST OF SOME ENDANGERED AND THREATENED PLANTS IN INDIA:-

Sl. No.	**Species Name**	**Family**	**Uses**
1	*Aconitum deinorrhizum*	Ranunculaceae	Aconite of medicinal value
2	*Allium strachevi*	Liliaceae	Leaves are medicinal and used for flavoring also.
3	*Atropa acuminata*	Solanaceae	Used in reducing hypertension
4	*Dioscorea deltoidea*	Dioscoreaceae	Used in washing silk ,wool, dying etc.
5	*Santalum album*	Apiaceae	Timber and hard wood have economic value
6	*Nepenthes khasiana*	Nepenthaceae	Used in urinary trouble & catching of eyes.
7	*Rauwolfia serpentina*	Apocynaceae	Used in antihyperteasive & in nervous disease.

8	*Acorus calamus*	Araceae	Rhizome carminative, emetic, antispasmodic used.
9	*Dioscorea prazeri*	Dioscoreaceae	Used in washing silk, wool, dying etc.
10	*Sasurea lappa*	Asteraceae	Used in perfumery, cosmetics and antiseptic.
11	*Dischidia rafflesiana*	Asclepiadaceae	Roots chewed with betel too.
12	*Cyperipedium cordigexem*	Orchidaceae	Highly ornamental, rare, threatened due to trade.
13	*Cardans nutana*	Asteraceae	Used as a blood purifier.
14	*Commiphora wighii*	Buperaceae	Small tree exploited for its gum resin from the bark scarce.

LIST OF RARE AND ENDANGERED HIMALAYAN PLANTS

(i) **TREES** :-

Sl. No.	**Species name**	**Family**	**Locality**	**Uses**
1	*Castanopsis tribuloides*	Fagaceae	Himalayas	Fruits edible
2	*Elaeocarpus*	Elaeocarpaceae	Sylhet, Khasi,	Fruits

	prunifolius		Jayantia Hills	edible
3	*Euonymus echinatus*	Celastraceae	In Himalayan regions, Khasi & Jayantia Hills	
4	*M. pterocarpa*	Magnoliaceae	Himalayas to Assam	Its roots and root bark are *used* as purgative, the flowers and fruits as carminative and in renal and veneral diseases.
5	*Pinus gerardiana*	Pinaceae	Kashmir, Himachal Pradesh, western Himalayas	Edible proteinaceous kernel, commercial timber.
6	*Populus gamblei*	Salicaceae	Punjab plains, Himalayas	Plywood, boats, shoe-heels.
7	*Rhododendron arboretum*	Ericaceae	Himalayas, from Kashmir to Bhutan.	Tender leaves are used as

				vegetable and to relieve head ache.
8	*Picea brachytila*	Piniaceae	N.E, Assam	As timber
9	*Populus euphratica*	Salicaceae	Punjab plains	fodder for livestock, timber and, potentially, fibre for making paper.
10	*Malus baceata*	*Rosaceae*	Southwards to Himalayas	Ornamental, fruits edible.
11	*Cycas beddomei*	Cycadaceae	Andra Pradesh, Karnataka, Kerela, Tamilnadu.	The male cones of the plant are used in Ayurvedic medicine as a cure for rheumatoid arthritis and muscle pain.
12	*Pterocarpus*	Fabaceae	India	Used as

	santalinus			woods
13	*Decalepis hamittonii*	Apocynaceae	The species is endemic to peninsular India	Used as vegetables &root is used in ayurvedic medicines.

(ii) HERBS

Sl. No.	**Species name**	**Family**	**Locality**	**Uses**
1	*Alpania galanga*	Zingiberaceae	Throughout India , from the foot of Himalayan to Ceylon	It has carminative, anti tuberculosis and stimulant properties also used as vegetables
2	*Atropa acuminata*	Solanaceae	Western Himalayas altitude. 6000 to 11000 feet from Kashmir to Shimla	used in herbal medicine for centuries as a pain reliever, muscle relaxer, and anti-inflammatory.

