A.V.C. COLLEGE (AUTONOMOUS)

MANNAMPANDAL - 609305, MAYILADUTHURAI

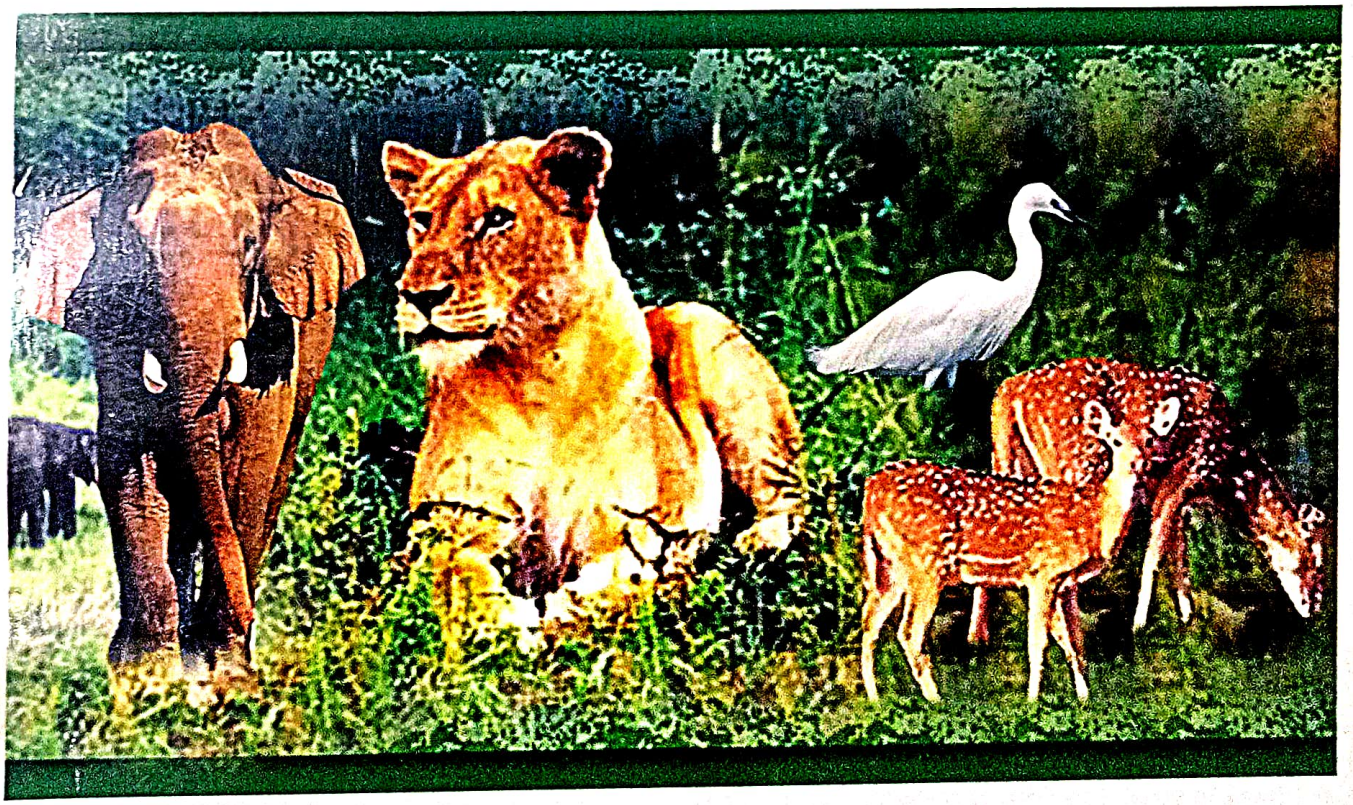
Nagapattinam District, Tamilnadu

UGC Sponsored National Seminar on

"EMERGING TRENDS IN CONSERVATION SCIENCE"

22nd & 23rd March 2011

EMCONS - 11



Organised by

PG & RESEARCH DEPARTMENT OF ZOOLOGY & WILDLIFE BIOLOGY

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(EMCONS' 11)

ABSTRACTS

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& WILDLIFE BIOLOGY

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HIGHLIGHTS OF THE PG AND RESEARCH DEPARTMENT OF ZOOLOGY & WILDLIFE BIOLOGY

The department was offering Zoology at the Pre University class and ancillary level from 1958 to 1966. University of Madras granted affiliation to this college to start B.Sc., Zoology course in the academic year 1966-1967. In 1980-81, the department had the privilege of starting the unique M.Sc. course in Wildlife Biology in India and thereafter it was recognized as a Research Department with the starting of part time and full time M.Phil courses in Zoology and Wildlife Biology in the year 1982. In addition, part-time and full time Ph.D. programmes were launched in 1983. Presently the Department is full fledged with UG, PG. M.Phil and Ph.D., both full time and part-time. Besides, M.Sc., Zoology was started during the academic year 1994-95 in the evening section.

In 2003-04, B.Sc. Biotechnology & M.Sc. Bio-informatics courses were started in the self finance section as a part of our Zoology Department and now they are functioning as independent departments.

Till date totally 45 Ph.Ds and 300 M.Phils were awarded based on their research works on elephants, large carnivores, endangered primates, coastal and nocturnal birds, and on the diversity of amphibians, reptiles and invetebrates including diversity of bees (honey bee), spiders, earth worms, molluscs, etc., in the last 30 years.

The faculty members have successfully completed more than 25 Research projects to the tune of more than 1 crore financially assisted by National and International funding agencies.

STAFF STRENGTH AND QUALIFICATION

The present position of this department is due to the unstained sincere and hard working of the faculty members. The present staff strength is 17 including 13 male and 4 female.

Dr. P.Govindan formerly Dean, Professor and Head of the Department of Zoology Annamalai Univesity worked as Professor Emeritus from 1980-1990. Prof Dr. D. Thomas from Kerala worked as P.G. Professor and Dr. R. Natarajan, Former Director, CAS, in Marine Biology, Annamalai Univesity joined as CSIR Emeritus Scientist on July, 1993 worked upto 1994.

Among the present faculty members, 9 have Ph.D. qualification and 7 have acquired M.Phil.degree with SLET and NET. One of them got trained at Smithsonian Institution,

USA on Wildlife Conservation and at Paignton Zoo UK, on captive animal management and another one got his Ph.D. in behaviorial ecology at United Kingdom. Three members had training on various aspects of Wildlife studies and management at the Wildlife Institute of India, Dehra Dun. Two of them are pursuing their Ph.D., programme on part-time basis.

The Department has a strength of 17 faculty members, with a teacher student ratio of 1:19 which is adequate to carry out the teaching and research activities normally. All the staff members are with M.Phil/Ph.D. research degree and most of them are guiding M.Phil/Ph.D. research degrees. They have totally attended.more than 100 seminars/ workshops/ symposia and presented around 100 papers of which 22 are international and 78 are national. Our staff members are members of board of studies and board of examiners in various universities and research institutes such as Bharathidasan University, University of Madras, Bharathiyar University, Mononmaniam Sundaranar University, Annmalai Univesity, Periyar University, Thiruvallular Univeristy, University of Delhi, Osmonia University, Salim Ali Centre of Ornithology and many autonomous colleges.

The faculty members have become the members of International and National Professional bodies and societies such as Association for the Study of Animal Behaviour, British Ecological Society, London Malaocological Society, American Psychological Society, Wader Study Group, Indian Society for Parasitology, World Pheasant Association, Bombay Natural History Society, Society for Agricultural Ornithology, World Wide Fund for Nature, India, IUCN Species, Survival Commission, Veterinary Specialist Group and Pheasant Specialist Group, Primate group, Amphibian group, etc.,

RESEARCH ACTIVITIES

Till date, 40 candidates have been awarded with Ph.D. degree and about 20 Ph.D. Scholars are actively engaged in their research programme. Within a span of ten years 300 scholars have completed M.Phil. and currently eight scholars are doing M.Phil. programme in Zoology and Wildlife Biology. Totally 80 M.Phil., scholars have been awarded degree for past five Years (2003-2008).

PROJECT DETAILS

Till date 30 Research projects with a total amount more than one crore have been successfully completed and submitted project reports to the respective funding agencies. Since the confirmation of autonomous status 15 projects worth of Rs. 68.65.559.00 have been completed till 2008.

ACADEMIC CURRICULUM

The academic curriculum of M.Sc. Wildlife Biology has special papers like Ornithology, Mammalogy, Ethology, Forest Entomology, Wildlife Management Techniques, Management of Zoos, Sanctuaries & National Parks and Recent Trends in Wildlife Biology, Computer and Mathematical Applications in Wildlife Science etc., The students understand the rich wildlife biodiversity and the importance of management and conservation through this course.

In the final semester (4th semester) the students exclusively carryout independent field project works in protected areas in collaboration with the Forest Department and other research organizations like Bombay Natural History Society (BNHS), Kerala Forest Research Institute (KFRI), Salim Ali Centre for Ornithology and Natural History (SACON), Indian Institute of Science (IISc.), etc., Students of this course are regularly participating in the wildlife census operations of several Wildlife Sanctuaries and National Parks and thereby get a very good opportunity for field training.

The students with a Wildlife Biology degree are having better prospects in the Forest Department, Zoos, and in protected areas as Biologists besides teaching career. Thus the Wildlife Biology degree holders have additional avenues of employment.

PROSPECTS OF WILDLIFE BIOLOGY GRADUATES

We proudly place on record that one of our alumni is the Additional Director in the Ministry of Environment, Forest and Wildlife and many are working as scientist at Salim Ali Centre for Ornithology and Natural History (SACON), Bombay Natural History Society (BNHS), Wildlife Institute of India (WII), Gujarat Government's Institute of Desert Ecology, Zoological Survey of India (ZSI), Central Marine Fisheries Research Institute (CMFRI), Centre for Cellular and Molecular Biology (CCMB), Snake Park and World Wide Fund for Nature. Furthermore, a few alumni are working as Wildlife Scientist in several countries viz., Unites States of America (USA), United Kingdom (UK), Singapore, Taiwan, China and Israel. Moreover, more than 50 alumni are working in several ongoing projects in many reputed Institutions. One of our alumni participated as a crew member in the Antarctica Expedition.

M.Sc. Zoology curriculum has been revised in order to enable the students to take up regional and National competitive exams including SLET and NET. In order to have a basic knowledge of other subjects. EDC subjects are offered to PG students of other department. We offer Health Education and Medical Zoology to students of other departments.

Based on the existing higher secondary syllabi, UG programme has been revised. In the revised syllabus, the recent subjects such as Biotechnology. Bio-informatics and Microbiology have been introduced.

The department has adequate learning facilities to students and research scholars with well equipped B.Sc. M.Sc., M.Phil., and Ph.D. labs. Modern equipments have been added in the last five years to enhance the laboratory facilities.

