



STUDY IN VARIATION IN MORPHO-PHYSIOLOGICAL PARAMETERS WITH REFERENCE TO YIELD AND QUALITY IN *JATROPHA CURCAS* LINN.

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The exploitation of bio energy has recently attracted much scientific and commercial attention as a means of addressing the looming energy crisis. Due to energy intensive industrialization and large population growth the resource availability is threatening with increase in global warming which is directly effecting the environment and human health. The rapid growth of the sector leads to improper land use, which resulted in extensive degradation of land. In this industrialized generation, transport sector is emerging as the largest consumer of liquid fuel, which is on extinction. *Jatropha curcas* an oil bearing plant that can thrive well on semi arid soil with low capital input for its cultivation can be an alternative renewable source, which substitute for conventional diesel. This plant offers tremendous scope for biodiesel, which will raise the economy of rural area by generating employments, promoting the women's status, reducing the poverty. By its plantation global warming will be decrease along with the use of its oil as biodiesel in conventional vehicles will prove to be eco-friendly. Its by-product can also be commercially supplied to market for economic benefits. The experiment was conducted at North-East Institute of Science & Technology (NEIST), Jorhat with an aim to determine the source variation in *Jatropha curcas* accessions collected from different states of India and to identify the best sources to be utilized for reforestation and future genetic improvement work. The evaluation of 34 cultivars revealed a good degree of variation for plant height, stem girth, branches per plant and 100 seed weight. Variation in the physiological parameters of different sources was also studied. The study shows that considerable amount of genetic variability exists in this species with respect to growth performance, which offers scope for selection and breeding to the breeders. The relative performance of these sources was fairly consistent throughout the observation period. This work will facilitate selection of promising accessions for multi-location evaluation and will also hasten the process of utilisation of germplasm. It further gives a direction to the effect and practice studies for genetic improvement of this species.





BAMBOO BIODIVERSITY AND BIOFENCING IN A LIVESTOCK FODDER VENTURE

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Bamboo; the tallest of the grass family, distributed widely in diverse climates are 1450 species under seventy genera. Being one of the fastest growing plants on earth Bamboo may be a boon to the farming fraternity. The role of Bamboo in livestock fodder venture in Kerala state may not have been scientifically reported so far. The fragmented land holding; the sloping terrains and the wide climatic zones existing in Kerala state make different types of bamboo species suitable and ideal to be clubbed with fodder and livestock enterprises. Though some varieties are scattered traditionally here and there in Kerala farm lands, a concrete effort to locate ideal bamboo species to be integrated with a Livestock component was taken up in CBF Thumburmuzhy; a livestock and fodder research station under Kerala Agricultural University. Bamboo in fodder land of the research station serves many purposes. Basically it was planned and planted for building up a bio-fencing to prevent crop raid by wild herbivores from an adjacent Reserve forest. The terrain is so steep that water harvesting is a need and planting Bamboo at the fodder land limits; prevents soil erosion and holds the running water. More over the bamboo if selected can be a fodder replacer in scarcity. A field trial was laid out during 2008 Saplings of 20 varieties of exotic and indigenous Bamboo collected from gene pool of Scientific Institutions were planted around fodder lands. The CBF research station has 25 hectares of Land out of which 18 hectares are under fodder cultivation, It has a boundary of around one kilometer with reserve forest and another 2 kilometer boundary with National High way. Based on the growth parameters corresponding species of bamboo were selected and planned for planting in the boundary. One month old bamboo saplings were collected for this. Neither intercultural operations nor agricultural care practices were done in these as we follow an organic fodder development. Varietal performance of the bamboo species were evaluated at periodic intervals. The height of the bamboo, number of clumps, girth and other foliage details were recorded at regular intervals. The Bamboo thickets and the fast increasing tillers formed the biological fencing around the boundary of the fodder land. Once the growth is complete the biological eco-friendly fencing will be an income generating plant source too. The effect of the root system of the bamboo planted around the fodder boundaries also prevented soil erosion. The runoff water that reaches the nearby Chalakudy river is a loss for the farm lands. The bamboo planted act as a barrier to block the runoff water and this in turn improved the water holding capacity of the fodder land. The bamboo root system will never hinder the growth of the fodder grass that is cultivated. The dried falling leaves unlike other tree species will not hamper the growth of fodder grass cultivated. Bamboo can be economically better in some types of terrains and lands. The fodder lands boundary. A list of the different ideal species of Bamboo for livestock fodder venture is presented and the growth rate of the species is also presented. This will give a farmer to ascertain his terrain and soil type and help him to select the ideal type of bamboo to be integrated with livestock and fodder. The revenue from this bio fencing will also be ascertained once the growth is complete. The major bamboo species grown at CBF Thumburmuzhy with better foliage were subjected to nutritional analysis. The different components like oxalate content, crude protein and crude fiber content of these bamboo types were evaluated and presented. The bamboo bio fencing is an ideal integration in livestock fodder venture.





INVENTORYING BIODIVERSITY OF RIVER CHANDRABHAGA OF GARHWAL HIMALAYA

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Freshwater, home to tremendous biodiversity, are subjected to acute human interferences. The riverine ecosystems are the integral part of the freshwater ecosystem. These ecosystem contain a number of representatives of benthic flora and fauna, which are washed up from the streambed. The river Chandrabhaga is a springfed small perennial river having its source in many natural small springs. The present investigation is focused on the biodiversity of the river. The Chandrabhaga fluvial system was thoroughly surveyed for inventorying aquatic biodiversity. Samples were collected from different sampling sites and then preserved in 5% formalin for further identification. The qualitative and quantitative analyses was done with the help of identification keys of Freshwater Biological Association UK. Few physico-chemical parameters were also analyzed to study the water quality of the river with the help of APHA. Biodiversity of the river i.e. Phytoplankton, Periphyton (benthic algae), Macro-invertebrates, Macrophytes and Fish fauna were obtained following standardized methods. Amongst plants 30 genera of phytoplankton, 33 genera of periphyton, 19 genera of aquatic macrophytes were recorded. A total of 26 genera of macro-invertebrates belonging to insect and mollusca were identified. 23 taxa of fishes were recorded of which *Schizothorax* and *Barilius* were the most dominant. The fluvial system of chandrabhaga is rich in terms of biodiversity but it is degrading due to excessive illegal mining activities in the catchment area. The fluvial system of Chandrabhaga is very important in the mountainous region of Garhwal Himalaya, as it provides a suitable habitat for the aquatic biodiversity. In addition, it also offers a conducive environment for the fishes Mahseer (*Tor*) and *Schizothorax*. There is the need for conservation and management of aquatic biodiversity for the proper functioning of river ecosystem.



MICRO-FUNGI ASSOCIATED WITH RATTANS OF WESTERN GHATS REGION OF GOA, INDIA

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World over, palm-associated fungi seems to be one of the well-explored ecological groups. Studies on microfungal diversity associated with palm genus *Calamus* was carried out during 2007-10. Isolation techniques such as moist chamber incubation, endophyte-planting and litter particle-planting methods revealed that *Calamus* spp. are good hosts for a number of fungi. Compared with the ratio of 1:5.7 for plants to fungi calculated by Hawksworth (2001), the number of fungi associated with *Calamus* spp. is far higher. Rachis and leaf sheaths of *Calamus* harbour most of these fungi. Taxonomy and different aspects of distribution of the associative fungi with rattans are discussed in this paper.



MICROBIAL BIODIVERSITY: CHALLENGE FOR NEXT GENERATION

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The word 'biodiversity', a contraction of the synonymous phrase 'biological diversity', is defined in the Convention on Biological Diversity (CBD) as 'the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'. The 'Outlook' outlines a possible new strategy for reducing biodiversity loss, learning lessons from the failure to meet the 2010 target. It includes addressing the underlying causes or indirect drivers of biodiversity loss, such as patterns of consumption, impacts of increased trade and demographic change. Ending harmful subsidies would also be an important step. Nearly a quarter of endangered plant species are threatened with extinction, natural habitats continue to vanish, and water bodies to be degraded. The world has failed to meet its target of a significant reduction in the rate of biodiversity loss by 2010, says the third 'Global Biodiversity Outlook.' The report's assessment of the Asia and the Pacific region is gloomy, even though some progress has been made. In 2008, the Asia-Pacific region contained the world's highest number of threatened species (more than 400 animal and 250 plant species in India). Over the period 2002-2009, nearly 2,500 species in Asia and the Pacific have gone onto the 'critically endangered', 'endangered' or 'vulnerable' list of the International Union for Conservation of Nature and Natural Resources (IUCN). India may have just 2.4 percent of the world's area, but it has eight percent of the world's biodiversity. India is one of the 12 mega diversity "hotspot" regions in the world, with tropical rainforests, alpine vegetation, temperate forests, wetlands, deserts, coastal areas and an inventory of over 47,000 species of plants and over 89,000 species of animals. Look at just the agro-biodiversity in India: There are 167 crop species and over 350 wild relatives. India is considered to be the centre of origin of 30,000-50,000 varieties of rice, pigeon-pea, mango, turmeric, ginger, sugarcane, gooseberries and so on and ranks seventh in terms of contribution to world agriculture. [* File contains invalid data | In-line.JPG *] But India is in danger of losing this rich biodiversity. Widespread habitat destruction has been one of the villains. Forests are the largest repository of biodiversity. Bhubaneshwar, the capital of Orissa, was built on 500 hectares of pristine sal forests. 23 per cent of the land in India is under forests and is being constantly eyed by the government as it is seen as the largest land bank available, says a former forest official insisting on anonymity. Medicinal plants face a high risk of extinction with continuing dependence on wild collections. Over the period 2000-2005, the rate of loss of primary forests was fastest in Cambodia, the Democratic People's Republic of Korea, Indonesia, Mongolia, Papua New Guinea, and Vietnam, accounting for a quarter of the world's total losses over that period. The report is based on scientific assessments, national reports submitted by governments, and a study on future biodiversity scenarios. It is collaboration between the Secretariat of the (Ahmed Djoglaf, executive secretary) of the UN Convention on Biological Diversity (CBD) and the United Nations Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC). "We continue to lose biodiversity at a rate never before seen in history — extinction rates may be up to 1,000 times higher than the historical background rate," says Ahmed Djoglaf. "India being one of the top twelve mega biodiversity countries in the world, the increasing rate of erosion of biodiversity has been causing great concern. Because of socio-economic changes, biological diversity has to come to occupying the central stage as it holds the 'key to the maintenance of the world'. Biodiversity is a multifaceted science bringing the ecologist and environmentalist together resulting in an interdisciplinary subject. Issues like ecosystem dynamics, global changes and impact of the loss of biodiversity at various levels such as local, national and global levels have become important. As a result of the loss of genes, species and ecosystems, the need for conservation of biological systems has come to be increasingly recognized. The need to understand traditional ecological knowledge for managing biodiversity by the local people has also come to be appreciated. As most of the minerals in India are in forest areas, there is tremendous pressure to cut forests for mining. If tribal areas have to be developed, roads, water and power has to be reached to them. But most of the tribal areas are in forests. Once roads enter forests, there are edge affects. With the ingress of population and vehicle, trees become the first casualty. Says a former forest official: "Forests are hardly ever seen as a symbol of development. But roads are. Mining in a forest is totally destructive. Government corporations often violate rules that lead to biodiversity destruction. As they are a part of the government setup, they do not take the required permissions." This major new assessment of the current state of biodiversity confirms that the world has failed to meet its target, set in 2002, to achieve 'a significant reduction in the rate of biodiversity loss by 2010'. "We continue to lose biodiversity at a rate never before seen in history — extinction rates may be up to 1,000 times higher than the historical background rate," says Ahmed Djoglaf, executive secretary of the UN Convention on Biological Diversity (CBD). The word 'biodiversity', a contraction of the synonymous phrase 'biological diversity', is defined in the Convention on Biological Diversity (CBD) as 'the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'