3	*Coptis teeta*	Ranunculaceae	Assam	As antibiotics
4	*Colohicum Luteum*	Liliaceae	Western temperate Himalayas Kashmir, Altitude 4000-7000 feet.	Carminative , laxative , Rheumatism
5	*Helminthostachys zeylanica*	*Ophioglossaceae*	Kashmir & N.W. Himalayas	Bitter tonic for improving appetite urinary trouble

LIST OF ENDANGERED PLANTS IN ASSAM.

Sl. No.	**Species Name**	**Family**	**Locality**
1	*Achanthephipium silhetense*	Orchidaceae	Garampani, Golaghat
2	*Aranthera tomentosa*	Rubiaceae	Assam
3	*Adinendra griffithii*	Theaceae	Assam
4	*Brassiopsis Polycantha*	Araliaceae	Upper Assam
5	*Begonia Tessaricarpa*	Bgoniaceae	Assam
6	*Bulbophllum mishmeense*	Orchidaceae	Assam
7	*Cassia Wallichiana*	Leguminocae	Manas
8	*Ceropegia Lucida*	Asclepiadaceae	Cachar
9	*Chysolossum Assamicum*	Orchidceae	Assam
10	*Dendrobium Aruanticum*	Orchidceae	Assam
11	*Dioscorea Deltoidea*	Dioscoreaceae	Assam

12	*Goodyera prainii*	Orchidaceae	Assam
13	*Habenaria Trifurcata*	Orchidaceae	Assam
14	*Hedyotis brunonsis*	Rubiaceae	Assam
15	*Lagerstroemia Minuticarpa*	Lythraceae	Assam
16	*Livistona Jenkinsiana*	Arecaceae	Assam
17	*Maba Cacharensis*	Ebenaceae	Cachar
18	*Magnolia Caveana*	Manoliaceae	Assam
19	*Michelia Baillonii*	Manoliaceae	Assam
20	*Michelia Mannii*	Manoliaceae	Upper Assam
21	*Ophiorrhiza Hispida*	Rubiaceae	Assam
22	*O. Tingens*	Rubiaceae	Assam
23	*Orophea Polycarpa*	Annonaceae	Cachar
24	*Paphiopedilum spicerianum*	Orchidaceae	Cachar
25	*Phlogocanthus asperula*	Acanthaceae	Upper Assam
26	*Polysolenia wallichii*	Rubiaceae	Cachar
27	*Stylidium Kunthii*	Stylidiaceae	Kamrup
28	*Symplocos glauca*	Symplocaceae	Assam
29	*Syzygium Assamicum*	Myrtaceae	Assam
30	*Vanilla pillifera*	Orchidaceae	Assam

CONSERVATION OR PROTECTION OF ENDANGERED PLANT SPECIES

Throughout the world, there is growing awareness for conservation and protection of endangered flora and fauna. Red Data Books on endangered animals, birds and flowering plants have been prepared by the survival service commission of International Union for Conservation of Nature and Natural Resource (IUCN). It has been estimated that out of 18000 to 20000 species of flowering plants in India , about 1000 species fall into the

conservation category (rare, endangered, vulnerable or depleted) and need adequate conservation .In fact , the 10^{th} general assembly of the IUCN held in New Delhi in 1969 had focused attention on the urgent need to protect endangered species in Indian flora and urged to the govt. to bring these endangered plants to effective cultivation .Thus some of our notable plants like *Rauwolfia serpentina* (Sarpagandha), *Dioscorea deltoides*, *Cypripedium cordigerum* (Lady slipper orchid), *Nepenthes Khasiana* (pitcher plant) and *Rheum nobile* have been decimated and are being threatened with extinction in their original habitat.

CONCLUSION

During last decade, various efforts have been made to rehabilitate the forest cover through launching of aforestation programme. These can be implemented well only when the problems related to these are fully understood.

Botanical gardens and sanctuaries play a major role in the conservation and protection of endangered flora and fauna. Exchange of information on plant material would serve in preserving germplasm. Cultivation of endangered plants in botanical gardens would serve as a collection for better genetic resources for future generation. Popularization of rare and endangered plants in the agricultural fields may be used to protect them extinction. Studies on germination, growth, flowering, fruiting, and acclimatization of species are also of great importance for successful cultivation.