The department has been conducting various research activities in Wildlife Biology in collaboration with Tamil Nadu Forest Department, Bombay Natural History Society, Salim Ali Centre for Ornithology and Natural History and Wildlife Institute of India, in M.Sc., M.Phil., and Ph.D. research in Wildlife Biology. The topics for research are suggested according to the requirements of information needed for Wildlife Conservation and management of the Forests and the students avail stipend or financial aid for partial financial support from the above agencies for the research work. Our staff members are also acting as resource person in various committees such as Tamil Nadu Forest Department, National Biodiversity Strategy and Action Plan, Department of Environment, Aduthurai Rice Research Institute, Tamilnadu Agricultural University and guest faculty at Wildlife Institute of India (WII), Dehradun, SACON, Coimbatore etc.,. Thus a lot of collaborative researches with external agencies are going on the department. Our staff members are also doing collaborative research with other departments of our college namely Botany, Chemistry, Microbiology, Biotechnology, Bioinformatics and Economics. We also offer consultancy services on the preparation of EIA (Environmental Impact Assessment) for Industries.

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PROGRAMMES (22-03-2011)

Registration	: 9.00 – 10.00 am
Inaugural Function	: 10.10 – 11.00 am
Prayer	:
Welcome Address	: Dr. K. Thiyagesan, HOD & Organizing Secretary EMCONS'11
Presidential Address	: Thiru. C. Senthilvel, Secretary, AVC Institutions
Inaugural Address	: Dr. A. Ramalingam, Director, AVC Institutions
Key Note Address	: Thiru. I. Anwardeen, IFS., District Forest Officer, Trichy Division
Vote of Thanks	: Dr. M. Varadharajan, Associate Professor of Zoology
Tea Break	: 11.00 -11.15 am

Technical Session I

Invited Talk I 11.15 – 12.15 pm

Introduction of Resource Person : Dr. S. Sandilyan

Resource Person : Dr. K. Kathiresan,
Professor, CAS in Marine Biology,
Parangipettai

Theme : "Conservation of Mangroves"

Invited Talk II 12.15 – 1.15 pm

Introduction of Resource Person: Mrs. G. Sharmila

Resource Person : Dr. N. Parthasarathy,
Professor & Head, CEES, Pondicherry University,
Puducherry

Theme : Conservation Science and Biodiversity

Lunch Break : 1.15-2.00 pm

Technical Session II

Invited Talk III 2.00 – 3.00 pm

Introduction of Resource Person: Dr. J. Pandiyan

Resource Person : Dr. K. Emmanauvel Rajan,
Assistant Professor, Department of Animal Science,
Bharathidasan University, Trichy

Theme : "Molecular methods to examine Genetic Diversity"

Tea Break : 3.00 -3.15 pm

Invited Talk IV 3.15 - 4.15 pm

Introduction of Resource Person: Dr. V. Thenmozhi

Resource Person : Dr. P. S. Easa
Wildlife Biologist, Asian Biodiversity Conservation Trust, Kerala

Theme : "Elephant Conservation Challenges in India"

Paper Presentations by Participants 4.15 - 5.15 pm

Chairman : Dr. P.S. Easa
Rapporteur : Mr. R. Manikannan and Ms. P. Umamaheswari

Oral Paper presentation : Abstracts No: 1 to 10

Day – II : 23.03.2011

Technical Session III :

Paper Presentations by Participants 9.00-10.00 am

Chairman : Dr. R. Nagarajan
Rapporteur : Dr. M. Karthikeyan and Dr. T. Sumathi

Oral Paper presentation : Abstracts No: 11 to 20

Invited Talk V 10.00 - 11.00 am

Introduction of Resource Person : Mr. V. Duraimurugan

Resource person : Dr. G. Ravikanth, Fellow,
Conservation Genetic Lab, ATREE, Bangalore
Karnataka

Theme : "Conservation of Forest Genetic Resources of Western Ghats"

Tea Break : 11.00 am – 11.15 am

: **Invited Talk VI 11.15am - 12.15 pm**

Introduction of Resource Person : Mr. M. Baskaran

Resource Person : Dr. D. Muralithara Rao, Assistant Professor,
Department of Biotechnology, SKD University,
Ananthapur, Andhra Pradhesh

Theme : "Molecular Tools for Conservation Science"

COASTAL MANGROVE FORESTS: ROLE IN MITIGATING CLIMATIC CHANGE & GLOBAL WARMING

Professor K. Kathiresan, D.Sc.,
Centre of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai: 608 502, India

Coastal Mangrove forests are highly productive ecosystems built by a small group of 73 species of trees and shrubs that occupy the boundary between land and sea of tropical and subtropical regions. The mangrove forests are often called "tidal forests", "coastal woodlands" or "oceanic forests". They are marvel of nature, ecological wonder and scenic splendor with arching roots, breathing roots, salt vomiting leaves and mud-dancing fishes and breath-taking beauty.

They cover 15.2 million hectares in 123 countries and territories, making them globally rare habitat type. India is endowed with a mangrove cover of 4639 sq. km; of which 60% is on east coast, 27% is on west coast and the remaining 13% on the Andaman and Nicobar Islands. Indian mangrove ecosystems are gifted with 4,011 species that include 920 floral (23%) and 3,091 faunal (77%) species and no other countries has recorded this much of species in the mangroves. Regarding the trends of change in mangrove forest cover, India showed a net increase of 58 sq. km within two years between the years 2005 and 2007 and thanks are due to the Government of India and State Forest Departments for the efforts.

Mangroves have higher levels of primary productivity than most other tropical or temperate forests. Their standing biomass can also be very high, as result of high levels of below ground biomass. This combined with the considerable storage of organic carbon in mangrove soils, may have a vital role to play in global carbon budgets and in the process of mitigating climate change. However, mangroves are likely to be one among the most at-risk ecosystems especially to sea level rise because of their location at the interface between land and sea, in the present context of the global climate change which is one of the greatest challenges that humans will face in this century. Hence, this abstract highlights the response of mangroves to climate change associated with changes in temperature, carbon dioxide, precipitation, storms and sea level rise and also strategies to mitigate climate change effects that include (i) protection of species and habitats, (ii) management of man-made pressure, (iii) establishment of green belts and buffer zones, (iv)restoration of degraded areas, (v) connectivity of mangroves with other systems, (vi) baseline data development and (vii) establishment of partnerships at local, regional and global scales. Mangroves in India are likely to absorb and respond to change and disturbances of climate change. Thus the mangrove restoration can be an efficient counter-measure for climate change in the coastal domain. This calls for intensive attention on managing the coastal mangroves for

resilience to climate change through implementation of adaptation strategies such as (i) to identify salinity and flood tolerant species and to plant them in the sites which are vulnerable to salinity and sea level rise; (ii) to record the plant species with details of their flowering, fruiting, germination, propagation, growth, evaporation demand as related to climate changes, (iii) enhancing the density of mangrove stand , diversifying the mangroves using most adaptable species, amendment of substrates for favourable colonization of mangroves. *Let us prepare for the worst and practice for the best to overcome vulnerability and to ensure coastal sustainability!*

CONSERVATION SCIENCE AND BIODIVERSITY

Professor N. Parthasarathy

Department of Ecology & Environmental Sciences, Pondicherry University, Puducherry-605 014.

We recognize that diversity at all levels-gene pool, species and biomes/ecosystems is important and needs to be conserved for sustainable development, thus helping the future generations from the ecological, economic and aesthetic benefits that they can derive form biodiversity. The most effective and efficient mechanism for conserving biodiversity is to prevent further habitat degradation by humans. We require sufficient knowledge for conserving biodiversity in small space and under increased anthropogenic pressure.

Four strategies conservation include 1). *In situ* 2). *Ex situ* 3) reduction of anthropogenic pressure and 4) restoration of disturbed habitats and endangering species

On the special occasion of "International year of Biodiversity -2010" and International year of forests-2011, we shall try to better understand conservation science from a broader perspective, particularly under changing environmental conditions world over, recognizing the ever increasing rates of deforestation and consequent biodiversity loss and realizing the need for conservation and habitat and species for ecosystem and species well-being, including humans. Conservation Science is thus a matter for scientists and society Beyond *in-situ* (BR, NP, RF etc.) & *ex-situ* modes (Botanic gardens, zoos and captive breeding centers), the complex web of interactions of biota, environment and sustainable resource use need to be better understood for framing effective conservation programmes. Regardless of geographic location problems and solutions are grossly similar, but needs fine tuning for addressing local conservation issues.

Principles- Climate as major ecosystem driver. We shall take a pictorial tour to worlds biomes and their major biota, structural organization, functional ecology and ecosystem services they render. Tropical forests are treasure of biodiversity and many of the elements of biodiversity are potential bioresources utilized by wild life as well as humans. In particular, the 34 biodiversity hot spots of the word constitute important genetic reservoir of bioresources. Lodging four of the 8 hottest hot spots of biodiversity viz., the Western Ghats - Sri Lanka Indo-Burma, Eastern Himalayas Sundaland which includes Nicobar and thus the Indian subcontinent forms a biologically significant location in world map.

The structural complexity of tropical forests, their high diversity and the complex web of species and environmental interactions for various ecosystem processes such as folivory, pollination, seed dispersal and nutrient cycling need to be understood in a holistic manner to better understand ecosystem functioning for effective forest management and

biodiversity conservation. Forests are not mere stock of wood and their functions are multi-fold. As population systems cannot be replicated, species loss is an irreversible phenomenon. Hence, bioresource use from ecosystems should be on sustainable basis i.e. well within the regenerative potential of species. Long term conservation of biodiversity can be achieved by, creating public awareness by educating local people on economic and ecological values of biodiversity and involving them in conservation programs. For better management it is essential to involve local people at grass root level.

We need to realize that species are thus products of long-term evolutionary history. The concern for conservation of bioresources increases because humans and wildlife depend on nature for everything. Even though extinction is a natural process, human activities considerably hasten this process, resulting in species loss. Hence, better understanding of conservation science would ensure ecosystem and species well-being, including wildlife and humans.

MOLECULAR METHODS TO EXAMINE GENETIC DIVERSITY

Dr. K. Emmanuvel Rajan[a]

Department of Animal Science, Bharathidasan University, Tiruchirappalli – 620 -024

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Microsatellites or simple sequence repeats (SSRs) are tandemly repeated motifs of 1-6 bases found in all prokaryotic and eukaryotic genomes. Present in both coding and noncoding regions of eukaryotic genome, characterized by a high degree of length polymorphism. Origin of such polymorphism is still under debate, despite the fact that the mechanism of microsatellite evolution is still unclear. Microsatellites have proven to be an extremely valuable tool for genome mapping in many organisms, but their applications span over different areas ranging from ancient and forensic DNA studies, to population genetics and conservation/management of biological resources. The task of microsatellite isolation can be quite involving in terms of effort and time because it traditionally consists of screening genomic libraries with appropriate probes. The number of positive clones (containing microsatellites) that can be obtained by means of this traditional method usually ranges from 12% to less than 0.04%. Such an isolation strategy can be effective only in taxa with a high frequency of microsatellites, whenever only a relatively low number of microsatellites are needed. However, the statistical power depends not only on the number of scored loci but also on other factors such as the degree of polymorphism of each locus and the sample size, and so the use of a limited number of loci might fail to provide sufficient information. In my lab, we isolated and characterized eight microsatellite markers for Indian false vampire bat *Megaderma lyra*. These loci were tested on 60 individuals representing four populations, and all loci were highly polymorphic. The mean number of observed alleles per locus was 13.1 (range from 5 to 24). Observed heterozygosity values range from 0.876 to 0.982, and expected heterozygosity value were ranged from 0.986 to 1.0. Out of eight loci, only two loci deviated significantly from Hardy–Weinberg equilibrium, and no pairs of loci were in linkage disequilibrium. These polymorphic markers will be useful to examine population structure, mating and dispersal behaviour, including monitoring the effect of habitat fragmentation and parental analysis.