LEAF PHENOLOGY OF SOME IMPORTANT EVERGREEN AND DECIDUOUS SPECIES OF BARAK VALLEY, SOUTHERN ASSAM, INDIA

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The initiation of growth in plants and phenological changes are governed by various environmental factors. The timing of phenological activities varies among different species and among individuals of the same species. Phenological activities such as shoot extension, leaf initiation, leaf expansion, leaf maturation, leaf packing, leaf fall and their correlation with different climatic factors were observed for two years in eight important species (four evergreen & four deciduous species) of a tropical wet evergreen forest located in the Barak Valley of southern Assam (24°35'04.3" N and 92°44'50.0"E) in NE India. The average leaf expansion period was longer only by less than one week in evergreen species than that of deciduous species (5.5 vs 5 weeks). Leaf recruitment period was significantly different ($P < 0.05$) for evergreen and deciduous species (5.3 vs 6.3 months). The leaf number per shoot was greater for deciduous species (average = 23.75) than for evergreen species (average = 8.25) and were significantly different ($P < 0.05$). The leaf longevity of evergreen species (417.64 days) was significantly greater ($P < 0.05$) than that of deciduous species (116.5 days). The leaf fall in deciduous species was concentrated during the dry season. In contrast to deciduous species the evergreens retained their leaves during entire dry summer, until new leaves were formed or just prior to new leaf formation. Although deciduous species show wide variation in timing of new growth initiation (some initiate leafing before the evergreens while others do later), but deciduous species complete growth earlier than evergreen species. The capacity of evergreen species to retain leaves during the dry winter season gives them an advantage over the deciduous species because they can maintain some photosynthetic activity during most of the winter season.



FISH BIODIVERSITY IN CHHATTISGARH, EASTERN INDIA

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Fish contributes a good share in the diet of human population of Chhattisgarh. However, there is a declining trend in the availability of fishes from the natural sources in the state. This is primarily due to loss of wetlands and over exploitation of the resources. Climate change and increasing pollution add further to the loss of fish fauna in the state. The present manuscript deals with the extant fish species in the state of Chhattisgarh and Bilaspur district in particular. At present the natural water bodies sustain the populations of rohu and catla as the major food fishes while *Puntius* spp., *Chela* spp., *Salmostoma* spp., *Mystus* spp., *Mastacembelus armatus*, *Macragnathus aculeatus* and *Channa* spp. as the other commonly available species. The Indian cat fish *Clarias batrachus* & *Heteropneustes fossilis* are at the verge of extinction in the State. Similarly *Notopterus notopterus* and *N. Chitala* are becoming very rare species.





TRADITIONAL FOREST FOODS AND USEFUL SPECIES: REGENERATING BIODIVERSITY AT VAN VADI, WESTERN GHATS

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Van Vadi nestles in the foothills of the Sahyadri range in the northern reaches of the Western Ghats, Taluka Karjat, District Raigad, Maharashtra. The land, about 64 acres, was bought about sixteen years ago with the pooled contributions of about 24 people committed to the primary objective of ecological regeneration. Progressive self-reliance in basic needs, including food; and harmonious coexistence with local inhabitants were the other main explicit aims. In broad academic terms, the methodology may be said to be one of participatory/action research. More specifically, our main 'intervention' was in protecting the land from tree felling and hunting, while doing some supplementary planting of locally suited/indigenous species, particularly evergreens and food yielding or other traditionally useful species. Maintaining friendly relations with local villagers to earn their goodwill was important. Additionally, soil and water conservation, rainwater harvesting, some organic cultivation of indigenous/locally suited food crops, and non-formal gatherings of people, particularly youth — for nature sensitization, environmental learning and community living – were some of our significant activities. In recent years, Van Vadi has been hosting an annual *vanutsav* (forest festival), a *shram utsav* (work camp), a *rop utsav* (planting camp), and occasional workshops on ecologically related subjects. Over the past sixteen years, Van Vadi has regenerated into a magnificent forest – tall, dense and very rich in biodiversity of traditionally useful trees and plants, including several dozen species of uncultivated forest foods, recognized and consumed by local villagers. Rainwater harvesting and groundwater recharge has greatly benefited the water security of the area. At least two downstream villages, whose bore-wells ran dry in peak summer, now have water all round the year. On about two acres, rainfed rice and native millets are organically grown, while one acre is planted with vegetables and fruit irrigated from the rain harvested (at low cost) in a surface stream-bed water body held back by a rock and earth check dam. Van Vadi has also gradually and steadily evolved as a non-formal centre of learning on co-existence in harmony with nature, inspiring many people over the years. It presently stands as an oasis that has withstood the ravages of modern 'development' and urban-rooted land speculation that has mowed down all surrounding forest areas in the vicinity. Van Vadi is a successful case study of ongoing ecological regeneration of forest, ground water and biodiversity, while progressively enhancing self-reliance in basic needs, including food, fuel, fodder, fibre, medicinal plants, etc. It efficiently sequesters carbon in the soil and in vegetative growth, mitigating climate change; and provides an inspiring sustainable alternative to the dominant energy-intensive development paradigm that degrades our natural wealth, threatening the well-being and survival of future generations. Initiatives like Van Vadi need encouragement and support from all quarters, and offer much hope for the future.



DIVERSITY OF AQUATIC AND WETLAND VASCULAR PLANTS OF SELECTED AREAS IN THIRUVANANTHAPURAM, KERALA

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Freshwater ecosystems are an integral part of a geographical region. Aquatic vascular plants play a crucial role in keeping the ecosystem stable. Karikkakom, Venpalavattom and Thiruvallam, the selected study areas are bestowed with a diversity of aquatic fields and each area showed different patterns in floristic diversity. The study revealed that the aquatic and wetland plants of the study areas were represented by 65 species of vascular plants under 58 genera belonging to 32 families. Of these 14 families with 24 genera and 27 species were included in the class Dicotyledons and 12 families with 28 genera and 32 species belong to the class Monocotyledons. The Pteridophytic plants are represented by only 6 families with monotypic genus and species in each. Comparative analysis on the diversity identified Karikkakom as the diversity rich zone for aquatic and wetland vascular plants over the other areas studied.





DIVERSITY OF BUTTERFLIES AT PACHAMALAI HILLS

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Pachamalai hills is a hill range, just 80kms north of Tiruchirapalli, is located with the highest peak at 1000m. Pachamalai hills are part of the Eastern Ghats, Eastern Ghats is older than Himalayas and Western Ghats. The Eastern Ghats are isolated hill ranges in Peninsular India and harbours primarily tropical deciduous vegetation, which represents species of high economic, timber, medicinal potential. It lies in 11° 31' and 22° N latitude and 76° 50' and 86 ° 30' E longitudes. The number of flowering plant taxa occurring in the Eastern Ghats is about 3200 with 98 endemic species (Reddy et al. 2002). Most of the endemic plants in Eastern Ghats show narrow range of distribution. This mountain range in itself has different small regions like Thenparanadu, Kombainadu , Athi Nadu and Vannadu. Practically all these forests are classified under three types as below: (i) Scrub Jungles to 400m (foot hills); (ii) Deciduous forest – 300 to 900m (slopes); (iii) Evergreen forest- 800 to 1300m (Plateau). Understanding and studying our interaction with the environment especially the biodiversity is important for several reasons. First, we depend upon our environment for living; second, our actions have brought us beneficial changes, such as longer life spans, material wealth, mobility, and leisure time. However, numerous others have spawned undesirable changes, from air and water pollution to soil erosion to species extinction, the compromise human well-being and can threaten human life. The elements of the environment were functioning long before humans appeared, and we would be wise to realize that we need to keep these elements in place. For this it is essential primarily to estimate the richness of biodiversity. This study focuses on estimating the diversity of butterflies at Pachamalai hills. The study recorded a total of 134 species showing the richness of the hills representing all the five families. The study also revealed the occurrence of new species unreported so far from this area. This paper is the first available checklist of butterflies at Pachamalai hills including some rare and Western Ghat endemic butterflies.





STATUS OF SARUS CRANE (*GRUS ANTIGONE*) IN THE BRAJ REGION OF BHARATPUR IN EASTERN RAJASTHAN, INDIA

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From January to December, 2007 a survey was carried out to assess the present status of the Sarus Crane at Bharatpur district in eastern Rajasthan in northwestern India. A total of 29 sites mostly potential habitats were surveyed in the entire district of Bharatpur. Of these, 12 sites showed the presence of cranes. A sharp decline of about 93% was noticed. All all, Nonera was identified as one of very important sites for cranes both as feeding and roosting ground. Sarus cranes used various habitat types including agricultural fields, harvested fields, wet barren lands with *Cyperus* sp., *Scirpus* sp. vegetation. The paper also highlights conservation issues for cranes in the region.





A PRELIMINARY STUDY ON DIVERSITY AND DISTRIBUTION OF PHYTOPLANKTONS IN ASHTAMUDI LAKE-THE SECOND LARGEST RAMSAR SITE IN KERALA

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Photosynthetic carbon fixation by phytoplankton represents the chief fraction of the organic production in most lakes. Thus diversity, distribution, abundance and variation in phytoplanktons give reliable information on energy turnover in an aquatic system. Their sensitivity and substantial variations in species structure often provide an indication of significant change in ambient conditions within an ecosystem and they are considered as good indicators of water quality. Ashtamudi Lake located at the geographical coordination of 76 13'-76 37'E and 8 54'-8 59' N in Kollam district is the second largest Ramsar site in Kerala with a waterspread area of 32km². In the present work, an attempt was made to explore the diversity and density of phytoplanktons in Ashtamudi Lake and their relationship with selected physicochemical parameters of the lake water. The water samples for physico-chemical and biological analysis were collected in one litre polyethylene bottles which were pre-cleaned with dilute HCl, then with soap solution and finally washed well with tap water. At the sampling location the bottles were again rinsed with water to be sampled and all the samples were properly labelled and parameters like temperature and pH were measured from the location itself using portable instruments. Physico-chemical parameters like temperature, pH, chloride, acidity, alkalinity, CO₂, nitrate and phosphate were analysed as per the standard methods (APHA, 1998). The phytoplankton water samples were immediately preserved in Lugol's iodine solution. The sedimented samples were observed under compound microscope for identification. Quantitative and qualitative estimation of phytoplanktons from each sites were carried out with the help of Sedwick-Rafter counting cell. Phytoplanktons were identified using standard books and photographs. A total of 121 species of phytoplanktons were identified from the lake, of which 20 species belonged to Cyanophyceae, 40 species to Chlorophyceae, 53 species were coming under Bacillariophyceae, 6 species in Dinophyceae and 2 species belonging to Euglenophyceae. The results indicated the predominance of Bacillariophyceae among the recorded species of phytoplanktons. The most abundant species in terms of population density were *Microcystis aeruginosa*, *Cymbella cesati*, *Cosmarium spp.* and *Oscillatoria spp.* The most diverse genera were *Cymbella*, *Staurastrum*, *Navicula* and *Nitzschia* and Euglenophyceae was the least represented group. The dominance of pollution tolerant species like *Oscillatoria*, *Anabaena*, *Microcystis*, *Navicula*, *Nitzschia*, *Synedra*, *Scenedesmus*, *Ankistrodesmus*, *Coelastrum*, and species of *Euglena* was also noteworthy. Physicochemical analysis of lake water exhibited richness in nitrates and phosphates which favor the growth of phytoplanktons in lentic systems. Spatial variations of phytoplankton communities were also evident in Ashtamudi Lake during the study.