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SYNTHESIS AND ANTIMICROBIAL STUDIES OF SILVER NANOPARTICLES USING LEMON JUICE, JUJUBE JUICE AND TAMARIND JUICE

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INTRODUCTION

Nanoparticles are being viewed as fundamental blocks of nanotechnology. The most important and distinct property of nanoparticles is that they exhibit larger surface area to volume ratio. The most effectively studied nanoparticles are those today that are made from noble metals in particular, Ag, Pt, Au and Pd. Metal nanoparticles have tremendous application in the area of catalysis, optoelectronics, diagnostic biological probe and display devices. Among those, Silver nanoparticles (AgNP) play a significant role in the field of biological systems, living organisms and medicine [1-3].

The nanoparticles can be synthesized by different methods including chemical, physical, irradiation, and biological methods. The development of new chemical or physical methods has resulted in environmental contaminations, since the chemical procedures involved in the synthesis of nanomaterials generate a large amount of hazardous byproducts [4]. Thus, there is a need for 'green nanotechnology' that includes a clean, safe, eco-friendly and environmentally nontoxic method of nanoparticle synthesis and in this method there is no need to use high pressure, energy, temperature, and toxic chemicals [5, 6]. The biological methods include synthesis of nanomaterials from the extracts of plant, bacterial, fungal species, and so

forth. The synthesis of nanoparticles from the plant extracts is considered to be a process [7]. Plant extracts include bark, root, leaves, fruit, flowers, rhizoids, and latex and are used to synthesize the nanoparticles. These nanoparticles show different dimensions including the size, shape, and dispersion which have more efficacy than those synthesized from the chemical and physical procedures. Therefore, the use of green plants for similar nanoparticle biosynthesis methodologies is an exciting possibility which has compatibility for pharmaceutical and other biomedical applications, as they do not use toxic chemicals for the synthesis of nanoparticles [8, 9]. Silver nanoparticles have wide application in biomedical science like treatment of burned patients, antimicrobial activity and used the targeted drug delivery, and so forth [10].Use of plant products for the synthesis of nanoparticles does not require high energy, temperatures, and it is easily scaled up for large scale synthesis, and it is cost effective too[11–13].

In the present work, we furnish an account of green technique for synthesizing silver nanoparticles using plant juices as reducing agents. Nanoparticles of different particle sizes have been accessed from Silver Nitrate solution using juices of *Citrus limon*(Lemon), *Ziziphus mauritiana*(Indian Jujube)and *Tamarindus indica*(Tamarind) as natural mild reducing agents and there inhibitory effects on both gram positive and gram negative bacteria.

MATERIALS AND METHODS

Reagents:

All the chemicals used were of analytical grade except the plant juices. Juices of *Citrus lemon, Ziziphus mauritiana* and*Tamarindus indica* were collected by cutting and rubbing the ripen fruits after washing. The juices were filtered and were used as natural mild reducing agents.

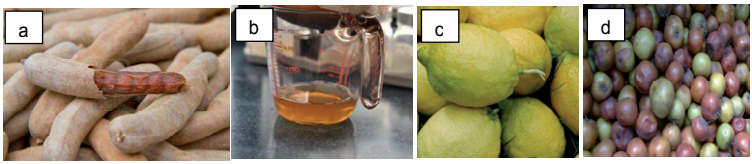
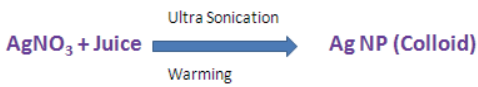


Fig.1:[a] *Tamarindus indica*,[b] *Tamarindus indica* juice, [c]*Citrus limon,* [d]*Ziziphus mauritiana*

Synthesis of Silver Nanoparticles (Ag NP):

To a certain amount of silver nitrate solutions (0.1N and 0.01 N), a certain amount (0.5 ml, 1 ml, 1.5 ml, 2 ml, 3 ml, 4 ml) of plant juices(V/V) were added dropwise with the help of a syringe with constant shaking in different test tubes. The mixture was sonicated by an ultrasonicator for 5 minutes. The solutions on warming produces silver nanoparticles of different characteristic colours. No external stabilising agent was used in the synthesis as the plant juices containing different chemical components acts simultaneously as reducing agent and capping agent for stabilization of nanoparticles. The AgNPs solution thus obtained was purified by repeating the centrifugation thrice at 5000 rpm for 20 min followed by redispersion in deionised water.