Bats (Chiroptera) enrich the mammalian biodiversity by the contribution of more number of species in mammalian order next to Rodentia (Findley, 1993). Bats play a major important role in ecology as a significant predator of agricultural pest (Pierson, 1998), top predator (Norber and Fenton, 1988) and in economy as a pollinator, seed dispersers of many tropical plants and reforestation (Racey and Swift, 1995; Muscarella & Fleming 2007). The classification of bats initially developed by Miller in 1907, still then the bat researcher following the same classification with some modification introduced by the advanced

molecular techniques. Chiropteran are classified into two sub-orders, the Megachiroptera consist of single family (Pteropodidae) and Microchiroptera consist of sixteen family (Craseonycteridae, Emballonuridae, Furipteridae, Megadermatidae, Molossidae, Mormoopidae, Mystacinidae, Myzopodidae, Natalidae, Noctilionidae, Nycteridae, Phyllostomidae, Rhinolophidae, Hipposideridae, Rhinophomatidae, Thyropteridae and Vespertilionidae), considered as diphyletic and made the investigators to use molecular tools to understand the phylogenetic relationship within the proposed taxonomic classification and genetic status (Teeling et al 2000). Throughout the world bats are at risk by destruction, fragmentation of roosting places, foraging habitat and hunting. The effective conservation and management of the species require broad understanding of ecology, behaviour and genetic status. A number of genetic markers (Allozyme, RAPD, DNA Finger Printing, MHC loci, VNTR, Minisatellites, Microsatellites) and mitochondrial DNA sequences have used in recent past to understand the natural populations. However, mitochondrial DNA (mtDNA) genes become a choice of marker to biologist to answer a wide variety of questions (Wang et al 2003). The circular mitochondrial genome codes for 13 poly-peptides (for mitochondrial respiratory chain) 22 tRNA, 2 rRNA (for protein synthesis) and one non-coding sequence (D-loop) (Jan-willem 1999). Since the mitochondrial genome codes only for few products, remains being coded by the genetic system of nuclear genome then translated by cytoplasmic protein synthesizing machinery for replication, transcription and for protein synthesis in mitochondria. The origin of this unique system commonly accepted by the theory called "the endosymbiotic theory" and further rise the question; i) why the eukaryotic cell possesses two genome, ii) why the organellar genome contain less product than required for its essential function. Later on studies demonstrate the central role of mitochondria in eukaryotic cell oxidative phosphorilation (Papa et al 1999) and started to assume an evolution and structure of mitochondrial genome. It has been reported that, mammalian mtDNA is taxon- specific, variable between and within orders but the variability is limited.

Matrilineal mode of descent, and its lack of recombination make an mtDNA genes sequence analysis as a essential tool to study the origin, population history, migration pattern, population structure and genetic relation (Torroni et al 1996). Along with the maternal lineages, acquired mutations sequentially accumulate associate with the different factors like different geographical regions (Ingman et al 2000). Mitochondrial DNA sequence variations display the relationship among the sequences, phylogenetic networks and estimating time of appearance of mutations associated with the particular haplotypes (Bandelt et al 1999). In general the mtDNA rate differences never observed more than 1.8 fold between the fastest and slowest species. Hence, it should not affect the qualitative phylogenetic inference. Further based on the evolutionary rate, accurate estimation of molecular dating obtained within Mammalia using appropriate weighting. A significant

positive correlation is observed, when genetic divergence among mammalian species calculated using first and second codon position with Stationary Markov Model (Saccone et al 1990).

Earlier studies reveled that among protein coding genes COI, COIII were conservative followed by *Cytochrome b*, tRNA-Met, tRNA -Leu, 12S rRNA, 16S rRNA also showing high degree of homologies, where as D-loop region is the most variable in the mitochondrial genome. However, nucleotide sequences of the above reported regions are adequate to resolve the phylogenetic relationship (Sumida et al 2000). Based on the previous analysis (Pesole et al 1999), concluded that mtDNA can be used as a good phylogenetic marker in the context of mammalian evolution (Burger et al 2003).

As a molecular genetic markers mtDNA genes started to answer the challenging nature of the bats. However, to date, the studies have been limited compared to the number of species classified approximately 970 species (Burland & Worthington-Wilmer, 2001) The cited information shows that, Chiropterologist started use the mitochondrial genes as a marker in their studies at early 1990's. There after every year number of sequences reported for different species increased steadily. Particularly, after 2000 advances in the sequencing technique attracted the researches to use mtDNA genes as a marker. The availability of universal primers for each mitochondrial genes and development in designing specific primers for each taxon make easy to analyze many genes and their variations within and between populations. Among them cytochrome *b* seems to be first choice of marker and the D-loop region occupy the second position in the sequence data base with 18.74% of reported sequence from Chiroptera. In variably, mitochondrial genes used as a marker in all family of bat species both in Megachiroptera and Microchiroptera to understand the behaviour, population genetic structure for conservation management, species boundaries to confirm the classical taxonomy, and Phylogeography and evolution of different species over all as well as within the continent.

THE CHALLENGES IN CONSERVATION OF ASIAN ELEPHANTS

Dr. P.S. Easa[a]

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The elephant is considered as the embodiment of strength, size and intelligence. It has always been looked with mixed feelings of love, worship and fear. Indian culture is associated with elephants, so much so that it has been the subject of a number of classics including 'Mathangalila' and 'Hastyayurveda'. India has a tradition and history in conservation of elephants and maintaining them in captivity for various purposes including war, festivals, timber logging and even for marriage processions. Asian elephants once ranged over a vast area from the Tigris and Euphrates in West Asia to South East Asia. However, today they are only found in Bangladesh, Bhutan, Myanmar, China, India, Indonesia, Cambodia, Laos, Malaysia, Nepal, Sri Lanka, Thailand and Vietnam. The historical range of elephants in India also is considerablly smaller. Presently they are confined to distinct geographical zones in India. The elephants in Andaman and Nicobar islands are considered to be feral, the descendants of the domesticated ones. The Indian sub continent has an estimated population of about 27000-29000. These are presently enclosed in the eleven Elephant Reserves spread over about 58,000 Km² forests in the North East, Central, North West and South India.

The North East population

Elephants in north-eastern India together with those of Bhutan, Bangladesh, Nepal and Myanmar had an almost continuous distribution at the turn of this century. Elephants in the region, about 9000, are now discontinuously distributed in an area of about 8900 km². The range extends from near western north Bengal (near the Indo-Nepal international boundary), along the Himalayan foothills up to the Mishmi Hills and the eastern Brahmaputra plains of Assam and Arunachal Pradesh. It then takes a 'U' turn and covers eastern Arunachal Pradesh, the plains of upper Assam and the foot of the Naga Hills. The Garo Hills of Meghalaya through Khasi Hills, parts of the Brahmaputra plains and the Karbi plateau. Elsewhere in the south, scattered populations survive. The elephant population in the North Bank of Brahmaputra extends from north Bengal through the Himalayan foothills and Bhabar-terai tract (called the Duar in this part of the country) touching southern Bhutan, northern Assam and Arunachal Pradesh. In eastern Assam, the range also covers part of the floodplains of Brahmaputra and Lohit river. Elephants on the South Bank of Brahmaputra are divided into Eastern, Central and Western populations. The Eastern population is spread over Dibang Valley, Lohit, Changlang and Tirap in Arunachal Pradesh, Tinsukia, Dibrugarh, Sibsagar, Jorhat and Golaghat in Assam and Mon, Mokokchung and Wokha. About 4500 km² of forests are available to elephants in the area. However, tea plantations are being used during movements. The population in the central area extends from

Kaziranga National Park across Karbi Plateau, parts of central Brahmaputra plains, and the basin of the Diyung river to the foot of Meghalaya plateau in Assam and Meghalaya. Elephants are separated from the South Bank- Western population due to expansion of Guwahati city, clearing of forest for *jhum*, human habitation along National Highway No. 40 connecting Shillong and Guwahati. The extent of elephant habitat is about 5050 km². The elephant population in the Western areas is seen in parts of Assam and Meghalaya through the foot of Meghalaya plateau covering the Garo and Khasi Hills. It covers Kamrup and Goalpara districts in Assam, and Ri-Bhoi, West Khasi Hills, East Garo Hills, West Garo Hills and South Garo Hills, in Meghalaya. The seasonal range of this population also extends to areas of Bangladesh. The habitat available for this population is about 6850 km². There are a few isolated populations in Dhansiri-Intanki covering part of Karbi Anglong district of Assam and Kohima district of Nagaland. In Karbi Anglong, elephants are distributed in Dhansiri and Daldali RFs. This population is confined chiefly to Intanki Sanctuary. The habitat used by this population is about 1050 km². Elephants regularly move between Dhansiri and Intanki across the inter-state boundary. Inside Assam, they move between Dhansiri, Daldali and other adjacent forests. The population in Barail-Jaintia Hills is along the southern faces of the Barail Range and Jaintia Hills. It is small, scattered and non-viable. It is in Cachar district of Assam and Jaintia Hills of Meghalaya. Because of severe pressures on the habitat in the narrow strip of foothill they were occupying, the Cachar herd has started to wander through tea gardens occasionally straying into Manipur. The herd of Narpuh Block I RF and Lakadong unclassed forests also occasionally move to the north-eastern areas of Sylhet in Bangladesh. The main habitat type of this population's range was tropical wet evergreen forest with bamboo brakes. However, due to large-scale felling, settlement and development along NH-44, *jhum* cultivation and extension of tea plantations, especially in Cachar, elephants spend a great deal of time in secondary jungles, tea plantations, light woodland near villages and other degraded forests. The total habitat available is 120 km² in Cachar and 150 km² in Jaintia Hills. Elephants used to move regularly between Barail RF and Narpuh RF (Block-II) through North Cachar RF. However, during the past half decade, the movement of Cachar herd towards Narpuh RF has ceased. A sizeable population of elephants occur in the forests of Tripura, especially in the southern areas of Dholai district, eastern areas of West District and in South District. The population is continuous with those of the Chittagong Hill Tracts of Bangladesh. These elephants are concentrating mostly in Gumti Wildlife Sanctuary as more and more areas are brought under *jhum* and logging. In Mizoram, a small population is found in Dampa Tiger Reserve of Aizwal district. This tiny population also moves regularly into the Chittagong Hill tracts in Bangladesh.

The North Bengal Population

The elephants in North Bengal form the western most extension of North-East India elephant population. There are about 300 elephants in this region spread over Darjiling and

Jalpaiguri districts covering nine forest divisions. Although the elephant population in this region is only about 1% of the total elephant population of India, the incidence of human-elephant conflict in this region is one of the highest. North Bengal has a forest area of 3050 km^2 covering about 24% of the total geographical area. However, the elephant holding area are mostly confined to an elevation of 900 m and the elephant habitat is about 2200 km^2 which is in Terai, Western Dooars and Eastern Dooars. The Terai and the western Dooars region of North Bengal is patchy with human habitation and tea gardens through which the regular movement of elephants occur.