BASELINE ASPECTS CONCERNING THE SITE SELECTION PATTERNS OF *APIS DORSATA* (HYMENOPTERA: APIDAE)

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Throughout the ranges of Southeast Asia, upland and low land forests, giant honey bees (*Apis dorsata*) are found to build their nests in aggregates on tall bee trees, often conducting seasonal, long- distance migration to escape from adverse climatic conditions and in search of nectar sources. Availability of nesting site is crucial for the conservation and sustainable utilization of this economically important honey bee. In this study, we have analysed the characteristics of the nesting sites of *A. dorsata* in two districts of Chhattisgarh, India based on an analysis of 200 nests. Protection from predators and anthropogenic disturbances, vicinity of nectarine locations, height of available nesting plants or man made buildings or towers, surface texture of nesting sites, sun direction, wind action and open surroundings to easily access bee pasturages are the major factors controlling the site selection of *A. dorsata*. They generally prefer horizontal branches of tall trees preferably *Ficus religiosa* and *Salmalia insignis* with less number of branches, and no intact barks. They aggregate in areas where old combs are available and worker bees assess the rate of disturbances and other factors based on available combs. The trees preferred by these bees are mostly more than 50 years old and most of the bee-trees are in the state of dying. It is suggested more bee trees should be planted to preserve the bees in the future.





ECOLOGICAL IMBALANCE CAUSED BY MANGROVE DEFORESTATION AND NEED FOR THEIR CONSERVATION ACTIVITIES

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Mangroves popularly called as "Nature's coast guards" are salt-tolerant evergreen forests found along sheltered coastlines, shallow-water lagoons, estuaries, rivers or deltas. This study on Mangrove forests covers the biology, species of the mangrove forests and the ecological benefits provided by them. The mangrove forests are being depleted at high rates during the recent times for industrialisation and development. The economic development in India followed by the expansion of cities geographically and construction of new ports has also resulted in considerable harm to this natural habitat of hundreds of species. The alarming rate of mangrove depletion rate in India and the ecological imbalance created by it are mentioned in this study. The study also throws light on the importance of the Mangalavanam mangrove forest in Cochin and the flora and fauna associated with it. This mangrove forest which forms the habitat for many endangered species is getting reduced due to the expansion of the Cochin city. The need to ensure that this natural gift located amidst the city is maintained well for ecological balance is also covered as a part of the study. To get a global view of the issue, the study extends to the mangrove conservation activities adopted world wide and also highlights few recommendations so as to conserve the mangrove ecosystems in India. This research study on 'mangroves' was carried out by collecting information through various secondary sources. Firsthand information was collected by visiting the Mangalavanam mangrove area. Aggressive management measures needs to be undertaken to sustain the mangrove resources in India. The following recommendations can be taken into consideration: Micro-propagation (Tissue Culture), mangrove nursery technique, Canal-bank planting technique and people's participation programmes should be encouraged. Adopting Comp-Mat, the latest method of mangrove planting which has been discovered by the Forest Research Institute of Malaysia (FRIM). Practicing Reef Ball Mangrove Division's system designed to minimize the timeframe in which the mangroves are in their juvenile stage – the tree's most vulnerable time. Self initiated coastal conservation measure by the women should be encouraged and also should be expanded elsewhere. Also proper support should be given both from authority also and in terms of monetary benefits for similar initiatives to bloom. Government should provide necessary support available funds to the concerned parties like NGO's to conduct research to develop successful measures of restoring mangrove forest ecosystem and to identify the right species for the right location that will facilitate/reap maximum benefit of restoration. Research can also be conducted to plant mangroves in areas where they do not occur in nature. Areas of severe mangrove deforestation or depletion must be under strict investigation to prohibit further depletion and punish the responsible parties.



ECOBHAVIOUR STUDY OF RHESUS MACAQUE (*MACACA MULATTA*) AND HANUMAN LANGURS (*SEMNOPITHECUS ENTELLUS*) IN LOHARGAL AREA WITH SPECIAL REFERENCE TO THE ARID ZONES OF THE ARAVALI HILLS OF RAJASTHAN

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Rhesus macaques (*Macaca mulata*) and Hanuman langurs (*Semnopithecus entellus*) are exceptionally adapted to coexisting with humans and thrive near human settlement, in both urban and agricultural areas. A field study was conducted in Lohargal area of Jhunjhunn district (Rajasthan) during 2008-2009. It is impossible to characterize their "natural" diet without considering the impact of humans. Because they are found in higher densities in areas of human settlements compared to forests, in some areas rhesus macaques and Hanuman langur derive, both directly and indirectly, a substantial part of their diet from human activities. A unique relationship existed in between man and monkeys particularly in temple areas. They coexisted in the forest areas and cooperate with each other in different contexts. On receiving an alarm bark given either one or more individuals of langur or macaque groups, all the animals of different groups of both the species responded by becoming alert or running and or climbing trees for safety point of view. While communal defense the urban or forest monkeys participate as a whole group, however, old other males or females play a prominent role.



TEMPORAL VALUATION OF FORESTS' CONTRIBUTION TO LOCAL ECONOMY AND ENVIRONMENT: KERALA

01 102

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Forests produce not only many goods but also render various types of services to the society. In order of importance, these goods and services can be grouped into local, regional or national, and global. While the goods produced by forests are tangible, the services, on the other hand, are intangible. The present study makes an attempt to value goods and services of forests in a village of Western Ghat Region of Kerala. While carrying out this, the study keeps aside the contribution of forests to the regional/national and global economies. Since the forest land and its associated resources together constitute a multi purpose natural resource system, the present study categorises forest products and services according to its nature. It helps to select appropriate valuation method for each categories of forest products and services. Our findings reveal that local people's dependency on forest is increasing over a period of twenty years. This recalls the need to preserve forests for the benefits of future generation.



CONSERVATION OF *GLORIOSA SUPERBA*

01 103

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From the beginning of human civilization the plants particularly ethnomedicinal plants have played a great role in human life for treatment of various diseases.. The entire planet is in search of reviving herbal medicinal plants for the betterment of mankind. *Gloriosa superba* is one such plant species which is important for its medicinal uses in India & Africa. It is used in disease like cancer, gout, scrofula, leprosy, snake bite & abortion and act as antipyretic, anthelmintic, purgative and antiabortive. It is a source of colchicines and colchieocides which are very costly being highly demand by pharma industries. Due to excessive use, for diverse medicinal purposes, the species is on the verge of extinction and is included in Red Data Book .The strenuous efforts of Botanist, Biotechnologist, Policy makers and conservationists are required to conserve it. .It is a matter of great concern to conserve this plant otherwise we will be loosing it by 2020.The paper discuss the use of *Gloriosa superba* in Ayurveda industry for its medicinal value & what step taken to conserve this multidynamic wonderful plant spotted first time in Hazaribag forest in Jharkhand.



A PRIMARY REPORT ON THE OCCURRENCE AND DISTRIBUTION OF NUDIBRANCHS (ORDER: OPISTHOBANCHIA; CLASS: NUDIBRANCHIA) FROM LAKSHADWEEP ARCHIPELAGO

01 104

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The occurrence and distribution of Nudibranchs in 11 atolls of Lakshadweep archipelago was investigated. Lagoon, intertidal reef flat, mudflats and outer reef slopes up to the depth of 28 meters were surveyed by Snorkeling and SCUBA diving with simultaneous recording by photography. Survey was conducted in all habitats such as soft and rocky substrates, deeper rock wall and caverns. Samples were collected and narcotised in 7% MgCl₂ diluted 1:1 in seawater before fixation. Specimens are then preserved in 4% formaldehyde neutralised with borax. Specimens were transferred to 70% ethanol after four weeks for prolonged storage. Identification up to species level was done with live specimens in the field. Conventional sources of nudibranch taxonomic characters, such as jaws and radula, are lacking in the Phyllidiidae. Characters used in this study are: general shape and body profile; colour and pattern; morphology of notal tubercles, ridges and the mantle margin; rhinophoral colour; number of lamellae on each rhinophoral clavus; gills; morphology of foot and foot-sole; oral tentacles; anatomy of the alimentary system; anatomy of the reproductive system. We recorded 12 species of Nudibranchs belonging to four genera namely *Phyllidia*, *Fryeria*, *Phyllidiella* and *Phyllidiopsis*. *Phyllidiella varicosa* was found to be distributed in all the islands selected for the study. *Phyllidiopsis phippiensis* and *Phyllidiopsis striata* were found in very low numbers and its distribution restricted to Agatti, Kalpeni and Minicoy islands. *Phyllidiella pustulosa*, *Phyllidiopsis gemmata* and *Phyllidiopsis krempfi* were observed only in lagoons and *Phyllidia coelestis* distributed from shallow lagoon at the depth of 2m to deeper regions up to the depth of 25m.



DISTRIBUTION PATTERN AND COMMUNITY STRUCTURE OF SEA CUCUMBERS (CLASS: HOLOTHUROIDEA) IN DIFFERENT BIOGEOGRAPHIC REGIONS OF THE SELECTED ISLANDS OF LAKSHADWEEP ARCHIPELAGO

01 105

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The distribution pattern and community structure of Sea cucumber (Class: Holothuroidea) was investigated in different biogeographic regions of three atolls of Agatti, Kavaratti, Kalpeni islands of Lakshadweep archipelago. Visual census was used to estimate the abundance of the species along 50m X 10m transects. 15 species of Sea cucumbers belong to 7 genera and 3 families were recorded and their distribution patterns in different atolls were worked out. *Holothuria atra* and *H. leucospilota* were randomly distributed in Agatti while they, showed aggregated distribution pattern in Kavaratti and Kalpeni. The community structure of Sea cucumber differs significantly ($P < 0.001$) in various biogeographic regions of the reef (Sea grass bed, Sandy area, Reef flat, Outer reef slop, Rocky and rubble area and Sea weed and algae quarter). Species richness and diversity index were estimated and compared between the different biogeographic regions of three atolls. Species richness in Agatti (1.61 ± 0.46) and Kalpeni (1.63 ± 0.82) atolls was found to be more or less similar and a lower value was estimated for Kavaratti (1.33 ± 0.42). Diversity of sea cucumbers was higher in Kalpeni (2.1 ± 0.72) and Agatti (2.0 ± 0.57) when compared to Kavaratti (1.6 ± 0.49). The distribution pattern and abundance of the sea cucumber resources is brought out for the three islands, which will be useful for the formulation of a management measures and demarcation of protected zones for this threatened category.