Schematic Representation of Synthetic Strategy



Concentration of $AgNO_3$ =0.1 N and 0.01 N

Ratio of $AgNO_3$ and Juice(V/V) =1 : 1,1 : 2, 1 : 3,1 : 4, 1 : 5,1 : 6, 1 : 7, 1 : 8, 1 : 9, 1 : 10 etc.

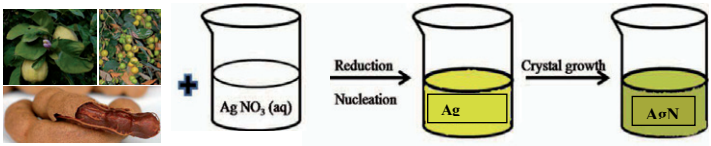


Fig.2: Fruit juice mediated production of AgNP

The synthesized AgNP were coded as L1, L2, L3 etc for lemon juice products, B1, B2, B3 etc for jujube juice products and T1, T2, T3 etc for tamarind juice product depending on the mixing ratio of juice and silver nitrate solution.

ANTIMICROBIAL ACTIVITY STUDIES

Silver nanoparticles synthesized using fruit juices were tested against multi drug resistant strains of both Gram positive and Gram negative strains. The microorganisms used were *Bacillus subtilis* and *Escherichia coli.* Disc diffusion method was used to determine the zone of inhibition. The sterile molten Muller & Hynton agar cooled to 45^0C was inoculated with different organism. The inoculum used was the young cultures and the inoculum size was standardized in such a way that each ml contains 108 cells. Under aseptic technique the inoculum was uniformly inoculated over the molten agar by using sterile cotton swab. Wattman No 2 filter paper disc of 6mm diameter containing 200 µl/disc of sample was placed over the inoculated medium. The plates were allowed to remain in the room temperature for 2 hours. After two hours the plates were incubated at 37^0C for 24 hours. The zone of inhibition was measured using a Zone Reader scale.

RESULTS AND DISCUSSION

The green synthesis of silver nanoparticles using plant juices was successfully carried out, as the change in the colour of the solution from pale yellow to dark brown colour exhibits the reduction of the silver nitrate in

aqueous solution due to excitation of surface plasmon vibrations in silver nanoparticles [14]. Applying the principle of green chemistry, the bioreduction of silver nitrate with *Tamarindus indica, Citrus limon*and *Ziziphus mauritiana* juicesas natural mild reducing agent resulted in the formation of AgNPs. The synthesized nanoparticles were stable for months at room temperature. The different colours were obtained due to the difference in particle size of the silver nanoparticles. The colour of the silver nanoparticles varied from pale red, reddish brown, orange, blue to blackish blue etc. It is pertinent to mention that the control of concentration of the solution is crucial to the synthesis as otherwise grey silver metal precipitates out. The plant juice contains a variety of phytochemical compounds such as starch, tartaric acid, citric acid, vitamin C, sugars and proteins, and these molecules are expected to self-assemble and cap the metal nanoparticles formed in their presence and thereby induce some shape control during metal ion reduction and arrest their agglomeration [15].

Tamarindus indica juice consists of a mixture of tartaric acid, invert sugar, protein, starch, fibres etc. These are responsible for reduction of Ag^{+} ion to AgNPas well as its stability.

Fig.3: AgNP using Tamarind juice as reducing agent

*Citrus limon*juice is a mixture of chemical components. Citric acid is one of the major components of the mixture, but so are water, ascorbic acid, and a number of others. The reducing agent mainly is citric acid and all are responsible for AgNP stability.