The North West Population

The North West range of elephants in India is one of the most fragmented habitats, which was once contiguous. It presently extends from Katerniaghat Wildlife Sanctuary in the east to Yamuna river in the west. The sub populations in the area include those between Yamuna to Ganga river, Ganga to Khoh river, Khoh to Haldwani, Haldwani to Sharda river, in and around Dudwa Tiger Reserve and Katerniaghat Wildlife Sanctuary. The elephant habitat is about 500 km long and 1 to 30 km wide and spreads over Uttar Pradesh and Uttaranchal states in an area of about 10000 km^2. This range has six Protected Areas and an estimated population of about 1600. This group of elephants faces almost all the conservation issues present in the other elephant ranges. Human settlements even exist inside the Protected Areas and the resultant habitat degradation, the elephant mortality due to train hits, the discontinuity of habitats requiring establishment of corridors, and poaching threaten the population.

The Central Indian Population

The Central Indian elephant population is spread over Jharkhand and Orissa states with seasonal movement to West Bengal. The 2500 elephants in the range occupies the most fragmented elephant habitats in the country. The elephants in Jharkhand are in two distinct populations in Palamau and Singhbhum. The Palamau population is in about 1200 km^2 of the Betla NP, Palamau Tiger Reserve and other adjoining areas. The Singhbhum population occupies about 75% of the available elephant habitats in the State, which is distributed over Dalma Wildlife Sanctuary and the forests of Saranda, Porhat, Kolhan, Chaibasa north, Chaibasa south and Dhalbhum Divisions. About 74% of the 700 elephants in the state occupies about 2570 km^2 area of Singhbhum. Mining activities in the elephant habitats and railway tracks in Tiger Reserve are major threats to the habitats. Degradation of habitats in Jharkhand areas result in migration of elephants to the adjoining areas in Chhatisgarh leading to human elephant conflict. Elephant habitats in Orissa consist of about 11100 km^2 forests which forms about 24% of the forest cover in the state. About 44% of the elephant habitats are in Protected Areas. The total elephant population in the state is estimated to be about 1841. These are distributed over 22 forest divisions falling under seven major river

basins *viz.* Mahanadi, Bitarani,Brahmani,Budhbalanga, Rushikulya, Vansadhara and Subarnarekha. The vegetation falls under the Northern Tropical semi-evergreen and deciduous types with moist and dry Peninsular sal forests dominating. The elephant habitats in the state are threatened due to degradation because of shifting cultivation, mining, fire and accidental deaths due to various reasons. The maintenance of the continuity of the fragmented habitats is a major challenge. Elephant herds move from Dalma Wildlife Sanctuary of Jharkhand to Midnapore East and west Forest Divisions, Bankura North and South divisions, Rupnarayan Planning and Survey division, Panchet soil conservation Division, Puruliya and Kangsabati Soil Conservation Division II. Increased elephant movement from Dalma with about 35 resident elephants?? in South Bengal result in severe human - elephant conflict in the area.

The Southern population

The southernmost elephant population in India is distributed over the Western Ghats and a part of the Eastern Ghats in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh states. It is between 8^0 15′ and 15^0 30′ N and between 74^0 15′ and 78^0 E. The elephant habitat in this range is diverse and includes tropical evergreen, semi-evergreen, moist deciduous, dry deciduous and dry thorn forests and grass lands in addition to the monoculture plantations. The elephants are seen at an elevation ranging from 100 m asl to 2000 m asl. There are about eight populations within the area based on the contiguity of habitats.

The Northern Karnataka part of the range has about 40-60 elephants, which are isolated from the rest of the populations in the Western Ghats. The elephants are seen in the Uttara Kannada and Belgaum districts of Karnataka state within the dry and moist deciduous forests.

The elephants in the crest line of Karnataka are highly fragmented and are distributed in the evergreen forests and montane grass lands of South Kanara, Mangalore, Shimoga and Chickmangalur districts. There are only about 60 elephants that exist in small isolated groups.

The Malnad plateau on the east of the Ghats has the moist deciduous forests of Bhadra Wildlife Sanctuary as the major elephant habitat. The largest single population of elephants in the whole of Asia is in the areas extending from Brahmagiri to Eastern Ghats comprising Nilgiris of Tamil Nadu, Bandipur-Nagarahole of Karnataka, Wayanad of Kerala and Biligiriranganswamy Temple Sanctuary of Karnataka with Satyamangalam, Kollegal, Hosur and Dharmapuri forest Divisions. The area with the diverse vegetation types has the largest number of Protected Areas spread over 3300 km^2 out of a total of about 12,600 km^2. The Reserve is considered to have an estimated minimum of about 6300 elephants. The area also has the highest incidences of human elephant conflicts. The isolated elephant herd of about 30 in the Kaundinya Wildlife Sanctuary in the Chittoor district of Andhra Pradesh had

originally moved from Hosur and Anekal areas. A herd of about 6 elephants is also reported from the isolated area in Tirupattur Division of Tamil Nadu. Such small populations of elephants are not expected to be viable. The population in Nilambur, Silent Valley and Coimbatore areas has about 2300 km² of habitats in a diverse vegetation types ranging from evergreen forests to high altitude shoal - grasslands because of the changes in the elevations. The Anamalai-Parambikulam area is spread over about 5500 km² and has about 1600 elephants. The area encompass a number of forest divisions in Kerala and Tamil Nadu including the Protected Areas *viz.* Indira Gandhi, Paramabikulam, Chimmoni, Peechi-Vazhani, Thattekkad, Eravikulam and Chinnar in addition to Palnis, Vazhachal, Nelliyampathi, Malayattur, Mankulam and Munnar areas. The diversity of vegetation due to lavational differences, minimum number of human settlements and the largest contiguous areas with least disturbance make this one the best conservation units for elephants.

The Idukki Wildlife Sanctuary and adjacent areas of Ayyappankoil and Nagarampra Ranges and part of Munnar and Kothamangalam forest divisions is the smallest population of elephants in an isolated patch of forests of about 300 km² with a number of settlements within and around. The population south of this is in the Periyar-Srivilliputhur-Highwavy extending up to the Achenkoil forest areas through Ranni, Konni, Punalur and Thenmala forest divisions. The area is about 3300 km² and has about 1500 elephants in the evergreen forest dominated unit. The southern most population of elephants in India, numbering about 200, is spread over the evergreen dominated areas of Agasthyamalai with Neyyar, Shendurney and Peppara wildlife sanctuaries and Kalakkad-Mundanthurai Tiger Reserve.

The Conservation Issues

The large body size, the quantity of resources required along with the area requirements for movement patterns makes elephants more vulnerable to changes in their habitats. There are also a few remnants of connecting links, which are habitat constrictions. Maintaining these connecting links, establishing the lost connectivity and widening the existing ones are on the top of priorities for elephant conservation. Elephant corridors will ensure access to more areas and resources, and moreover conflict free habitat to roam around. This will also guarantee love and affection from a human community ensuring the harmony of living together. About 90 elephant corridors requiring immediate attention are identified and prioritized for conservation action.

Elephant populations also are threatened by poaching and poisoning. About 60-65 elephants are annually poached for ivory based on official records. One hundred eighty six elephants died due to electrocution during a seven year period. Poisoning was responsible for the death of about 40 elephants within five years. There were 72 causalities due to train accidents within the past five years. Thus, human encroachment into elephant habitats, the greed of people for ivory and the low tolerance of people to elephant related problems have

all resulted in the endangered status of the species. The most important threat to the elephants has been the loss and shrinkage of their habitats, resulting in the creation of fragmented subpopulations, with few elephants each. This isolation will have a lasting impact on the population. The decrease in available areas and fragmentation also leads to human-elephant conflicts, crop-raiding and property damage. About 2800 people have been killed all over India by elephants during the last 10 years. Six hundred and eighty two people lost their life due to elephant depredation in North Bengal alone from 1986-87 to 1999-2000, which gives an average of 2.34 casualties per elephant and 49 person per year in the region. Confinement to small reserves, isolation into small pockets and the development programmes around such remnants often force the animals to enter human areas to search for water, food and even for better shelter. These interactions with human beings often results in serious conflicts, mostly in the form of crop raiding. A study in Wayanad areas of South India has estimated a loss of Rs.38170/- ha per year; one of the highest in the country.

A number of factors have been suggested to contribute to the crop raiding behaviour. One is related to their movement pattern, where the traditional elephant paths have been converted for human use. The increased nutritive value and palatability of the cultivated crops in addition to easy availability also is another reason. Humans compete with the wildlife for resources, often causing serious degradation and forcing animals to search widely for better food.

People employ a variety of techniques to scare the elephants away, most often by guarding from tree top platforms known locally as 'machans'. There also are techniques throwing fireballs, which are harmful to the animals. More recent mitigation measures include prevention of elephant entry by erecting electric fences or by creating trenches around the cultivated areas or along the areas bordering the elephant habitats. There are advantages and disadvantages to all of the techniques employed. Some require constant maintenance, whereas others are not eco-friendly. Some need a lot of financial investment to develop or maintain.

One controversial option to mitigating human elephant conflict is to capture the problem animals and put them into captivity or translocate them to another area. There are many potential problems with this tactic. Identifying specific problem elephants could be very difficult. Translocations done in the recent past have not been particularly successful as many elephants return home even from great distances. There could also be attempts to take the elephants into captivity under the guise of mitigation. The conservation issues of elephants are elephantine and unfortunately even the solutions are controversial. The attitude of the people, especially of those in the areas surrounding elephant habitats is crucial to saving the remaining populations. A better human-wildlife interaction leading to harmony would ensure long-term survival of a unique species.

CONSERVATION OF FOREST GENETIC RESOURCES OF WESTERN GHATS

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In India, as in many other tropical regions, extensive land cover and land use changes have left behind forests that are highly fragmented and non-contiguous. It is estimated that in India about 244 plants species fall in one or the other category of threatened plants, which also includes several medicinal plants (IUCN, 2000). Of these, 7 species are already extinct and 44 species are critically endangered (IUCN, 2000). In Western Ghats alone, almost 100 tree species of high economic importance are threatened and critically endangered. The major threat to these critically endangered species is their extremely small population sizes, far below the size that can sustain them. Further, extraction of non-timber forest produces (NTFP's) species has also led to reduction in population size of many of the critically endangered species. Indiscriminate and unsustainable extraction can also change the level and pattern of genetic diversity in plant species. In few cases over extraction has lead to loss of genetic diversity that may ultimately reduce the evolutionary potential of a species. Thus, unless urgent conservation action is taken up in terms of recovering these species, many of these may be completely lost. However, one of the greatest impediments about the need to conserve genetic diversity arises from poor data demonstrating relation between easily perceivable demographic features and the loss of genetic diversity and fitness in populations. Genetic diversity is an important and fundamental requirement for the evolution of species. The genetic diversity harbored within tree species has enabled adaptation of forests to changing and adverse climatic conditions and also resulted in the accumulation of unique and irreplaceable genes of interest. The Western Ghats of India is a rich repository of genetic diversity and contains some of the most economically important and endemic species. In this paper, the impacts of unsustainable extraction of forest resources on the genetic variability of the species are reviewed with specific cases illustrating the need the need to conserve the genetic diversity of the forest species. Finally, the role of protected areas in conserving the genetic variability of economically important species is discussed.