ENERGY PLANTATION PROJECTS INDIA LIMITED

01 106**Jayanth Ganapathy**

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Energy Plantation Projects India Ltd (EPPI) operates in the Non Conventional and Renewable Energy space. The company was set up to produce Biomass Energized Electrical Power Stations. The Company was registered in October 2005, and started operating from February 2006. The company is located and has its head quarter in the village of Nattarasankottai, about seven kilometres from the District Town of Sivagangai in Southern Tamil Nadu, India. Other offices are in Bangalore and Mumbai. Green Power using the nature's bounty is the driver of all core values of EPPI. The company's policies, procedures and practices were developed over a period of time based on simple, honest and understandable corporate wherewithal that is based on technological and urban sophistication as well as based on rural forestation advantages. To make biomass security feasible for EPPI's power stations, the company established a 300 acre man-made high density regenerative forest with fast growing trees with intensive applied R&D right from the year 2002. With the help from Universities and other Research Stations, EPPI identified eight different varieties of trees that grow fast and tall. They grows to a height of about 25 feet in three years. They are all resistant to dry areas. This helped EPPI develop over a period of eight years, extensive wherewithal and capability to make Man made high density regenerative forest with fast growing trees. The Forests are fully grown within three to four years and are designed to grow continuously for a few decades. The company is now in a position to replicate this model even better as time goes on. The Man Made High Density Regenerative Forest is the Back bone of EPPI's business concept. Since the entire concept revolves around this, it was necessary for EPPI to establish the forest first and show to the world that it is indeed possible to establish such Man Made High Density Regenerative Forests. EPPI's plantation is the first of its kind, with modern agricultural facilities like drip irrigation system, electrical systems and equipments connected with UG Cabling, periphery guarded with solar fencing and out of the box thinking ideas to manage the ground water resources. Apart from this, the plantation is managed as per standard agricultural and forestry methodologies & practices. Apart from this existing plantation at Sivagangai District in Tamil Nadu, EPPI is all set to establish another 500 acres of such forests at Ramnad district and many other locations in the near future. In conclusion, EPPI has become a pioneer in setting up a 360 degree model from Afforestation to Power Generation.





DISTRIBUTIONS OF PESTIFEROUS TERRESTRIAL MOLLUSCS IN BANGALORE REGION, KARNATAKA

01 107

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Pestiferous mollusks are one of the biggest threats to agricultural and horticultural crops worldwide. Globally, several studies have documented the species that are pest and the loss incurred from them. In India, the surveys mainly conducted in the Northern India and several papers have published in this regard. However, there are hardly any comprehensive survey which looked at all pestiferous snails and slugs in Southern India. We conducted surveys during 2008-2010 in anthropogenic and natural habitats to document the distribution of native and introduced malacofauna in the Bangalore region (12.97°N 77.56°E / 12.97; 77.56), Southern India. The snails and slugs identified during the survey include *Achatina fulica* (Bowdich), *Ariophanta solata* (Benson), *Macrochlamys indica* Godwin-Austen, *Laeviculis alte* (Ferrussac), *Mariaella dussumierei* (Gray) and *Deroceros leave* (Muller). Among these the marsh slug, *Deroceros leave* (Muller) is a first time record from Southern India. The potential costs of these species on agriculture or the environment are largely unknown, but potentially immense.



FOLIAR EPIDERMAL VARIATIONS IN *HEMIDESMUS INDICUS* R.BR. (PERIPLOCACEAE)

01 108

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Hemidesmus indicus R.Br. popularly known as Indian Sarasa parilla is a monotypic species belonging to the family Periplocaceae. The plants are perennial much twining shrubs with polymorphous leaves. *H.indicus* is an important root drug and has extensive applications in various Indian systems of traditional medicine. The species exhibits a wide range of variations in its vegetative morphological features especially in the foliar characters. The present investigation dealt with the foliar diversity in 12 accessions of *H.indicus* collected from different localities of Thiruvananthapuram, Kollam, Ernakulam and Idukki districts. Parameters like size and shape of leaves, length and breadth of guard cells, subsidiary cells and stomatal complexes and frequency of stomata were considered. The data were subjected to ANOVA and polygraph analysis. Existence of wide range of diversity in the foliar characters of the accessions evidenced from ANOVA, and it may be due to changes in the irradiance level. Correlation between stomatal frequency and stomatal index with change in the altitude was studied. Role of stomatal index and stomatal frequency for the identification of the best performing genotype was discussed. Polygraph analysis revealed graphs with similar size and different shapes. The role of altitudinal conditions for inducing foliar variations was also discussed with the help of polygonal graph.



HETEROTROPHIC BACTERIA IN THE SHELF SEDIMENTS OF BAY OF BENGAL

01 109

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Biodiversity and community structure are now recognized to be important determinants of ecosystem functioning. Microbial surveys have shown high diversity in marine sediment deposits. Heterotrophic bacteria play a significant role in the biogeochemical cycling of elements. In this regard, the marine ecosystem has been studied to a much lesser extent compared to the terrestrial environment. The present study was carried out to determine the heterotrophic bacterial community in the continental shelf sediments of Bay of Bengal. The continental shelf regions of Bay of Bengal (Karaikal, Cuddalore, Cheyyur & Chennai) extending from latitudes 10°36' 007'' N to 13°02'713''N and longitudes 08°007' 066'' E to 8°037'185''E covering twelve stations was studied. Sediment samples were collected onboard Fisheries & Oceanographic Research Vessel (FORV) *Sagar Sampada*, MoES, Govt. of India from 50, 100 and 200m depth regions using Smith McIntyre grab. Sediment texture analysis was carried out using particle size analyzer (SYMPA TECH, Germany) and total organic matter by wet oxidation method (El Wakeel & Riley, 1957). Total bacterial count was done by Acridine Orange Direct Count (AODC) method. Total heterotrophic bacterial population was estimated using ZoBell's agar media employing conventional spread plate method. The bacterial isolates were identified up to generic level as per Bergey's Manual of Systematic Bacteriology (1984). Sediment was generally greenish in colour and was found to be sandy at 50m and 100m depth. However at 200m depth it was silty sand (off Karaikal and Cuddalore) and clayey silt (off Cheyyur and Chennai). Depth wise variation in the organic matter content was noticed with the maximum at 200m depth followed by 100m and 50m depth. In the shelf sediments, bacterial population showed significant variation latitudinal and depth wise. Population was found to be more at 200m depth where the organic matter content was high. A total of 269 cultures were isolated from the shelf sediments, of which 70% were gram negative and remaining 30% were gram positive. The isolates were identified based on morphological and biochemical tests and classified into 14 genera. *Bacillus* (24%) was found to be the dominant genus, followed by *Vibrio*(17%) and *Alteromonas*(15%).



SUBSTRATE DEPENDENT VARIATION IN THE BACTERIAL DIVERSITY IN MARINE BIOFILMS

01 110

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Biofouling communities contribute significantly to the biogeochemical cycling and total productivity of the aquatic ecosystems. Information on the distribution, composition and interaction of the microbial communities in biofilm is rather sparse compared to other components of aquatic systems. Substrate specificity of biofilm forming bacterial community and its diversity in different substrates was investigated from Puthuponnani backwaters for a period of five months. Substrates like Stainless steel, wood, glass, tile and tyre were sterilised and suspended in backwaters to assess the pattern of colonisation and succession of microbial community. The samples were taken during 24 hours, 48 hours, 96 hours and then on monthly basis. The main bacterial groups observed on different substrata were *Pseudomonas*, *Alcaligenes*, Enterobacteriaceae, *Bacillus*, *Staphylococcus*, *Acinetobacter*, *Arthrobacter*, *Vibrio*, *Flavobacterium* and *Moraxella*. The dominant groups observed were Enterobacteriaceae, *Pseudomonas* and *Bacillus*. Highest species richness was observed on steel ($d = 0.86$) and lowest on wood ($d = 0.63$). Evenness index did not vary significantly ($P < 0.05$) with the selected substrates showing similar pattern in the distribution of microbes. Highest microbial diversity was observed on steel ($H' = 0.93$) and lowest in tile ($H' = 0.66$). Higher values of Species richness and diversity were recorded during the initial month which gradually decreases with time due to grazing or macro-fouler invasion.



DIVERSITY OF CYANOBACTERIA IN THE MINED SPOILS OF WESTERN GHATS, KARNATAKA (INDIA)

01 111

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Cyanobacteria (blue green algae) are a diverse group of photosynthetic prokaryotic organisms found in freshwater and marine environments. The origin of these organisms dates back to three or four billion years. There are more than 2000 strains of cyanobacteria distributed all over the world; showing remarkable ecological diversity and have high adaptability to extreme conditions like temperature, desiccation, illumination, radiations, salinity, pH, toxicants and nutrient availability. They play an important role in maintaining food chain and conserving biodiversity as one of the primary producers. The present study was carried out by taking the mined spoils of manganese ores near Joida taluk (74° 09' to 75° 10' East longitude and 13° 55' to 15° 31' north latitude) of Uttara Kannada district. A total of fourteen soil samples from two-mined area were collected. Soil samples were subjected to Enrichment culture using De's Modified Beneck's medium. A total of fifteen species were recorded in the present investigation, out of which blue green algal species were more, possibly because of their adaptability to the extremities. Hence the present work is an effort, in which assessment of blue green algae in mine spoils has been made, which could be of considerable interest in soil reclamation of mined spoils.

**BIRD'S NEST FUNGI IN INDIA: A NEW RECORD FROM SIKKIM****01 112****Kanad Das* and Ruilin Zhao¹**

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Members of the family Nidulariaceae Dumort. (currently under Agaricales) are generally considered as Bird's Nest Fungi. Nidulariaceae is represented in India by 3 genera and 15 species, namely, one species of *Nidula*, 13 species of *Cyathus* and one species of *Crucibulum*. *Nidula emodensis*, the only known species of the genus *Nidula* from India was reported earlier from the state Sikkim in 1854. Recently, a number of macro-fungal explorations were undertaken in different parts of Sikkim Himalaya and a large number of samples were collected. The morphological examination followed by thorough literature survey of those samples revealed some unrecorded species for India. Out of which, one appeared to be *Nidula candida*. The detailed description of this species along with the coloured plates is presented in this communication for the first time from India. Moreover, a provisional key to all the 16 species of Bird's Nest Fungi (including *N. candida*) found from Indian subcontinent is also provided.



MORPHOMETRIC STUDIES ON THE MARINE CRAB *CHARYBDIS NATATOR* (HERBST, 1789) (BRACHYURA: PORTUNIDAE)

01 113

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For the present morphometric study random collection of brachyuran crab *Charybdis natator* were carried out from the offshore region of Nagapattinam (Lat. 11° 15' NS and Long. 79° 46' EW) on south east coast of Bay of Bengal. Carapace length was chosen as main references. Animals were sexed and weighed individually. Length and width of carapace and abdomen, chelate leg length. Chelate length and nature of fifth legs were recorded and these data were analysed statistically. The result indicated that there is no significant difference in carapace length and width, they are isometric in both sexes. The propodus length of the left and right chelae are more or less same in the marine crab *Charybdis natator*. The fifth leg shows no sexual dimorphism. The abdomen is broader in female than in male however the relative growth of the abdomen is isometric in both sexes. The abdominal width of the female clearly shows an alteration in the growth rate. This increase in the abdomen in the female is used to carry and protect the eggs. The present study focused that the relative growth parameters of these marine crabs are isometric.