Fig.4: AgNP using Lemon juice as reducing agent

Ziziphus mauritiana juice contains about 6% sugar, 1.6% Proteins and ascorbic acid (40 mg/100g). These chemicals could be responsible for both reduction of Ag^{+} ions to AgNP and their stability.

Fig.5: AgNP using Indian Jujube juice as reducing agent

The antimicrobial activity of the synthesized silver nanoparticles was studied by monitoring the zone of inhibition in Sterile Muller Hinton agar, cooled to 45^{0}C by disc diffusion method. The synthesized silver nanoparticles (AgNP) exhibited very good inhibitory effect against both gram positive, e.g., *Bacillus subtilis* and *gram* negative, e.g., *E. coli* bacteria relative to standard norfloxacin. The diameter of inhibition zones are represented in table-1 and the values are graphically represented in bar diagram [Fig.6].

The AgNP synthesized using jujube juice has shown higher inhibitory effect against *Bacillus subtilis* ascompared to *E. coli.* However, AgNP obtained from lemon juice has shown almost similar inhibitory effect against both *E. coli* and *Bacillus subtilis.* Silver nanoparticles from tamarind juice also exhibitedvery good antimicrobial activity against both *E. coli* and *Bacillus subtilis.* The solvent used was deionised water and it has no antimicrobial activity as such.

.Table.1: Antimicrobial studies against some selected microbes

Microbes	Standard NX10 (mm)	L1 (mm)	L2 (mm)	L4 (mm)	L5 (mm)	L6 (mm)	B4 (mm)	B6 (mm)	B7 (mm)	T1 (mm)
Bacillussubtillis	50	21	17	20	23	25	23	23	25	23

E. Coli	50	20	20	24	20	22	18	17	14	18

Codes for synthesized nanoparticles

L1= AgNP prepared by mixing Lemon juice: Ag NO_3 = 1:1

L2 = AgNP prepared by mixing Lemon juice: Ag NO_3 = 1:2

L4 = AgNP prepared by mixing Lemon juice: Ag NO_3 = 1.5:1

L5 = AgNP prepared by mixing Lemon juice: Ag NO_3 = 1.25:1

L6 = AgNP prepared by mixing Lemon juice: Ag NO_3 = 1:1.5

B4 = AgNP prepared by mixing Jujube juice: Ag NO_3 = 1.5:1

B6 = AgNP prepared by mixing Jujube juice: Ag NO_3 = 1:1.5

B7 = AgNP prepared by mixing Jujube juice: Ag NO_3 = 1:2

T1 = AgNP prepared by mixing Tamarind juice: Ag NO_3 = 1:2

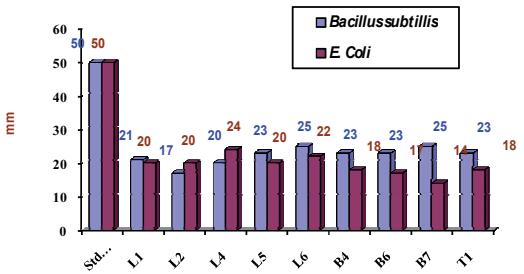


Fig.6: Graphical representation of antimicrobial activities of the selected AgNP

The exact mechanism of the inhibition of the bacteria is still unknown, but some hypothetical mechanisms show that the inhibition is due to ionic binding of the silver nanoparticles on the surface of the bacteria which creates a great intensity of the proton motive force and the one hypothesis states that

the silver nanoparticles invade the bacterial cell and bind to the vital enzymes containing thiol groups [14-16]. It is also believed that silver nanoparticles after penetration into the bacteria have inactivated their enzymes, generating hydrogen peroxide and caused bacterial cell death [17]. Heavy metals are toxic and react with proteins, therefore they bind protein molecules and as a result cellular metabolism is inhibited causing death of microorganism [18]. The present investigation showed that plant juice mediated synthesised silver nanoparticles can be used as effective growth inhibitors in various micro organisms, making them applicable to diverse medical medicines and antimicrobial control systems.