MOLECULAR TOOLS IN CONSERVATION OF BIODIVERSITY

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India is one of the 12 mega biodiversity countries in the world. The country is divided into 10 biogeographic regions. The diverse physical features and climatic situations have formed ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems, which harbour and sustain immense biodiversity. Biogeographically, India is situated at the tri-junction of three realms - Afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore, has characteristic elements from each of them. This assemblage of three distinct realms makes the country rich and unique in biological diversity.

The country is also one of the 12 primary centres of origin of cultivated plants and domesticated animals. It is considered to be the homeland of 167 important plant species of cereals, millets, fruits, condiments, vegetables, pulses, fibre crops and oilseeds, and 114 breeds of domesticated animals.

About 4,900 species of flowering plants are endemic to the country. These are distributed among 141 genera belonging to 47 families. These are concentrated in the floristically rich areas of North-East India, the Western Ghats, Eastern Ghats, North-West Himalayas and the Andaman and Nicobar Islands. These areas constitute two of the 18 hot spots identified in the world. It is estimated that 62 per cent of the known amphibian species are endemic to India of which a majority is found in Western Ghats.

Approximately 65 per cent of the total geographical area has been surveyed so far. Based on this, over 46,000 species of plants and 81,000 species of animals have been described by the Botanical Survey of India (BSI) established in 1890 and Zoological Survey of India (ZSI) established in 1916, respectively. This list is being constantly upgraded, specially in lower plants and invertebrate animals. The Forest Survey of India established in 1981 assesses the forest cover with a view to develop an accurate database for planning and monitoring purposes.

Molecular techniques offer a wide range of possibilities to support decision makers, and genetic studies are becoming a primary argument in wildlife conservation. The importance of genetic variation in biodiversity evaluation has been recognised (EHRLICH & WILSON,1991). Molecular biology tools have already been used to guide expensive conservation programs, including risky reintroduction projects (e.g. brown bear *Ursus arctos* (TABERLET & BOUVET, 1994); bearded vulture *Gypaetus barbatus* [NEGRO & TORRES,

1999]). The protection of genetic diversity has been incorporated into national and international legislation. To optimise the use of molecular biology in conservation, a wise rationalization of the techniques and a realistic interpretation of the data produced are needed. Technological seduction and the availability of numerous informative techniques should not interfere with the recognition of the actual limitations of these techniques, both in the theoretical ground and in supporting the real problems that nature is facing (HEDRICK, 1996). For instance, it is important to recognise that molecular information might not be as critical for the immediate survival of a species as improving its habitat (CAUGHLEY, 1994) and reducing the exploitation of natural resources in this habitat (BEGON et al., 1999). Current limitations are also evident from the recognition, for instance, that no agreement has yet been reached on how to incorporate genetic diversity into land-use planning (MORITZ & FAITH, 1998). It is also important to note that special care needs to be taken before reaching management conclusions in endangered species, where in spite of the urgency implied, erroneous recommendations could be detrimental to a species and ecosystem. Recommending the separate management of already-reduced populations could promote inbreeding. Proposing population intermixing could promote the hybridisation of specific adaptations to a particular environment (WAYNE et al., 1994).

The main goal of molecular techniques is to detect the variation in DNA sequences, directly through sequencing or indirectly through other methods sensitive to sequence variations. This variation can be detected using a wide range of techniques. Successful experiments should be based in the future on a justified trust and collaboration between field and laboratory biologists. The molecular trend of research during recent years and the ease and speed with which molecular data can sometimes be published might have worked against the funding of field projects and of projects in many other areas of biology crucial for conservation biology. This trend will certainly need to be reviewed in the future when we try to translate molecular data back to nature.

THE CONSERVATION GENETICS OF WILD, SMALL AND THREATENED POPULATIONS USING MOLECULAR APPROACHES

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Most museums of natural history have as one of their missions uncovering the relatedness among species. Traditionally, scientists have used measurements of physical characteristics, embryology, and the fossil record to help determine this relatedness. Many scientists are now using molecular biology tools in addition to these traditional approaches. It is also important to conserve threatened or endangered species by not only maintaining viable population sizes, but also preserving genetic diversity. This lecture aimed to reveal the genetic diversity and population structuring of wild, small and threatened populations using molecular approaches.

Conservation genetics is the application of genetics to preserve species as dynamic entities capable of coping with environmental changes. Genetic diversity is one of the three fundamental levels of biodiversity, so it is directly important in conservation of biodiversity, though genetic factors are also important in the conservation of species and ecosystem diversity. Conservation of genetic variability is important to the overall health of populations because decreased genetic variability leads to increased levels of inbreeding, and reduced fitness. The effects of small population size are of major concern in conservation biology, since endangered species have small and declining populations. Small populations suffer from inbreeding and loss of genetic diversity resulting in elevated extinction risks. Consequently, a major objective of genetic management is to minimize inbreeding and loss of genetic diversity. There are 11 major genetic issues in conservation biology, (i) inbreeding depression (ii) the accumulation of deleterious mutations (iii) loss of genetic diversity and ability to evolve in response to environmental changes (iv) adapting to conditions in captivity (v) out breeding depression (vi) fragmented populations (vii) taxonomic uncertainties, which can lead to a reprioritization of conservation efforts (viii) genetic drift as the main evolutionary process, instead of natural selection (ix) management units within species (x) use of molecular genetic analysis to understand aspects of species biology importance to conservation (xi) use of molecular genetics in forensics (Frankham 1995, Frankham *et al.*, 2002, Frankham 2003).

India is one of the 17 megadiversity country in the world, harbours a high level of biodiversity. This diversity is also unique: four of the 34 global hotspots of biodiversity, the Western Ghats, the Himalayas, the North-Eastern India, South of Brahmaputra along with

Andaman and the Nicobar Islands, part of the Sundaland hotspot are located within the country. The biodiversity hotspots contain an unusually large proportion of endemic species as compared to other parts of the world. The megadiversity countries and the biodiversity hotspots in particular, can make remarkably unique contributions to science (Bawa 2006).

If genetic diversity becomes low at many genes of a species, that species becomes increasingly at risk. It has only one possible choice of information at all or nearly all of its genes, all the individuals are nearly identical. If new pressures (such as environmental disasters) occur, a population with high genetic diversity has a greater chance of having at least some individuals with a genetic makeup that allows them to survive. If genetic diversity is very low, none of the individuals in a population may have the characteristics needed to cope with the new environmental conditions. Such a population could be suddenly wiped out. The genetic diversity of a species is always open to change. No matter how many variants of a gene are present in a population today, only the variants that survive in the next generation can contribute to species diversity in the future. Once gene variants are lost, they cannot be recovered.

Specific genetic techniques are used to assess the genetics of a species regarding specific conservation issues as well as general population structure [Frankham 2005]. This analysis can be done in two ways, with current DNA of individuals or historic DNA [Haig 1998]. Techniques for analysiing the differences between individuals and populations include alloenzymes, RFLP, AFLP, RAPD, SSCP, minisatellites, microsatellites, single-nucleotide polymorphisms, sequence analysis and DNA fingerprinting.

These different techniques focus on different variable areas of the genomes within animals and plants. The specific information that is required determines which techniques are used and which parts of the genome are analyzed. For example, mitochondrial DNA in animals has a high substitution rate, which makes it useful for identifying differences between individuals. However, it is only inherited in the female line, and the mitochondrial genome is relatively small. In plants, the mitochondrial DNA has very high rates of structural mutations, so is rarely used for genetic markers, as the chloroplast genome can be used instead. Other sites in the genome that are subject to high mutation rates such as the Major Histocompatibility Complex, and the microsatellites and minisatellites are also frequently used. These techniques can provide information on long-term conservation of genetic diversity and expound demographic and ecological matters such as taxonomy (Wayne and Morin 2004)

Another technique is using historic DNA for genetic analysis. Historic DNA is

important because it allows geneticists to understand how species reacted to changes to conditions in the past. This is a key to understand the reactions of similar species in the future (Woodworth *et al.*, 2002). Techniques using historic DNA include looking at preserved remains found in museums and caves. Museums are used because there is a wide range of species that are available to scientists all over the world. The problem with museums is that, historical perspectives are important because understanding how species reacted to changes in conditions in the past is a key to understanding reactions of similar species in the future. Evidence found in caves provides a longer perspective and does not disturb the animals (Wayne, 2004).

Another technique that relies on specific genetics of an individual is non invasive monitoring, which uses extracted DNA from organic material that an individual leaves behind, such as a feather. This too avoids disrupting the animals and can provide information about the sex, movement, kinship and diet of an individual (Wayne, 2004). Other more general techniques can be used to correct genetic factors that lead to extinction and risk of extinction. For example, when minimizing inbreeding and increasing genetic variation multiple steps can be taken. Increasing heterozygosity through immigration, increasing the generational interval through cryopreservation or breeding from older animals, and increasing the effective population size through equalization of family size all helps minimize inbreeding and its effects. Deleterious alleles arise through mutation, however certain recessive ones can become more prevalent due to inbreeding. Deleterious mutations that arise from inbreeding can be removed by purging, or natural selection (Frankham 1995). Populations raised in captivity with the intent of being reintroduced in the wild suffer from adaptations to captivity (Woodworth *et al.*, 2002).

Inbreeding depression, loss of genetic diversity, and genetic adaptation to captivity are disadvantageous in the wild, and many of these issues can be dealt with through the aforementioned techniques aimed at increasing heterozygosity. In addition creating a captive environment that closely resembles the wild and fragmenting the populations so there is less response to selection also helps to reduce adaptation to captivity. Solutions to minimize the factors that lead to extinction and risk of extinction often overlap because the factors themselves overlap. For example, deleterious mutations are added to populations through mutation, however the deleterious mutations conservation biologists are concerned with are ones that are brought about by inbreeding, because those are the ones that can be taken care of by reducing inbreeding. Here the techniques to reduce inbreeding also help decrease the accumulation of deleterious mutations (Haig, 1998).

These techniques have wide range of applications in conservation. For example, in Cutthroat Trout mtDNA and alloenzyme analysis, hybridization between native and non-

native species was shown to be one of the major factors contributing to the decline in their populations. This led to efforts to remove some hybridized populations so native populations could breed more readily. Cases like these impact everything from the economy of local fishermen to larger companies, such as timber. Specific molecular techniques led to a closer analysis of taxonomic relationships, which is one factor that can lead to extinctions if unclear (Haig, 1998).

New technology in conservation genetics has many implications for the future of conservation biology. At the molecular level, new technologies are advancing. Some of these techniques include minisatellites and MHC (Haig, 1998, Frankham, 2005). These molecular techniques have wider effects from clarifying taxonomic relationships, as in the previous example, to determining the best individuals to reintroduce to a population for recovery by determining kinship. These effects then have consequences that reach even further. Conservation of species has implications for humans in the economic, social, and political realms. In the biological realm increased genotypic diversity has been shown to help ecosystem recovery, as seen in a community of grasses which was able to resist disturbance to grazing geese through greater genotypic diversity. Because species diversity increases ecosystem function, increasing biodiversity through new conservation genetic techniques has wider reaching effects than before.