LINKING INSECT DANCE WITH PLANT ROMANCE: LESSONS OF BIODIVERSITY CONSERVATION FROM ARNEBIA BENTHAMII

01 114

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The valley of Kashmir is witnessing ruthless use of pesticides in agriculture and horticultural sectors. This has drastically affected the insect diversity and insect abundance in the region. This threat is striking at the heart of biodiversity with incompatible plant species experiencing the heat of pollination crisis and thus survival. *Arnebia benthamii* is a critically endangered alpine herb with tremendous medicinal importance. This species is self-incompatible and obligate xenogamous, thus requiring a pollinator for materialising the sacred sexual ceremony. In the absence of its pollinators, this species fails to set seeds and therefore fails to survive in environments which are devoid of the dancing action of its biotic partner-the pollinator. This case study further unravels how the survival and seed set of this incompatible species is enhanced with increased action of its pollinators in different populations under different circumstances. This study clearly depicts the importance of insect diversity for sustaining plant diversity. It also suggests that any conservation program, whether In-situ or ex-situ, for any threatened incompatible plant species is bound to fail, if its pollination service are not assured.





IMPLICATION OF MEDICINAL PLANTS IN THE CONSERVATION OF BUTTERFLY DIVERSITY IN ACHANAKMAR AMARKANTAK BIOSPHERE RESERVE, CENTRAL INDIA

01 115

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Biodiversity provides millions of people with livelihood helps to ensure food security and is rich source of both traditional medicines and modern pharma and neutraceuticals. Any change in floral biodiversity modifies the global environment and affects the faunal diversity. The repository of medicinal plants in the natural sal forest of Achanakmar Amarkantak biosphere reserve is found to support significantly rich butterfly diversity. In this study a detailed survey was done on the medicinal plants and butterfly population of the bioreserve. Seventy plant species belonging to 43 families of Angiosperms were recorded. These plants support about 25 species of butterflies. The voracious butterfly larvae eat the foliage of the medicinal plants and pupate on them. Most of the adult butterflies solely depend on this plant for their nectar requirement. Increasing anthropogenic disturbances and animal grazing in the biosphere reserve are likely to affect the species richness and diversity of medicinal plants. This will drastically affect the populations of butterflies solely dependent on these rare medicinal plants. Conservation of butterfly biodiversity in this biodiversity in this biosphere reserve is possible only when the loss of medicinal plant biodiversity is presented.





SURVEY OF EARTHWORM SPECIES USED FOR VERMICOMPOSTING IN TIRUNELVELI DISTRICT, TAMIL NADU, SOUTH INDIA

01 116

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Over 4,400 individual species of earthworms have been recorded throughout the world, but the researchers have broken them into three categories, largely descriptive of their habits in the soil and the three categories are endogeic, anecic and epigeic. Endogeic worms build complex lateral burrow systems through all layers of the upper mineral soil. They are the only category of worm which actually eats significant volumes of soil and not strictly the organic component. These worms tend to be medium sized and pale coloured. Anecic worms build permanent, vertical burrows that extend from the soil surface down through the upper mineral soil layer. Epigeic worms live in the top soil, and duff layer on the soil surface. These small, deeply pigmented worms have a poor burrowing ability, preferring instead an environment of loose organic litter or loose topsoil rich in organic matter to deeper soils. Epigeic species feed in organic surface debris and have adapted beautifully to the rapidly shifting, dynamic environment of the soil surface. Though there are 4,400 species available in the world, only around 30 species are endemic. Out of these species only a few are engaged in vermiculture. The present study survey was conducted during 2010, June-October in seven sub divisions of Tirunelveli District. The subdivisions were Ambasamudiram, Alangulam, Pavoorchathiram Cheranmahadevi, Tenkasi, Tirunelveli and Palayamkottai. Totally about fifty formers were practicing the vermicomposting process in small scale with 3-5 kinds of species. They reported their most preferable species for vermicomposting are *Eisenia foetida*, *Eudrillus eugeniae* and *Perionyx excavatius* because of the consumption, growth and reproductive rate of this species were very high when compared to other species.





TRADITIONAL KNOWLEDGE AND PLANT BIODIVERSITY CONSERVATION IN MEITEI HOMEGARDENS OF BARAK VALLEY, ASSAM

01 117

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Homegardens are considered a sustainable production system in the tropics which contributes to biodiversity conservation. This paper deals with indigenous knowledge and practices in conservation of the plants used by the Meiteis of Barak valley, Assam. Data was collected through surveys, plant inventories, direct observations and interviews. Data was collected through surveys, plant inventories, direct observation and interviews. 11 different management zones and 10 plant uses were identified. Fruit and timber yielding trees were the most important use categories. Some of the plants were conserved due to their specific uses such as *Meyna laxiflora*, *Parkia timoriana*, *Toona ciliata*, besides few plants of multipurpose nature. Bamboo also formed an important component of Meitei homegardens which is use as fencing material and also for making other traditional products. The bamboo clumps in the homegarden of study village also formed the nesting site of cattle egret. Meitei possesses certain religious beliefs and practice that result in the conservation of nature and its biodiversity. The Meiteis used plants in various ways in their day today life. Such valuable traditional ecological knowledge systems are based on strong socio-cultural and traditional beliefs, confounded by the economic status of the people. The present study reveals that Meiteis have helped in conservation of plant biodiversity through their use.





BUTTERFLY GARDEN: BIODIVERSITY CONSERVATION IN HUMAN STRESSED ENVIRONMENTS

01 118

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Butterflies are one of the most fascinating insects which are playing significant role in ecosystem services. Creation of butterfly habitats through landscaping and introduction of suitable host plants to sustain different species of butterflies is an emerging technique of butterfly conservation. The Kumarakom Butterfly garden is such a garden inside the *Coconut Lagoon* heritage resort at Kumarakom, Kottayam district Kerala. The present study evaluates the changes due to the development of butterfly garden in such a human stressed environment, both in terms of biodiversity conservation and as an environmental education tool. The study showed that the introduction of more than 80 species of host and food plants in the garden gave a 240.74% increase in the butterfly diversity. Significant increase in density of individual species also observed. The 20 fold increase in tourist visit to the garden suggests that the butterfly garden holds immense potential as a tourism tool of environmental education and biodiversity conservation.



FLORA OF CHANDRAGIRI RIVER DELTA OF KASARAGOD DISTRICT-KERALA

01 119

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Biodiversity is the degree of variety in nature and not in nature itself. The conservation of biological diversity distinct but related biological resource. Biodiversity includes diversity of forms, right from the molecular unit to the individual organism and then on to the population, community, ecosystem and biosphere levels. Scientists estimate that more than 100 million different species inhabit the earth. Each species is adapted to its unique niche in the Environment, from the peaks of mountains to the depth of deep sea hydrothermal vents and from polar ice cap to tropical rain forests. Climatic change, pollution, introduced species, industries, population are the factors responsible for determination of biodiversity. Kasaragod district lies on the North West boundary of Kerala between 11°48'30"N latitude and 74°52'30"E latitude. Hilly villages are on the eastern side of this district luxuriant with green vegetations and plantation crops. Chandragiri River is the longest river of this district. The study sites are located on Kottaruvam hills lies between 12°28'35"N and 75°27'30"E is the Delta region of Chandragiri river near the Chandragiri fort, under the Archeology department, Govt of India. For the construction of Chandragiri road the hills have been vertically sectioned. I have attempted a new study on this region, since these hills are much important Botanically and no studies have been done till today. From ground level up to 1M elevation there was dense flora of Pteridophytes mainly *Gleichenia palmata*. Soil of this region was analyzed and found to be wet, clayey and highly fertile and enhances for the luxuriant growth of Pteridophytes-the vascular cryptogams. The fossils are found in the deepest layer of the soil. The pteridophytes found in this region are the group was already reported in ancient era. Up to 1M elevation from ground level pteridophytes *Adiantum lunulatum*, *Asplenium trichomanes*, *Blechnum cernulatum*, *Lygodium palmatum*, *Lycopodium cernuum*, *Pteris cretica*, *Selaginella kraussiana* etc were identified and studied. Up to 3M elevation flora of angiosperms studied are *Ageratum conyzoides*, *Alstonia scholaris*, *Alternanthera sessilis*, *Anacardium occidentale*, *Casuarina equisetifolia*, *Exacum bicolor*, *Eupatorium odoratum*, *Hyptis suaveolens*, *Hydrocotyle umbellata*, *Ichnocarpus fruticens*, *Justicia procumbens*, *Justicia simplex*, *Leucana leucocephala*, *Mimosa pudica*, *Melastoma malabathricum*, *Pennisetum polystachyon*, *Stachytarpheta jamaica*, *Tinospora cordifolia*, *Vernonia cinerea*, *Zizipus* sps etc. This region may be of much interest for students and researchers of pteridology and Paleobotany. Nowadays plant species including Pteridophytes of this area are endangered due to the Soil mining and deforestation. Some plants of this region are endemic so there is an urgent need for the conservation of flora of Chandragiri River Delta which are important for their Academic, Medicinal, Ornamental values.



ALTITUDE-WISE VARIATIONS IN DIVERSITY OF FRESHWATER MICROALGAE IN ANAMALAI AREA OF WESTERN GHATS

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The Anamalai, the highest peak of Western Ghats has been marked as one of the three Hot spots in Western Ghats. The diversity of higher plants in this area has been well documented except for the lower forms. The present investigation aimed to delineate the diversity of freshwater microalgae with respect to the altitude in Anamalai region. We sampled freshwater microalgae from streams of Nelliampathy (1440m), Valparai (1200m), Parambikulam (700m) and Sholayar (550m) to determine the altitude wise variations in distribution and abundance. One hundred and forty one species of phytoplankton belong to fifty seven genera and five classes were recorded from four stations during the survey in 2009-2010. Bacillariophyceae was the dominant group with sixty one species under twenty-six genera followed by Desmidiaceae with forty three species under eleven genera. The dominant genera were *Pinnularia* and *Cosmarium* from Bacillariophyceae and Desmidiaceae respectively. The Euglenophyceae was less represented with only eight species. Margalef's species richness was found to be lower in high altitude region (Nelliampathy; $d=7.90$ and Valparai; $d=7.09$) and higher in low altitude region (Parambikulam; $d=9.01$ and Sholayar; $d=11.14$). Diversity of micro algae is also showing a decreasing trend with increasing altitude. The result of the present study is useful for the development of a reference point for the microalgae based impact assessment of the Chalakkudy river system, as this group is considered as the major indicators of stress on the environment.