CONCLUSION

In the present study, the silver nanoparticles are synthesized successfully by utilizing the natural reducing agents *Citrus limon, Ziziphus mauritiana* and*Tamarindus indica*juices. The synthesis of silver nanoparticles using juices of fruits provides an environmental friendly, simple and efficient route for synthesis of noble metal nanoparticles. This green synthetic strategy would a powerful tool for large scale synthesis of Ag NP in a cost effective way. Furthermore, this method can be scaled up and other fruits juices can be used for the synthesis of nanoparticles of desired dimension. The synthesized nanoparticles showed a broad spectrum antimicrobial activity against both Gram positive and Gram negative bacteria. Investigation on the antibacterial activity of synthesized silver nanoparticles using tamarind, lemon and jujube juice against *E. coli* and *Bacillus subtilis* reveals high potential as antimicrobial agent in pharmaceutical, food, and cosmetic industries.

For detailed study and deeply characterization of nanoparticles, in future X-ray diffraction measurements (X R D), transmission electron microscopy measurements (TEM) and scanning electron microscopy measurements (S E M) may be practiced. Until these data it will be impractical to comment on

their dimension especially actual particle size and morphology and their correlation with antimicrobial properties.

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PHYTOCHEMICAL SCREENING AND *IN VITRO* EVALUATION OF CRUDE EXTRACTS OF *CITRUS MACROPTERA* (RUTACEAE) FOR POTENTIAL ANTIBACTERIAL ACTIVITY.

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INTRODUCTION

Citrus macroptera belongs to the family Rutaceae, is a rich source of vitamin C. There are about 140 genera and 1300 species in the family Rutaceae. They are widely distributed in tropical to warm and temperate regions. In our country the family is represented by several important genera such as *Citrus, Aegle, Feronia, Murraya, Ruta* etc. Usually the plant species are trees or shrubs. Some of the shrubs are climbing and xerophytes. Species of *citrus* are small trees. They are grown in the gardens for their fruits rich in vitamins. Most of the species belong to this family are fairly important from economic view point as it consists of many fruit yielding and medicinal plants. Some of the plant species are used in various ways in the pharmaceutical, confect ional and toilet preparations. The fruits are used for making jam, jelly, pickles and alcoholic drinks. Most of the *citrus species* are a very good source of vitamin C.

The leaves of *Citrus aurantium* are the source of an essential oil which is used in the preparation of cosmetics, perfumes and confect ional. An essential oil is extracted from the leaves of *Citrus limmettiodes,* known as 'Petigrain oil' which is used in perfumery, confectionary etc. It is rich in vitamin C. *Citrus lemon* fruits are known as 'Pat nimbu' employed in the preparation of pickles and lemon squash. *Citrus maxima, C.medica, and*

C.paradisi are rich in vitamin C and their fruits are edible. *Citrus reticulata* is also rich in vitamin C, fruits are edible and the extracted essential oil is used in the manufacture of perfumery and cosmetics and other pharmaceutical products. From *Citrus sinensis,* orange oil is extracted from fruit peel.*Citrus macroptera,* a shrub is grown particularly in the North Eastern region of India, i.e., Assam, Mizoram and Tripura state. The pericarp of the fruits of *Citrus macroptera* is consumed by both plains (Bengalee) and tribal people of North Eastern India. The extract from the juicy hairs of *Citrus macroptera* is generally used to treat against headache, stomach ache. It is also reported that the leaves extract or dry leaves are used in the preparation of curries, different types of dishes. It is believed that the plant possesses an antioxidant potentiality and alkaloids. The alkaloid components may be used to treat against the diseases caused due to microbes.

In this context, antibacterial potential of *Citrus macroptera* against some pathogenic bacteria was studied. The study includes effect of some organic and aqueous extracts of *Citrus macroptera* against four bacterial strains. Preliminary phytochemical screenings were also conducted.