ROCK SITES OF MEDAK DISTRICT OF ANDHRA PRADESH - A POTENTIAL SITES FOR BIRD CONSERVATION

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The rocks of Medak district constitute a very important geological heritage of the Deccan-Southern peninsular India. The rock structures of this region contribute to the interacting landscapes and serve an important ecological function with diversified floral and faunal components. In the present study, for the first time, an attempt has been made to survey such marvelous sites, to prepare a systematic analysis of avian diversity. A total of 12 sites in different mandals of Medak were surveyed and associated avifauna was recorded. A total of 216 species of with 17 orders and 49 families were recorded in this area. Several anthropogenic activities are causing fragmentation of habitat and affecting the sustenance of avian biodiversity. An urgent awareness program is needed to restore these marvelous structures as centers of educational, recreational and cultural heritage for overall sustenance of the biodiversity and in particular avian diversity of the region.

STUDIES ON AVIAN DIVERSITY IN ADJOINING AREAS OF NAGARJUNA SAGAR TIGER RESERVE IN PARTS OF NALGONDA DISTRICT, ANDHRA PRADESH

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The study was carried out in adjoining areas of Nagarjuna Sagar Tiger Reserve (NSTR) falling under reserve forest associated habitats such as Rocky hills, scrub jungle, and Agricultural fields of Peddagattu and Sherpalli regions of Nalgonda district of Andhra Pradesh from April 2010 to till date. In spite of fragmentation of habitats, the area are potential in terms of avian diversity is concerned. During the survey a total of 149 species representing 19 orders and 52 families were recorded. Of these 6 species namely *Chaetornis striata, Threskiornis melanocephalus, Anastomus oscitans, Anhinga melanogaster, Mycteria leucocephala* and *Circus macrourus* are categorized under IUCN threatened list. The predominant orders representing with high number species includes Passeriformes, Chardriformes and Falconiformes. The diversity of birds is also compared with the available checklist of birds of NSTR. The abundance of bird species and their utilization of the habitats indicate the richness and health of the tract. The survey not only provides us information on the distribution and abundance of species but also help us to know the key species of ecological importance and their conservation.

EMERGING TRENDS IN THE CONSERVATION OF PULICAT LAKE – AN IMPORTANT AVIFAUNA HABITAT AND A PROPOSED RAMSAR SITE

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Pulicat Lake is the second largest lake in India. It covers an area of 760 sq.km and sprawls in the states of Andhra Pradesh and Tamil Nadu. The vast mudflat expanse of the wetland has supported large population of flamingos and more than 112 species of other wetland birds. It is a unique ecological habitat for winter avian migrants to this region. Being an important waterfowl habitat and a known site for banana shrimp, the lake today faces challenges for its very existence. Salt production, drainage, ground water extraction and grazing have been amply focused as threats to the lake in last 3 decades. In recent years man made activities in the catchment area, top soil removal from the lake bed, air, water and noise pollution including vehicular trespass, poaching biotic interference including human pressure are threats not only to the lake ecology but for biota to withstand the adversity.

STATUS AND DISTRIBUTION OF HERONRIES IN TAMIL NADU

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Tamil Nadu has quite a few important heronries. Comprehensive studies on the heronries to understand their status, distribution and conservation issues are limited. The present work is an effort to document the status of heronries in the above referred perspective in Tamil Nadu. Number of breeding birds and heronries were studied using standard ecological methods. Field surveys were conducted between March and September 2007 in about 41 known heronries in 14 districts. Nineteen out of forty one heronries are reported as Important Bird Area in Tamil Nadu. Distribution of heronries shows that not all the districts in Tamil Nadu have ideal breeding locations for fish-eating birds. Relatively more number of heronries have been recorded in Thirunelveli (8), Kanyakumari (7) and Ramanathapuram (6) districts. The remaining districts hold between one and three sites. With respect to species distribution, Little Egret, Little Cormorant and Indian Pond Heron were found in nearly twenty heronries, while Black Ibis and Wooly-necked Stork were found only in one place. Although around 10 heronries are reported be lost over a period of time reasons for the same are not clear. Available information indicates that the disturbance by people living close to the heronries, removal of nesting substrates, lack of suitable nesting trees and poaching are found to be the major reasons for the loss. Increasingly, heronries in Tamil Nadu are found within or close to human habitations. Thus, there is a need to educate local people living close to these sites and to involve them in conservation.

STUDIES ON THE MICROCLIMATE OF NEST, VENOM, ANTI BACTERIALACTIVITY AND PROTEIN PROFILE OF RED TREE ANT (*Oecophylla smaragdina*)

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The present investigation was made to study the microclimate environment of the weaver ant (*Oecophylla smaragdina*) in Thanjavur and Papanasam area. The data was collected from 200 different trees of 16 different species in Thanjavur and 300 trees of 21 species in Papanasam. In each area, 25 nests were selected to assess, the light intensity and thermoregulation. In the overall results of Thanjavur area, 3956 nests associated with 200 trees and 3902 of nests associated with 300 trees were observed in Papanasam area. Althrough, the atmospheric temperature having fluctuation, the inside of the nest was not influenced by temperature and light intensity. During the low temperature (Light) also didnot affect the nest inside temperature. The temperature was always constant. Along with this, alkaloids, protein profile and antimicrobial activity were studied. The secretion of ant inhibited the growth of *Escherichia coli, Staphylococcus epidermidis* and *Staphylococcus aureus*. The major proteins of 44kDa and 205 kDa in queen were observed and 45 kDa protein were present in worker ant.

STUDIES ON ANTIBACTERIAL ACTIVITY OF *ARAUCARIA BIDWILLI* AND *THUJA OCCIDENTALIS* LEAF EXTRACTS

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The efficacy of leaf extracts from two ornamental plants *Araucaria bidwilli* and *Thuja occidentalis* was investigated for their phytochemical and anti-bacterial properties. Phytochemical screening of leaf extracts of *A.bidwilli* revealed the presence of phenolic compounds, essential oils, alkaloids, tannins and cardiac glycosides. In *T.occidentalis*, alkaloids, tannins, phenols, phlobotannins and essentials oils were present. Leaves of *T.occidentalis* showed higher protein and carbohydrate content in comparison with *A.bidwilli*. TLC analysis confirmed the presence of alkaloids in both leaf extracts. Anti-microbial assay of ethyl acetate extracts of *A.bidwilli* and *T.occidentalis* indicated potent activity against pathogenic strains of bacteria like *Pseudomonas aeroginosa* and *Escherichia coli*. The medical significance and the potential use of these extracts for exploitation as anti-bacterial agents are discussed and future prospects outlined.

EFFECT OF DIFFERENT SUBSTRATES ON LENGTH WEIGHT RELATIONSHIP OF *CLARIAS BATRACHUS* LARVAE

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Utilization of three substrates rice straw, bamboo poles and small stones for the culture of *Clarias batrachus* larvae was studied for a period of 75 days. In the present study the larvae were cultured separately in three substrates. The water quality parameters such as dissolved oxygen, pH, water temperature, alkalinity and dissolved carbon dioxide were monitored regularly. The addition of substrates showed minor variations in water quality parameters. The initial total length and weight of twenty larvae were recorded for the individual tanks. At the end of 75 days, all surviving larvae were collected and counted. The final total length and weight of larvae were recorded. Among the three substrates the growth response of the larvae was more in rice straw substrates followed by small stones and bamboo poles but less when compared to control. These results suggest that the utilization of substrates will help to increase significantly higher growth of *Clarias batrachus* larvae.

AN INCIDENCE OF DISEASE OUTBREAK AT NALABANA BIRD SANCTUARY, CHILIKA LAKE, ORISSA

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Chilka Lake in Orissa is Asia's largest inland salt-water lagoon spread across 1,100 sq.km. The lagoon has a unique assemblage of marine, brackish and fresh water ecosystem with estuarine characters which offer potential feeding grounds for winged visitors. During 2006 winter, thousands of migratory birds died in the Nalabana Bird Sanctuary. Our preliminary investigations to find out the role of select chemical pesticides did not reveal any positive leads. Under these circumstances, since the mortality of birds continued, it was essential and imperative to look at the possible role of certain diseases. In this background a study was initiated during 2009- 2010. Direct count method was followed to estimate the number of birds. Northern Pintail, Northern Shoveler, Eurasian Wigeon, Garganey and Gadwall were abundant. Forest officials, fishermen and local people were requested to inform us if they came across any dead birds. Around 1200 birds were estimated to have died between December 2009 and March 2010. To identify the factor responsible for the mortality, carcass of 20 birds were collected and analysed for contaminants and disease. While varying levels of pesticide residues were detected in different tissues namely brain, heart, muscle, and liver none could be related to mortality. On the other hand Histopathological, Bacteriological investigations and subsequent PCR confirmatory tests revealed that heavy mortality of birds in Nalabana Bird Sanctuary is due to the outbreak of Fowl Cholera caused by *Pasteurella multocida*. Carcass infected with *Pasteurella multocida* can spread the disease to other birds and also to adjacent areas. Hence, carcass collection and disposal by way of incineration is the best option. Control strategy for wetland with epizootics would warrant regular surveillance.

AVIAN DIVERSITY ANALYSIS THROUGH MARKET SURVEY - A CASE STUDY FROM TUENSANG, NAGALAND

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Nagaland one of the northeastern states of India, hunting is considered as culturally important among tribal communities. We assessed avian diversity by monitoring a daily market at Tuensang Town, eastern Nagaland. Market surveys were done twice a week from May 2009 to April 2010 during morning hours (0730-0930). In all, 1879 birds belonging to 35 species (20 families) were observed during the survey. Large numbers of carcasses were found during winter compared to summer, as hunting is banned during this season by local communities. Birds belonging to (family) *Pycnontidae* (Bulbuls) dominated in number and minimum by *Strigidae* (Owls). The Great Barbet (*Megalaima virens*) accounted for maximum number of birds found in market. Rare species such as the Forest Eagle Owl (*Bubo nipalensis*) was also recorded during this study. Hornbills, a part of the naga culture were once common, but could not be recorded during this study. This indicates that Hornbills have been extirpated from the region. In general, status of many species in the wild are rare, which is reflected in poor representation of them in markets, which were reported to be common earlier as per enquiry made during surveys.

ASSESSMENT OF POPULATION OF RANA HEXADATYLA IN OUSTERIE LAKE, PUDUCHERRY WITH SPECIAL REFERENCE TO PHYSICO-CHEMICAL FACTORS

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The Ousterie lake has been declared as a wildlife sanctuary by the Government of Puducherry. It is the most important fresh-water lake of Puducherry region. It is also one of the most important wetlands of Asia. The lake is situated near Oussudu village and is part of both Tamil Nadu and Puducherry. The lake has been declared as a bird sanctuary. In the present study an attempt was made to survey the study animal *Rana hexadactyla* and their population estimation employing capture and recapture method and the ecological investigations of Ousturi lake was selected. The ecological investigations included the physico-chemical analysis of water, to investigate the water quality. The analysis of water was done by standard methods. The results of the ecological investigations revealed nitrate and sulphate content was lower in the month of February and March. It is evident from present study that several water quality parameters viz., temperature, pH, turbidity, dissolved oxygen, electrical conductivity and total dissolved solids show monthly variations during the study period, whereas other parameters viz., nitrate and sulphate although showed significant monthly variations but pattern was not similar during study period. Basing on the observations and the results, discussions were made in the light of published references.