FLOWERING AND FRUITING PHENOPHASES IN A TROPICAL DRY DECIDUOUS FOREST OF BHADRA WILDLIFE SANCTUARY, KARNATAKA, SOUTHERN INDIA

01 121

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The timing of many phenological events and seasonality represent resource availability, pollinator availability and competition, abundance of herbivores, suitable conditions for seed germination and establishment, and phylogenetic constraints. This study was conducted in Umblebailu (13°46'to 13°52' N, 75°36'to 75°42'E) region of Bhadra wildlife sanctuary located in Chikmagalur and Shimoga districts (13°25' and 13°50' N, 75°15' and 75°50' E) of Karnataka, Central Western Ghats. Woody stems above 30 cm diameter at breast height (dbh) with clearly visible canopies were marked with a unique tag number on either side of the transect about 2 Km. A total of 277 individuals of 45 species these marked individuals were monitored for reproductive phenophases once in a month. Reproductive phenology includes both flowering (flower bud, pollinated flower) and fruiting (fruit bud, immature fruit, ripened fruit) phenologies. The timing of the phenophases in relation to seasonal average rainfall, mean maximum and minimum temperature was determined by regression analysis (spearman's rank correlation) to examine how variations in rainfall and temperature influenced the peaks and troughs of phenology cycles. Flower bud and rainfall had a strong negative influence during two ($r_s = -0.476$, $p < 0.004$), three months lag period ($r_s = -0.797$, $p < 0.00000002$). Mean maximum temperature had a positive influence during corresponding ($r_s = 0.440$, $p < 0.007$), one ($r_s = 0.376$, $p < 0.02$), two ($r_s = 0.356$, $p < 0.03$) month lag period and minimum temperature had a negative influence during three months ($r_s = -0.589$, $p < 0.0003$) lag period. Pollinated flower and rainfall had a negative influence during three month ($r_s = -0.496$, $p < 0.003$) lag period. Mean maximum temperature had a positive influence during corresponding ($r_s = 0.447$, $p < 0.006$), one ($r_s = 0.446$, $p < 0.007$), two ($r_s = 0.376$, $p < 0.02$) month lag period and minimum temperature had a negative influence during three months ($r_s = -0.434$, $p < 0.01$) lag period. Fruit bud and rainfall is not significant during corresponding as well as lag periods. Mean maximum temperature had a positive influence during corresponding ($r_s = 0.637$, $p < 0.00002$), one ($r_s = 0.516$, $p < 0.001$) month lag period and minimum temperature had a negative influence during two ($r_s = -0.349$, $p < 0.04$) three months ($r_s = -0.504$, $p < 0.002$) lag period. Immature fruit and rainfall is not significant during corresponding as well as lag periods. Mean maximum temperature had a positive influence during corresponding ($r_s = 0.327$, $p < 0.05$) months, minimum temperature has no significant influence during corresponding and lag months. Ripened / matured fruit and rainfall had a negative influence during corresponding ($r_s = -0.476$, $p < 0.004$) months. Mean maximum temperature had no significant influence during corresponding as well as lag months, minimum temperature had a significant influence during corresponding ($r_s = -0.559$, $p < 0.0003$) and one ($r_s = -0.459$, $p < 0.005$) months lag period. Understanding of flowering and fruiting patterns and their underlying mechanisms is a key to assessing the ecosystem health of the forest. Overall the timing of the phenophases in relation to seasonal rainfall and temperature suggests that the response of flowering and fruiting phenophases is an indication of regional impact of changing climate (environmental changes) data on biology and ecology of tree species is need of the hour for biodiversity and conservation strategy.





PURITY ASSESSMENT OF A RIPARIAN ECOSYSTEM – A RAPID PURSUIT USING ENTOMOLOGICAL INDICATORS

01 122

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Diversity fluctuations of aquatic insects due to increased perturbation at selected segment of river Achencovil was estimated with the aid of Rapid Bioassessment Protocol. Sampling was done in the alternative months during the period of March to July 2010. River segment in the co-ordinate range 9°14.573'N - 9°15.641'N and 76°35.792'E - 76°34.628'E were selected for applying the protocol. Using multi-habitat, composite sample method insects were collected and identified upto family level. Taxa richness, measures of tolerance/intolerance, feeding, habit and Family-level Biotic Index were calculated. All results were analysed for significant level of pollution using Hilsenhoff's Family Biotic Index. Negligible occurrence of intolerant insects was noted in contrast to a percentage composition of tolerant organisms as high as 52.94% in the samples from the selected segment. Dominant taxa measures gave a result of 27.95% of insects from family Coenagrionidae from test site in the month of May. Families of Gomphidae, Chlorocyphidae, Dytiscidae, Elmidae, Hydrometridae, Belostomatidae and Tipulidae were absent in samples from test site when compared to reference site. Hilsenhoff's Family Biotic Index calculated for purity assessment of water at test site ranged between 7.9 and 8.13 which found to be higher than that of the value of range 5.86 – 6.56 obtained at reference site. Month wise between-site test computed for metric responses to pollution showed that 7 among 8 metrics match predicted values of increased perturbation at test site. Family Biotic Index above 7.71, tolerance value of 9 for dominant taxon from the area and the negligible presence of intolerant taxa shows that the diversity of aquatic invertebrates has sharply declined due to anthropogenic interventions like industrialization near the river and other unscientific exploitations. This segment of river Achencovil has to be given prime concern for ceasing all sorts of contamination since the depletion of aquatic biodiversity and non-availability of pure water are going to be the inevitable consequences.





LADYBIRD BEETLES (COLEOPTERA: COCCINELLIDAE): A NOVEL APPROACH TOWARDS MAINTENANCE OF BIODIVERSITY

01 123

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India has an incredible affluent assortment of both flora and fauna. The fauna is extremely distinctive establishing the ecosystem steadiness in a drastic compartment. Ladybird beetles are cosmopolitan in distribution. They diminutive insects ranging in size from 1-10 mm, vibrantly clad with shades of red, yellow or orange with spots on their elytra, belonging to the order Coleoptera and family Coccinellidae. North India has an exceedingly loaded population of ladybird beetles together with both the herbaceous and aphidophagous species. They are elected as farmer's friends as they prey upon a number of insect pests like aphids, mealybugs, thrips other soft bodied insects and phytophagous mites. They are persuasive biocontrol agents and indispensable gears of Integrated Pest Management. They have already been time-honored as successful biocontrol agents against coccids, diaspid and other pest infestations.





ANTI MICROBIAL EFFECT OF A HIGHLY IMPORTANT MEDICINAL PLANT- *GYMNEMA SYLVESTRE* R BR

01 124

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Gymnema sylvestre belongs to family Asclepiadaceae and the plant is considered to be a good source of large number of bioactive molecules. It is a vulnerable medicinal plant species and is a slow growing perennial woody climber. Antimicrobial property of this plant was analyzed here. Leaves and stem of the plant was collected separately, dried and powdered. Active ingredients from the fine powder of stem and leaves were extracted by distillation. Solvents used were methanol, acetone and petroleum ether. Nutrient agar medium and potato dextrose agar medium were used for anti bacterial and anti fungal study respectively. In antimicrobial study, clinically and industrially important organisms were selected. Bacteria selected were *Bacillus firmis* and *Paracoccus sps*. For anti fungal study organisms selected were *Saccharomycetes*, *pseudozyma sps* and *Asperfillus niger*. Results shows that extracts from different plant parts showed antimicrobial effect. Among them methanol extract of leaves and acetone extract of leaves were found to be more suitable for antimicrobial effects. So evidently there is scope for development of new antimicrobial agents using this plant.



BIODIVERSITY OF NATURAL DYE YIELDING PLANTS OF PATAN DISTRICT, GUJARAT

01 125

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Natural dye yielding plants received more attention in research and product development since from ancient times. Patan District is famous for its traditional art of PATOLA, which is prepared by using natural plant based dyes. The present inventory includes information on dye yielding plant species as surveyed from Patan District of North Gujarat region. Numerous different angiosperm species belonging to different families have been found useful and the information on their habit, correct botanical name, vernacular name, parts useful and status of the plant in the zone were recorded. Plant parts like stem, root, rhizome, leaf, bark, seeds etc were found useful for dyeing purposes. The work shows that North Gujarat region is rich in dye yielding plants wealth useful for dyeing.





NEW RECORD OF ONE GENUS AND TWO SPECIES OF ANT (HYMENOPTERA: FORMICIDAE) FROM WEST BENGAL

01 126

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Ants (Insecta: Hymenoptera: Formicidae) are found in almost all ecological niches, and also to be associated with different trophic levels of the ecosystem they live in. Importance of ants in maintaining the ecosystem is well understood and accepted by the scientists. Studies on ant in India are mostly restricted on its taxonomy, marked by the pioneering publication of Bingham in the year 1903. Nearly 650 species of ants distributed over 85 genera and 13 subfamilies have so far been recorded from India. Tiwari *et al.* (1998) reported 128 species belonging to 47 genera of ants from West Bengal in the *Fauna of West Bengal*. Later on, Ghosh *et al.* (2005, 2007) and Ghosh & Sheela (2008) contributed to the studies on ants of West Bengal. During studies on the effect of pollution on road side soil ants of Kolkata, collection was made for a period of one year from 16 different sites of Kolkata. Quarterly collection of four samples of soil from each site were made, which were then extracted through a modified Tullgren funnel and the ants were identified using stereo-wildzoom microscope. Altogether 26 species under 16 genera of ants were identified. Out of which two genera [*Lepisiota* (Santschi), *Pyramica* Roger] and eight species of ants [*Tapinoma indicum* Forel, *Camponotus badius* (Smith), *Lepisiota frauenfeldi* (Mayr), *Paratrechina indica* (Forel), *Monomorium atomum* Forel, *Monomorium destructor* (Jerdon), *Pheidole watsoni* Forel, *Pyramica nepalensis* (Andrade)] are recorded here newly from Kolkata. Of these, the genus *Pyramica* represented by *Pyramica nepalensis* (Andrade) is reported here for the first time from the state of West Bengal along with the species *Camponotus badius* (Smith).





EARLY YIELD AND GROWTH PERFORMANCE IN A SET OF BRAZILIAN WILD *HEVEA* GERmplasm IN INDIA

01 127

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Natural rubber (*Hevea brasiliensis*), with its center of origin in the Amazon rainforests of Brazil, is a strategic industrial crop cultivated mainly in the Southeast Asian countries. In view of the narrow genetic base of cultivated rubber in this region, a huge collection of wild *Hevea* germplasm was made by the IRRDB during 1981 from three states in Brazil viz., Acre (AC), Rondonia (RO) and Mato Grosso (MT) and distributed to member countries including India. Around 4500 accessions are being conserved in nurseries in India, and are under different stages of evaluation for identification of desirable genes and their use in crop improvement programmes. In the present study, a set of 24 wild accessions of *Hevea* along with the modern control clone RRII 105 were planted in 1994 employing simple lattice design with four replications in the traditional rubber growing region of Kerala state, India. They were evaluated for their early yield by test tapping in the fourth year. Girth recorded in the first five years of growth and girth increment per year was estimated over four years period. The characters assessed in the third year included crotch height and plant height. Highly significant differences between clones was observed for juvenile yield and growth characters. MT 1012 had the highest juvenile yield of 2.53 g/t/t followed by RO 895 (1.79 g/t/t) and MT 940 (1.50 g/t/t), where as the control clone RRII 105 recorded 6.33 g/t/t. In the first year after planting girth ranged from 4.81 cm (MT 932) to 7.81 cm (AC 757) and in the 5th year after planting it was 21.78 cm (AC 736) to 30.10 cm (MT 940). Girth increment per year ranged from 3.74 cm (AC 736) to 5.79 cm (MT 940), crotch height ranged from 2.49 m (MT 939) to 4.72 m (AC 757) and plant height from 4.74 m (MT 932) to 7.31 m (AC 757). Coefficient of variations and broad sense heritability indicated wide variation. Correlations worked out between the six quantitative traits revealed that girth was significantly positively correlated with girth increment and plant height. The accessions were ranked using all the above parameters except 1st year girth, for overall performance. Rank sum values ranged from 20 to 107 with a general mean of 64.92. AC 757, MT 1012 and RO 895 ranked first, second and third respectively with the maximum number of desirable traits. Based on this study the top 10% of the potential accessions showing early growth vigour and yield were identified which could be useful in broadening the genetic base of present-day cultivated rubber.