MATERIALS AND METHODS:

Collection of plant material: *Citrus macroptera* (Shatkora; local Bengali name) was collected from the Matijuri area of Hailakandi district in the month of November, 2010. The plants were identified and voucher specimens have been deposited in the Department of Botany, S.S. College, Hailakandi.

Extraction procedure and phytochemical screening: The plant material was carefully cleaned under running tap water and finally with sterile distilled water. It was air-dried and powdered with the help of a mixer grinder. Approximately 20 gm. of powdered plant material of *Citrus macroptera* was extracted by cold percolation in benzene, methanol, ethanol or about 200ml. autoclaved water. The extracts were then decanted, filtered

with Whatman No. 1 filter paper and concentrated at reduced pressure below 40^0Cthrough rota vapour and lyophilized to obtain dry extract. 0.1 mg. crude extracts were taken up for biological screening and also to observe the presence and absence of different phytochemical constituents, viz, alkaloids (Dragendorff's test), saponins (foam formation), flavonoids [using manganese (Mn) and dil. HCl], and terpenes (Liebermann- Burchard's test) according to standard methods (Sofowo, 1982, Trease and Evans, 1987).

Test micro-organisms: Four test micro-organisms were used in antibacterial sensitivity test procured from Microbial Type Culture Collection and Gene Bank (Silchar Medical College, Silchar) i.e., Gram positive *Bacillussubtilis* and *Staphylococcus aureus* and Gram negative *Escherichia coli* and *Klebsilla sp.* All the bacterial strains were maintained at 4^0C nutrient agar slants and sub-cultured as required.

Antibacterial activity: The disc diffusion method was employed to evaluate the antibacterial activity. Bacteria were cultured overnight at 37^0C nutrient broth andwere used as inoculums. 20ml. nutrient agar medium was poured in sterilized Petri plates and allowed to solidify at room temperature. 24hour broth culture of test bacteria was used as inoculums under sterile condition. The freshly activated 100ul of organisms was set to 0.5 optical densities and spread with a sterile L shaped bent glass rod. Using cork borer several wells of 6 mm. diameter were punched. To each well 100ul crude extract of various concentrations were added. Ciprofloxacin were used in making of extracts. The plates were incubated at 37^0C. Streptomycin and Ciprofloxacin were used as positive and negative control respectively. The experiment was performed and average results were recorded.

RESULT AND DISCUSSION

Preliminary phytochemical screening of the plant showed the presence of alkaloids and flavonoids in *Citrus macroptera* while other

components were absent. The results of testing antibacterial activity of crude extracts of *Citrus macroptera* are presented. These were obtained by the disc diffusion method against various bacterial strains. Streptomycin and ciprofloxacin were used as positive and negative control respectively. Plant was extracted using both aqueous and organic solvents. The maximum antibacterial activity was observed in methanol extract of the plant against the *Staphylococcus aureus* and minimum zone of inhibition observed in benzene extract against *Klebsilla*. Data obtained demonstrates that the antibacterial activity of plant depends largely upon the types of solvent used for extraction. Data also indicate that almost all organic extracts of the plant showed antibacterial activity against the tested bacterial isolates.

From the work done, it can be concluded that the barks of *Citrus macroptera*, contained alkaloids and flavonoids which was confirmed by the different tests performed, while other components were absent. They also showed the antibacterial activity against bacteria. Alkaloids and flavonoids are an important group of polyphenolic compound which may be used against many diseases and ailments.

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Fig1: Leaves of *Citrus macroptera*

Fig2: Extracts of *Citrus macroptera*

Fig3: *Klebsiella* sp*, S. aureus showing* zone of inhibition in benzene extract

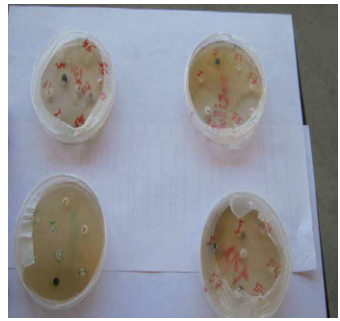

Fig4: *E. coli, B. subtilis & K.sp* showing zone of inhibition in benzene extract

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