ASSESSMENT OF FOOD PLANTS IN THE FORAGING AREAS OF GAUR (*BOS FRONTALIS* Lambert, 1804) IN MUDUMALAI TIGER RESERVE, TAMIL NADU, SOUTH INDIA

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The assessment of feeding habits of wild ruminants is of the outmost importance for the correct determination of the carrying capacity of their habitat and for the study of their population dynamics. Gaur (*Bos frontalis* Lambert, 1804) is endemic to South Asia and 80% of the world population is in India. The foraging areas of the Gaur and their preferred food plant species are threatened by habitat degradation due to anthropogenic pressure. We investigated diet composition of Gaur by direct observation and feeding trail plots among different age-sex classes in all three vegetation types (Tropical dry deciduous forest, Moist deciduous forest and Thorn forest) of Mudumalai Tiger Reserve from January 2003 to August 2004. Gaur showed polypagous feeding habit and it was observed to feed on 155 species of plants belonging to 38 families under 23 orders. The orders namely rosales, malvales, polemoniales, lamiales, rubiales and myrtales had the diet plants species of trees, shrubs and herbs. Among different plant physiognomic types trees and shrubs were constituted greater proportion by Rosales and Malvales. Herbs constituted 32% of overall plant selected and consisted of 49 species in 17 orders and dominated by Asterales. The orders asterales and myrtales were least abundant in the gaur diet constitute 4% each. The highest percentage of herbs belongs to order asterales (27%) followed by rosales (10%). The orders such as curvembryae, gentianales, myrtales, ranales and umbellales were included in other category each constitute 2%. The plant orders asterales and personales were common in both herbs and shrubs. The plant families of Poaceae, Fabaceae, Asteraceae and Malvaceae collectively formed the major food species. The diet species of gaur was compared with other areas and discussed.

NEW BEHAVIOUR ON THE BREEDING BIOLOGY OF PURPLE RUMPED SUN BIRD (*Necterina zylanica*)

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This paper explains the unique nest building and breeding biology of the Purple rumped sun bird (*Necterina zylanica*) which were not described earlier. This bird belongs to the order Necteriadae. The observations were done starting from the site selection for nest building and breeding behaviour of this bird on a wire used for drying clothes in A.V.C women's hostel from 09-08-2010 to 03-09-2010. Interestingly the female has utilized two days only to give the final touch where it shows that it is very keen to select the soft nest material needed for the preparation of the bed for laying eggs to the nest other than that the male took the charge of building the nest from the beginning. In the last, during the final touch by the female, it has been seen that it used to pull the fibres and silky material with its beak inward over the rim of the entrance, tucking it into the wall and shaping the bottom by pressing its head, tail against the rim and alternately pushing with one foot and then the other against the floor and inner sides.

COMMENSALISM IN GREATER RACKET-TAILED DRONGO (*Dicrurus paradiseus nicobariensis*) WITH LONG-TAILED MACAQUE (*Macaca fascicularis umbrosa*) IN GREAT NICOBAR BIOSPHERE RESERVE

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A study was conducted during July 2010- February 2011 to assess the foraging association between greater racket-tailed drongo (*Dicrurus paradiseus nicobariensis*) and long -tailed macaque (*Macaca fascicularis umbrosa*) by focal animal sampling method. Great Nicobar Island is the southernmost island of India, surrounded by the Bay of Bengal and Andaman Sea. It is one of the largest island in the Nicobar group with an area of 1045 km², of which 885 km² area declared as Biosphere Reserve in 1989 under Man and Biosphere Reserve program. The biosphere reserve has tropical evergreen forest type and houses two national parks viz., Campbell Bay and Galathea. Literature review reveals that, drongos are well known for their participation in mixed foraging bird flocks with clear commensalism, catching the disturbed insects. During this period, greater racket-tailed drongos were observed on their foraging association with long-tailed macaques. The drongos were observed more frequently in association with long-tailed macaque and involved in 60% of commensalism. They stayed 2-3 mts in horizontal with or below the macaque. They adjusted their perching height according to the movement of the macaque for the successful rate of capturing the disturbed insects. The drongo and the macaque associations were not subject to significant diurnal and monthly variation. Macaques seemed not affected by the presence of the greater racket-tailed drongos. The foraging association between the two species was interpreted as a product of the opportunistic feeding strategy and commensalism of greater racket-tailed drongos. The detailed feeding behaviour of the greater racket-tailed drongo and long-tailed macaque were discussed in this paper.

STUDIES ON LEAF GALLS IN THE MEDICINAL PLANT (*Ficus glomerata*)

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India is endowed with a rich plant biodiversity with tremendous medicinal properties. *Ficus glomerata* commonly called as the "Fig tree" is a popular medicinal plant in India, which has long been used in Ayurveda for the treatment of various diseases. The extracts of this plant have been reported to possess phytopharmacological and phytochemical properties like anti-microbial, anti-cancer and anti-oxidant activity. In the present study, the aqueous and ethanolic extracts of normal and gall leaves were screened for the presence of phytochemicals. The psyllid insect *Paurosylla depressa* was identified to be responsible for gall formation. The differential occurrence of phytochemicals in the normal and gall leaves of *F. glomerata* was observed with the predominance of Tannins, Phenols and Saponins in normal leaves and Quinones, Alkaloids and Sterols in the gall leaves. The ecological and functional significance are discussed along with their implications for phytomedicinal studies.

MILLIPEDE SPECIES IN SIRUMALAI HILLS OF TAMIL NADU

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An inventory of millipede's species was conducted during August 2010-January 2011 in Sirumalai hills. The Sirumalai hills, situated in the southern most part of the Eastern Ghats in Tamil Nadu are known for their rich floral and faunal biodiversity for their close location to the Kodaikanal hills of the Western Ghats. They lie in Dindigul district, between 100°0'-10°30'N and 77°33'-78°15'E and at altitudes ranging from 400 to 1650 m. The lower hill ranges consist of highly disturbed scrub forests while tropical dry deciduous forest occupy major portion of middle hill ranges. Semi-evergreen forest occurs in the higher elevations and along valleys. Of the 80,000 species of Millipedes belong to the class Diplopida of Arthropoda only about 12000 species have been properly described. Millipedes have a long distinguished history on our planet, spanning over 400 million year. Their ecological importance is immense: the health and survival of every deciduous forest depends on them, since they are one of the prime mechanical decomposers of wood and leaf litter, especially in the tropics. Despite their importance they are very poorly known and have long been neglected in all areas of biological research. Millipede species of the Genus *Spinotarsus*, *Arthrosphaera* and *Xenobolus* were found to inhabit in these study areas. These epigeic invertebrates greatly affect decomposition process both directly through fragmentation of organic material and indirectly control or stimulation of microbial population and dissemination of their propagules and that regulate the composition of soil faunal communities and its consequence for ecosystem functions. Hence, the identification and enumeration of these millipedes' species is essential as they play an important role in the energy recycling of the forest ecosystem.

STUDIES ON THE MICROBIAL FLORA IN MARINE SHRIMP *(Penaeus monodon)*

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The affected shrimp *Penaeus monodon* were collected from shrimp culture pond at Kallimedu, Nagappattinam District, Tamil Nadu, India. Serial dilution technique and potato dextrose agar medium were used for the isolation of fungi. The fungal population was totally from five different species which were isolated from the front gut, mid gut, hind gut of infected shrimp *Penaeus monodon*. The isolated fungus was confirmed as *Aspergillus niger, A.nidulans, A.sulphureus, A.fnetii* and *A.fumigatus*. The poor water quality and the contaminated feeds were leading to fungal disease in *Penaecus monodon*.

STUDIES ON LEAF GALLS IN THE MEDICINAL PLANT *(Ficus glomerata)*

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India is endowed with a rich plant biodiversity with tremendous medicinal properties. *Ficus glomerata* commonly called as the "Fig tree" is a popular medicinal plant in India, which has long been used in Ayurveda for the treatment of various diseases. The extracts of this plant have been reported to possess phytopharmacological and phytochemical properties like anti-microbial, anti-cancer and anti-oxidant activity. In the present study, the aqueous and ethanolic extracts of normal and gall leaves were screened for the presence of phytochemicals. The psyllid insect *Paurosylla depressa* was identified to be responsible for gall formation. The differential occurrence of phytochemicals in the normal and gall leaves of *F. glomerata* was observed with the predominance of Tannins, Phenols and Saponins in normal leaves and Quinones, Alkaloids and Sterols in the gall leaves. The ecological and functional significance are discussed along with their implications for phytomedicinal studies.

DIVERSITY AND ABUNDANCE OF INVERTEBRATES IN BHARATHIAR UNIVERSITY, MARUDHAMALAI HILLS, COIMBATORE

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Many arthropods dwell in the leaf litter for its survival and these invertebrates' plays an important role in nutrition recycling and decomposition. An Investigation of Leaf litter invertebrate diversity in an around area of Bharathiar University was conducted during the year December 2009 to April 2010. The total number of 645 individuals belonging to 6 orders was collected in 3 plots by using various standard trapping techniques. (Grass land Ecosystem (Plot A), Thorny Scrub jungle (Plot B) and Human Altered area(Plot C), The richness and abundance was assessed using Shannon Wiener Index in various habitats of the study area. During the study period the impact of anthropogenic activity and the conservative strategies also analyzed.

ABUNDANCE OF POLYCHAETE WORMS IN THE EAST COAST OF TAMILNADU, SOUTHERN INDIA

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Totally six species of polychaete worms were identified and they are belongs to five families. The overall polychaete density was observed maximum during the month of January 2009 and minimum during the month of November 2008. However, their density more or less same trend was observed during the month of December 2008. There was a significant relationship between polychaete density and among the months studied in the Tharangambadi tidal flat. The present study revealed that the benthic form i.e. polychaete worm abundance will differs depends on the seasonal effects.

A STUDY ON THE DIVERSITY OF FRESHWATER BIVALVES IN THE RIVERS OF KARNATAKA AND KERALA

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Fresh water bivalves can be found in most of the rivers in India. However a comprehensive study of these bivalves is lacking in South India. The bivalves of these states have not been studied thoroughly and the available information on these is scattered. Hence a survey of freshwater bivalves from rivers of the Western Ghats of Karnataka and Kerala was undertaken. A total of 16 rivers of which 7 rivers from Karnataka and 9 rivers from Kerala were studied for a period ranging from November 2009 to December 2010. A total of 20 species belonging to 3 families UNIONIDAE Fleming, 1828, ETHERIIDAE and CORBICULIDAE of Class BIVALVIA have been recorded. Maximum numbers of species were from family UNIONIDAE, of which genera *Lamellidens* Simpson, 1900 and *Parreysia* Conrad, 1853 were dominant. In the present study we have also found one of the most unique and rare bivalves *Pseudomulleria dalyi* E.A. Smith, 1898 from the Western Ghats of Karnataka.