SEASONAL INFLUENCE OF HALOBACTERIAL BIODIVERSITY IN CAPE COMORIN COAST

01 128

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Hypersaline environment has received increasing attention in recent years, not only by biologist, but also by geologist and geochemist because of the occurrence of deposits of phosphorus, uranium and several other resources (Krumbein and Jens, 1981). Hypersaline stromatolitic environments have recently been described as paleoecosystem reaching back in earth's history as far as 3.5 billion years. Hypersaline environs represent unique and interesting challenges to biological survival. Hypersaline waters are the one that had higher concentration of salt than seawater (Edgerton and Brimblecome, 1981). These habitats constitute a typical example of extreme environment in which relatively low microbial diversity can be found (Brock, 1979). Volcani (1936) first showed that the Dead sea considered to be too salty to sustain life was not a sterile lake, but was inhabited by variety of microbial life. A variety of organisms inhabits hypersaline environments such as brine shrimp (*Artemia salina*), brine fly (*Ephedra*), microalgae belonging to the genera *Dunaliella* and cyanobacteria and some heterogeneous groups of prokaryotes, archaea and bacteria (Rodriguez-Valera *et al.*, 1985). Microbial life can be found over the whole range of salt concentrations from fresh water to marine biotopes of hypersaline environments such as salt pans, brines etc. Extreme halophiles are those could live in hypersaline environments like solar salterns and natural saline lakes. A group of archaea, Halobacteriaceae is capable of outliving others in the hypersaline environments. Halobacteria exist in a broad range of habitats including hypersaline soil, water, sea sands, seaweeds, salt forms and salted fish (Onishi *et al.*, 1980). Their extreme tolerance to salt made them highly successful bacterial flora in their specific habitats. Halophilic archaea belong to the order Halobacteriales are found in large numbers in the crystallizer ponds of the solar salterns. Their massive population often imparts red colour to the brine (Oren, 1993; 1994). Halobacteria live in high salt concentrations (3 – 5 M NaCl) typically and die in diluted media. High Na⁺ concentrations are required for their membrane stability. Most halophiles are highly adapted both externally and internally to combat the osmotic pressure of salt solution and to live in this extreme environment. Hypersaline environments are ubiquitous and are spreading as a result of irrigation and other uses of freshwater. Many geological formations, like petroleum reserves are associated with hypersaline brines. Many industrial processes required large quantity of salts frequently release brine effluent into the environment. Halophiles are likely to be useful for bioremediation of contaminated hypersaline brine (Das Sarma and Arora, 2001). Seasonal distribution of halobacterial population in seawater were enumerated. Summer season recorded the maximum halobacterial population (0.4×10^3 CFU l⁻¹) in both Rajakkamangalam and Chinnamuttom stations, whereas, northeast monsoon found minimum counts in Chinnamuttom (0.087×10^3 CFU l⁻¹). The halobacterial population was found maximum during northeast monsoon season (0.595×10^3 CFU g⁻¹) in Colachel and minimum in southwest monsoon (0.125×10^3 CFU g⁻¹) in Chinnamuttom station. The counts of halobacteria varied from 5.6×10^3 CFU g⁻¹ (northeast monsoon) to 59.15×10^3 CFU g⁻¹ (summer season) in Puthalam salt pan. Interestingly, higher counts of THB were recorded during northeast monsoon (119.55×10^3 CFU g⁻¹) in Kovalam salt pan, while the minimum counts were recorded during summer season (5.635×10^3 CFU g⁻¹) in Puthalam saltworks. The species composition of Halobacterial population in Cape Comorin coast. The *Halobacterium* sp. was found to be the dominant one (42.1%) followed by *Halococcus* sp. (20.6%), *Haloarcula* sp. (15.1%), *Natronobacterium* (11.1%), *Natronococcus* sp. (6.4%) and *Haloferax* sp. (4.8%). More over, among the total isolated halobacteria (n = 120), marine derived species are 23.1% and the salt pan-derived species are 76.9% (Fig. 15). Of these, 18.3 % of organisms belonging to alkaliphiles and 81.7 % belonging to neutrophiles. Considering the environmental importance of bacterial flora, the present study was made an attempt to assess the occurrence and distribution of halobacterial and total heterotrophic bacterial counts in water and sediment samples along the Cape Comorin coast. It is obvious from the present study that, the bacterial counts were found maximum in sediment samples than in water in both beach and salt pan irrespective to the sites and months. On the other hand, the relevance of the distribution of halobacteria and THB to environmental parameters is highly warranted.





LARVAL DIGENEAN DIVERSITY IN NON-COMMERCIAL MARINE FISHES OFF THE SOUTHWEST COAST OF INDIA

01 129

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Parasites of non-commercial fishes are poorly known, especially off the southwest coast of India. During a survey of the metazoan parasites of non-commercial fishes in the by-catches off the southwest coast of India (Kerala coast) during 2006-2008, ten species of larval digeneans were collected from six species of fishes belonging to six families (Plotosidae, Fistulariidae, Tetraodontidae, Dactylopteridae, Synanceiidae, Uranoscopidae). The parasites are, *Opistholebes* sp. and *Maculifer* sp. (Opistholebitidae), two different species of *Stephanostomum* (Acanthocolpidae), *Proisorhynchus* sp. and three different species of *Bucephalus* (Bucephalidae), didymozoid larva (Didymozoidae) and *Tetrochetus coryphaenae* (Accacoelidae). The highest prevalence was noted for *Stephanostomum* sp. (7.7%) in *Plotosus lineatus* and the highest mean intensity for *Opistholebes* sp. (65.0) in *Lagocephalus inermis*. In *L. inermis*, five species (*Opistholebes* sp., *Maculifer* sp., *Proisorhynchus* sp., *T. coryphaenae* and didymozoid larva) of larval digeneans were encountered. *Fistularia petimba* harboured two species and *P. lineatus*, *Dactyloptena orientalis*, *Minous monodactylus* and *Uranoscopus guttatus*, one species each. Of the parasites collected, *Maculifer* sp. is reported for the first time off the southwest coast of India and six species of digeneans are recorded from six new host species.





ETHNO-MEDICINAL WISDOM OF TRIBALS OF AURANGABAD DISTRICT (M.S.), INDIA

01 130

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The present communication provides interesting unpublished traditional phytotherapy of seventy-two indigenous medicinal plants used by rural and tribal population of Aurangabad district, Maharashtra, India to treat various human ailments. Aurangabad district a part of Deccan plateau is situated at the centre of Maharashtra state with an area of 10,106 square kilometer lying between 19° 18' and 20° 40' North latitudes and 74° 40' and 76° 40' East longitudes. The district includes nine tehsils with a population of 19, 71,006. Roughly triangular in shape, the southern side corresponds to the river Godavari and the northern side to the northeast trending arm of the Ajanta ranges. The major part of the district is predominantly inhabited by rural population which is 62.5 per cent of total population. For gathering information regarding plant and plant parts used medicinally by the tribal and local people, several field trips were undertaken in the tribal areas of Aurangabad district viz. *Kannad*, *Vaijapur*, *Sillod* and *Soygaon* during 2007-2009. The desired information was collected during field trips on the basis of interview with the tribals and local people by repeated enquiries, changing the pattern of questioning and by showing the collected plants to one tribal healer/ rural people to another of a distinct locality and asking them for its use as medicine and vice-versa. Under the enumeration, the plant species are arranged in alphabetical order, along with family and local names in parenthesis, place of collection, voucher number and their ethnobotanical information. Ethnobotanical information gathered during survey has been verified with available literature in different regions of India on medicinal plants. It was found that some common medicinal plants like *Ammannia baccifera*, *Ailanthus excelsa*, *Baliospermum montanum*, *Clerodendrum phlomidis*, *Crinum asiaticum*, *Dolichandrone falcata*, *Heteropogon contortus*, *Hymenodictyon obovatum*, *Jatropha curcas*, *Pergularia daemia*, *Polycarpaea corymbosa*, *Setaria italica*, *Salvadora persica*, *Verbascum chinense* etc. having new uses which are not reported earlier. As the traditional herbal remedies are based on ancestral knowledge and empiric experiences, we have provided the tribal and folk phytotherapy and technology for preparation of drug so that at least a few plants can be considered for efficacy and analysis for further studies. A thorough investigation may provide remedies for different human diseases and also raw material for undertaking further scientific research to confirm the reportage.



BIODIVERSITY OF MARINE GASTROPODS (MOLLUSCA: GASTROPODA) ALONG KERALA COAST

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Phylum Mollusca forms a significant component in the marine biodiversity of India. With nearly 10,000 living species, gastropods are by far the largest and most diverse class of molluscs. The marine gastropods are commercially valuable not only as a nutrient-rich food with great export potential and as ornamental curios, but also as a source of a wide array of bioactive compounds. The gastropod molluscs of Kerala coast were surveyed for a period of one year from the bycatch of trawlers and from the rocky shore habitats. A total of 132 species of gastropods representing the families Fissurellidae (1), Trochidae (3), Turbinidae (2), Neritidae (2), Littorinidae (1), Cerithidae (2), Potamididae (1), Turritellidae (4), Strombidae (4), Crepidulidae (2), Xenophoridae (3), Cypraeidae (4), Naticidae (1), Tonnidae (1), Fidae (1), Cassidae (3), Ranellidae (11), Bursidae (5), Epitoniidae (2), Muricidae (13), Buccinidae (9), Collumbellidae (1), Nassariidae (1), Melongeniidae (1), Fasciolaridae (4), Volutidae (1), Vasidae (1), Olividae (4), Marginellidae (1), Harpidae (1), Mitridae (1), Cancellaridae (2), Conidae (8), Turridae (7), Terebridae (3), Architectonicidae (1), Hydatiinae (1) and Bullidae (1) were recorded during the study. Family Muricidae (Order Neogastropoda) and Family Naticidae (Order Mesogastropoda) exhibited the maximum species diversity. Families like Ranellidae, Buccinidae, Conidae and Turridae also showed comparatively higher species diversity. About 21 families limited their representation with one or two species. The abundant species in the collection included *Bursa* spp., *Babylonia spirata*, *Tibia curta*, *Murex* spp., *Natica lineata*, and *Conus inscriptus*. Rare ornamental species like *Conus milneedwardsi*, *Cymatium peryjii*, and *Conus geographus* were recorded during the present collection. Shannon diversity index of gastropods was 3.062 in Kerala coast and the Margalef species richness was 14.25, indicating higher diversity. The values of Pielou's evenness index (0.1619) showed lesser even distribution of species, with relatively more value for dominance index 0.08592. The study revealed rich diversity of marine gastropods along Kerala coast.