STUDIES ON THE BIOCHEMICAL COMPOSITION AND TRACE ELEMENTS IN *HEMIFUSUS PUGILINUS*

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This work aims at studying the sexwise variation in the level of protein, carbohydrate and lipid in the mantle, foot, liver, intestine and gonad of the marine mollusc *Hemifusus pugilinus* during 2009-2010. The study reveals significant variations ($P<0.05$) among the various organs of *H. pugilinus* which in turn are attributed to the reproductive state of the animal. Further, the amount of trace elements such as cobalt, copper, iron, magnesium, manganese, nickel and zinc present in the tissues of the study animal indicate higher values in males than females.

STRENGTHENING COMMUNITY CONSERVATION EFFORTS IN EASTERN NAGALAND

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Nagaland is a part of the Indo Himalayan zoogeographic region. The altitudinal range and its geographical position i.e. at the cross road of biodiversity rich Indian and Indochinese zoogeographical sub-regions resulted in its being a mega biodiversity state. Over exploitation (hunting) of animals, slash and burn (Jhum) cultivation and ownership of the forests (95% of forests belong to community) are major factors in biodiversity loss in the state. Major objective of our study was to develop Community Conservation Areas (CCA) in Eastern Nagaland and encourage them to set aside areas within their village lands with restrictions on hunting, fishing, and tree felling. In this programme, we trained a core group of 29 individuals from different tribes who facilitated the work. We provided support with respect to linkages to development and financial aspect to villagers. We also used the Blyth's Tragopan, the state bird of Nagaland as a flagship species for enhancing conservation reach. In all, 776 CCAs has been created in the eastern districts of Nagaland, and the same are being managed by people. Currently, we are working on the concept of larger joint CCAs for long-term viability of the biodiversity conservation in the area. Also, legal status of these CCAs is being worked out with Government of Nagaland.

MOLECULAR PHYLOGENY OF ASIAN HONEYBEE *APIS CERANA INDICA* (FABR.) POPULATIONS OF KARNATAKA AND ANDHRA PRADESH, SOUTHERN INDIA: INFERRED FROM MITOCHONDRIAL DNA SEQUENCE DATA

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In India there are two distinct colour morphs of Asian honeybee *Apis cerana indica* occurs such as Yellow morphs (Plain) and Black morphs (Hill). To study the geographic distance between the *A. c. indica* sampled locations in this present study and to analyse the phylogeny of genomic regions (COI- tRNA leu- COII) of mitochondrial DNA were PCR amplified and sequenced from samples collected within their natural range distribution in the states of Karnataka and Andhra Pradesh, southern India. DNA sequences were analyzed using parsimony, distance and maximum likelihood methods to investigate phylogenetic relationships within the species. The phylogenetic analyses strongly supported the basic topology recoverable from morphometric analysis, grouping the honey bees into different major clusters. Such results were supported with the previous literature as these morphs were associated with a widely distributed mitochondrial haplotypes that is present throughout mainland populations of South East Asian.

HUMAN DIMENSIONS OF CONSERVATION ECOLOGY: PANARCHY, ENVIRONMENTAL ENTITLEMENT ANALYSIS, PACE-LAYERING AND PARTICIPATORY ACTION RESEARCH - A 'NEW ECOLOGY' PERSPECTIVE

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Applied human ecology and participatory action research on a continuum, is the key to conservation ecology and sustainable science, in contexts, processes, of human communities on the edge. The present paper presents an ecclectic approach to conservation initiatives, which may seem a beginning for conceptual framework, relevant to South India. A 'new ecology' methodological primer is attempted and the terms are cast, for their relevance, as a discussion. The paper aims at the teaching and research audience and opens to deal with chaos, uncertainty and emergence, in conservation issues.

AN OVERVIEW OF FOREST RESOURCES AND ECOTOURISM IN EASTERN NAGALAND

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Forest resources and ecotourism in eastern Nagaland was reviewed by following field surveys. As per 2007 satellite imageries, the eastern districts had 83% of forest cover. Forest types of the area include (1) Northern Tropical wet Evergreen forests in Mon district; (2) Northern Tropical Semi Evergreen Forests, at the foothills on Assam-Nagaland Border districts (3) Northern Sub- Tropical Broad-leaf wet hill forests altitude below 1,800 m and above 500m in all the districts (4) Northern Sub -Tropical pine forests between the elevations of 1000 m to1500 m in Phek and Tuensang districts and (5) Northern montane wet Temperate Forests at elevations above 2000m in the Saramati (Kiphere) mountain ranges. Most of the plants (trees) are utilized as medicinal, cultural, traditional, ornamental and construction purposes. The picturesque landscape, vibrantly colourful people and rich tribal traditions in songs and dances makes Nagaland, the great potential for tourism resort. Each tribe has its own colourful festival spread throughout the year- Sekrenyi (Angami) in February, Moatsu (Ao) in May, Tulini (Sema) in July and Tsukhenyie (Chakesang) in March. Mostly the Hornbill festival attracts tourists from many parts of the world. Tourist attending the above festivals may be taken to important forest areas as well. The state has high ecotourism potentials, and the same have to be utilized in sustainable manner. Appropriate publicity should help in attracting tourists to festivals and Nagaland.

GREENOVATION TECHNOLOGY IN THE CONTEXT OF INTEGRATED SOLID WASTE MANAGEMENT

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Integrated solid waste management is a set of management alternatives including source reduction, reuse, recycling, composting etc., with the aim of reducing the amount of wastes. The main objective is to device environmentally sound treatment and disposal methods. Integrated waste management is a practical solution by which waste materials are put back into productive use. India produces around 3000 million tones of organic wastes annually. This waste biomass comes from domestic, agriculture, urban and industrial sources. Utilization of these waste materials for productivity purposes is important for both economical and environmental reasons. As a part of in-campus programme, generated paper wastes and garden litter are considered for greenovation phenomenon. Paper recycling within the context of waste management is a green enterprise, creating awareness. The recycling potential is immense yet remains untapped due to sub-optional reuse. Not even 10% of waste paper is recovered in our country. Hence, an attempt is made to recycle and reuse the paper waste generated inside the college campus. Several methods have been developed to convert agro-waste into organic manure to replace chemical fertilizer, of these methods vermicomposting is an important aspect as it converts waste to wealth by using a cheep ecofriendly option, the earthworms. A meaningful alternate for unnecessary burning of dried leaves and twigs from the college garden, in order to minimize environmental pollution and obtain good organic fertilizers, the biological potential of earthworms is utilized in waste management and biofertilize production.

STUDY ON CHANGES OF BLOOD PARAMETERS IN THE *OREOCHROMIS MOSSAMBICUS* (PETERS) EXPOSED TO ENDOSULFAN

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Freshwater ecosystem consists of a large number of fauna and flora in them. These aquatic organisms are very sensitive to slight alteration in the environment. This show a degree of remarkable changes when the aquatic ecosystem is polluted. Aquatic ecosystem is polluted in many ways, mainly intensive agriculture system. By usage of different kinds of Fertilizers and Biocides for improvement of crop yield. Endosulfan is neurotoxic organo chlorine insecticides of the cyclodiene family of pesticides. In the present study, the fresh water common fish *Oreochromis mossambicus* was exposed to the different concentration of endosulfan, such as 0.0035 mg/l and 0.0005 mg/l are lethal (120h LC 0) and sublethal (120h LC100) are respectively. In treated fish blood parameters like total Erythrocytes, Hemoglobin content, Mean Corpuscular Hemoglobin and Morphology of Erythrocytes were examined. The total erythrocytes and hemoglobin content were decreased trend over the control. On other hand Mean Corpuscular Hemoglobin (MCH) showed decreased, due to pesticide stress. The diameter of the cell and nucleus were decreased in the treated fish. The significance of the results will be discussed.

SIGNIFICANCE OF SAMUDHRAM LAKE, THANJAVUR DISTRICT, TAMILNADU, A CAUVERY DELTA REGION AS A WETLAND HABITAT

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Cauvery delta region are known for number of natural as well as man-made wetlands, like Udhayamarthandapuram lake, Vaduvoor lake, Kallperambur lake, Karaivetti lake and Thirumeni lake. Samudhram lake is one among them. There had been no study about Samudhram lake. So the present study is being undertaken. Among the winged visitors to the lake, Darter, Large Cormorant has also been found in the lake, establishing its importance as a birds' habitat. Other particulars, variety of species of birds observed, threats pertaining to the lake and the steps to conserve it are discussed and the suggestions are given.

MICROHABITAT PREFERENCE AND COMMUNITY STRUCTURE OF ANURAN-AMPHIBIAN IN A .V.C. COLLEGE CAMPUS, MANNAMPANDAL, TAMIL NADU

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We studied the amphibian community structure and mcrohabitat preference in A.V.C. College Campus. The survey was made during rainy night hours between 9 pm to 2 am during the month of November and December 2010. The survey methods involve extensive survey and careful visual estimation of amphibians in all the possible microhabitats present in the study area. Pathways, leaf-litter within the area was turned, bricks were lifted and searched underneath, shrubs and grass were shaken and gleaned, fallen logs were ripped apart, tree holes, temporary water pools were searched for the presence of amphibians with the help of four person team. Five different microhabitat categories were selected, viz., leaf litters, temporary water pools, tree holes, shrubs & grasses (ground vegetation), pathways, open flour & edges of buildings. A total of 13 species identified belonging to four families. There was significant difference found among the species occupying in different microhabitats (Chi-square =1339.16, df = 4). Among them abundance of *Duttaphrynus melanostictus* was high. Species diversity was found Shanon-winner index H'= 0.818. Among all *Duttaphrynus melanostictus, Kaloula taprobanica, Microhyla rubra, Ramanella variegate, Polypedates maculates* found to be more generalized in preference of microhabitat compare to others (having higher niche breadth value). *Euphlyctis cyanophlyctis* was exclusively encountered in temporary water pool.

DIVERSITY OF BENTHIC AND MOLLUSCAN ORGANISAMS IN POINT CALIMERE WILDLIFE SANCTUARY, TAMILNADU, SOUTHERN INDIA

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Macrobenthic organisms occupying the bottom of water body form an important link in detritus based food chain and the benthic macro-invertebrates community has been used frequently to assess the aquatic environment. Macrobenthic organisms play an important role to sustain the population of waterbirds in different wetlands by acting as a potential prey. The Point Calimere Wildlife Sanctuary support a wide variety of waterbirds and act as important wintering groud for many species of migratory birds. We surveyed the benthic and molluscan organisms in the swamps of Point Calimere Wildlife and Bird Sanctuary across the period between 2004 and 2006. Totally eight species of benthic animals and 29 species of molluscan were identified in different habitats during the study period. Among them eight species of benthic organisms belonged to five classes viz., Insecta, Polycheata, Malacostra, Ostracoda and Adenophorea and five orders viz., Diptera, Canalipalpata, Decapoda, Myodocopida and Rhabditida and in six families viz., Chironomidae, Spionidae, Penaeoidae, Portunidae, Cypridinidae and Pasiphaeidae. Among the molluscan organisms 21 species belonged to class Gastropoda and eight species were from class Bivalvia. They belonged to five orders viz., Archaeogatropoda (5 species), Mesogastropoda (12 species), Veneroida (6 species), Pterioida (2 species) and Neogastropoda (4 species) and included under 19 different families.

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