ASSESSMENT OF VEGETATION STATUS IN *ANOGEISSUS LATIFOLIA* FORMATIONS IN HALIYAL FOREST DIVISION, KARNATAKA

01 132

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Formations are the rare phenomenon in natural ecosystems. *Anogeissus latifolia* is an important deciduous tree species which has formed a unique formation in Haliyal Division of Karnataka. The vegetation growth leading to the formation in successional stage depends upon the type, quantity and stratification of the vegetation. As such a quantitative assessment of these formations is essential to understand its ecological status. The study was carried out to know the extent of diversity of the species and predominance of *Anogeissus latifolia* in Haliyal Forest Division, Uttara Kannada district, Karnataka during 2006-07. Simple random sampling was adopted for analyzing vegetation composition and regeneration status. Study revealed that, *Anogeissus latifolia* was found to be predominant followed by *Tectona grandis* and *Terminalia alata*. The occurrence of species was found to be predominant with *Anogeissus latifolia* and *Tectona grandis* and least with *Emblia officinalis*. However, regeneration of *Anogeissus latifolia* exhibited high superiority over other associated species with respect to all floristic parameters (such as density, frequency and Importance Value Index). The investigation concludes that *Anogeissus latifolia* was found to be the most predominant species. It exhibited higher density, frequency and Importance Value Index (IVI) in both tree layer and regeneration, indicating ecological success of the species due to prevailing edaphic and other locality factors and also due to lesser disturbance to this species.





FIRST RECORD OF PASSERINES BREEDING FROM CHANDERTAL WETLAND IN LAHAUL & SPITI DISTRICT OF HIMACHAL PRADESH

01 133

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Birds belonging to Passeriformes are commonly known passerines and constitute the most rich and diverse group among the avian orders. Studies on avian fauna of Chandertal wildlife sanctuary and wetland in greater Himalayan range of Himachal Pradesh, unveiled four passerines species belong to four different families. The studied area (wetland) is internationally known Ramsar Site (No. 1569) due to its characteristic and a few endangered flora and fauna. The lake with 2.5 km circumference and few small semi-permanent water bodies interspersed with grassy meadows and rocky pastures, hosts different alpine chordates and non-chordate fauna. *Erymophila alpestris* (L., 1758), *Pyrrhocorax graculus* (L., 1758), *Phoenicurus ochruros* (Gmelin, 1774) and *Motacilla citreola* Pallas, 1774 have been recorded in small flocks along with their juveniles and immature during summer season of each consecutive four years (2006-2009).





SOME OBSERVATIONS ON ANATID FAUNA OF CHANDERTAL WETLAND IN NORTH-WEST HIMALAYAS

01 134

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Birds belonging to family Anatidae are mostly migratory and ecologically dependent upon wetlands for some phases of their life cycle. Chandertal wetland and wildlife sanctuary is situated above the tree line in North-West Himalayas, at an altitude of 4370 meters above the mean sea level and internationally known Ramsar site (No. 1569) due to its unique floral and faunal diversity. The lake with its 2.5 km circumference and with a few small semi-permanent water bodies interspread in between grassy meadows and rocky pastures, hosts different alpine chordates and non chordate fauna. The present study on the cold desert wetland revealed the presence of *Tadorna ferruginea* (Pallas) (Brahminy Shelduck) and *Athya fulgula* (L.) (Tufted Pochard) (Anseriformes: Anatidae) during summer season of the year. The four years continuous survey (2006-09) unveiled the Brahminy Shelduck as rare and Tufted Pochard as very rare species in the studied area.





BIODIVERSITY AND CONSERVATION OF PULICAT LAKE ANDHRAPRADESH

01 135

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The Pulicat lake is 18,440 hectare in area with the boundary limits range between 13.33° to 13.66° N and 80.23° to 80.25°E, with a dried part of the lagoon extending up to 14.0°N.; with about 84% of the lagoon in Andhra Pradesh and 16% in Tamil Nadu. The lagoon is aligned parallel to the coast line with its western and eastern parts covered with sand ridges. Pulicat lake is the second largest brackish water lagoon in the country. At the southern end, it opens into the Bay of Bengal, which is separated from it by a narrow strip of land. Area of the lake varies with the tide; 450 square kilometres (170 sq mi) in high tide and 250 square kilometres (97 sq mi) in low tide. Climate of the lagoon coast line is dominated by Tropical monsoons. Air temperature varies from 15 °C to 45 °C. Its soil varies from sandy, clayey to fine alluvial. The Buckingham Canal, which runs parallel to the Coromandel Coast, passes through the southern end. A creek of the Buckingham canal joins the lagoon system near Ennore. Receiving a perennial supply of freshwater from the rivers *Swarnamukhi*, *Kalangi* and *Araniar*, Pulicat is endowed with diverse natural resources, which include aquatic and terrestrial fauna and flora. Its aquatic resources include white and tiger prawns, mud and lagoon crabs, mullets and catfish, edible oyster, and clam varieties such as *Meretrix casta*. Its rich fauna comprises rare and endangered reptiles, insects, amphibians, snakes, Green sea turtles, sea-turtles, birds and mammals. It is home to 50 species of water birds. Its natural plant species such as *Capparis brevispina*, *C. rotundifolia*, *Garcinia spicata*, *Hydroceratriflora*, *Lepisanthis tetraphylla*, *Pisonia aculeat.* *Halophila ovalis* is occurred in back waters. Two Orchids namely *Cymbidium olofolium* and *Vanda testacea* are found in this region. Mangroves are located in at Chandrakuppam and Karlabylu. *Aegiceras corniculatus*, *Avicennia marina*, *Excoecaria agalocha*, *Lumnitzera recemosa* are the prominent mangroves found. Rare medicinal plants are also found in this region. Cane bushes like *Calamus rotang* in large number along the water courses are present. *Azadirachta indica*, *Barringtonia acutangula*, *Terminalia arjuna*, *Alangium salvifolium*, *Atlantia monophylla*, *Bacopa monnieri*, *Caesalpinia coriaria* *Canthium parviflorum*, *Chloroxylon swietenia*(billudu), *Crataeva magna*, *Phyllanthus reticulates* *pouzolzia zeylanica*, *Suregada angustifolia*, *Caesalpinia coriaria* (divi divi) are found in this region. *Halophila ovalis* popularly called sea grass appear prominently this can be used as biofertilizer. Along the coast *Pandanus tectorius* bushes are present. Herbs and cultivated crops such as cashew, paddy, fruits and vegetables are also can be seen. The International Union for the Conservation of Nature and Natural Resources (IUCN) recently declared the Pulicat lagoon system a Ramsar site of international importance and the World Wide Fund for Nature declared it a protected area. According to the 1991 Coastal Regulation Zone notification, "the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters influenced by tidal action in the landward side up to 500 meters from the high tide line and the land between the high tide line and the low tide line are classified as CRZ I" and must be protected. As per this notification, the entire Pulicat water system, including the lagoon, the Encore Creek and the Buckingham Canal, is designated CRZ I. There is an urgent need to conserve the biodiversity of Pulicat lake through two basic strategies In-situ and Ex-situ methods. Biodiversity is the wealth of nation. Everyone should know the significance of biodiversity. It should be conserved for better living of present and future generations. Various techniques of Biotechnology to be used effectively for the conservation of Biodiversity.



DIVERSITY OF PARASITIC ISOPODS IN MARINE FISHES OF TAMIL NADU, SOUTH EAST COAST OF INDIA

01 136

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The present study reported 26 species of marine fishes which were infested by 12 species of parasitic isopods, for the first time along Tamil Nadu coastal environment in the period of December 2008 to November 2009. The nature of infestation of isopod parasites in different host fishes is described. Different microhabitat in the regions of the host body, namely bronchial region, buccal region and body surface are infested by many species of isopod parasites. Most of them like *Joryma brachysoma* and *Nerocila phaeopleura* is found host specific, while *Ryukyua circularis* and *Glossobius* sp. showed less specificity. The prevalence rate of parasites during different months and the range of host specificity of isopods were studied.





DIVERSITY AND DISTRIBUTION OF AQUATIC INSECTS IN THE RIVER ACHENCovil DURING MONSOON SEASON IN RELATION TO WATER QUALITY

01 137

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The present study aims to analyse the diversity and distribution of aquatic insects at selected sites of Achencovil river with respect to its physico-chemical environment. Persistent absences or declines or in some cases appearances of aquatic insects may indicate a change in aquatic health. Aquatic insects and surface water samples were collected from six sampling stations of Pandalam segment and each of them having a 500m distance. The sampling was carried out monthly between June- October 2010 (monsoon). Aquatic insects were collected by following the single habitat and multihabitat composite sampling method. Collected samples were preserved in 70% ethanol and assigned to order, family and genus using standard taxonomic keys. Surface water samples for physico-chemical analysis were collected in 1L sterilized plastic containers and analysed using standard methods. Principle component analysis (PCA) of the category multivariate analysis was applied to relate the relationship between faunal changes and physico-chemical variables. Diversity indices were also calculated to explain the site wise variation in the insect diversity, dominance, abundance, richness, evenness and distribution. A total of 319 individuals belonging to 8 orders, 19 families and 20 genera were recorded during the 5 month sampling period of the study. The greatest diversity was observed among Ephemeroptera (28.21%). Ctenipocoris belonging to the family Naucoridae ranks the most abundant genus in the present study. Ranatra belonging to the family Veliidae was the least recorded genus. Among the water quality parameters, dissolved oxygen was found to be the principle component (PC1) affecting the distribution of aquatic insects. Total Dissolved Solids (TDS) was the second principle component, while pH found to be third principle component. Shannon-Weiner diversity index (H') was ranging from 0.995-1.237, which shows that site 4 possess highest diversity of aquatic insects. Simpson's dominance index (D) was ranging from 11.625-19.286, indicating maximum dominance at site 5. Hill's Number (H_p) observed are ranging from 12-20, showing that site 3 and site 4 possess most abundance in the occurrence of aquatic insects. Margaleff richness index (M) ranges from 9.459-13.428, indicating maximum richness at site 1. Mackintosh Distance (U) value comes in the range 0.344-0.736, shows that aquatic insects possess only a narrow range of distribution. Mackintosh Evenness (E) values are ranging from 1.263-1.28 shows that aquatic insects are not evenly distributed in these sites. Almost all numerical values in the present study shows statistical significance ($P < 0.05$). The study explains that water quality parameters have great influence in the diversity and distribution of aquatic insects at Pandalam segment of river Achencovil especially during monsoon. Moreover this study also explains the importance of using aquatic insects as bioindicators of environmental disturbances.



BIRDS OF PACHAMALAI HILLS, EASTERN GHATS

01 138

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Today Earth's biological diversity, or biodiversity, the cumulative number and diversity of living things, is declining dramatically; many biologists say we are already in the midst of one of the greatest mass extinction events in Earth's history. So it is high time to primarily estimate the richness of biodiversity. A study was carried out to estimate the biodiversity of birds at Pachamalai hills at Eastern Ghats. Pachamalai is a green hill range situated about 80kms north of Tiruchirapalli. Pachamalai hills forms an eastern offshoot of the Eastern Ghats. It lies in 11° 31' and 22° N latitude and 76° 50' and 86 ° 30' E longitudes. The Eastern Ghats are isolated hill ranges in Peninsular India and harbours primarily tropical deciduous vegetation, which represents species of high economic, timber, medicinal potential. Based on geological and tectonic considerations, the Eastern Ghats are formed of four sections (Meher-Homji, 2001): the portion north of the Mahanadi River; the portion between the Mahanadi and the Godavari where the mountainous character of the Eastern Ghats is most clearly marked; the third section lies between the Krishna River and the Chennai. The last section comprises the tract between Chennai and the Nilgiri hills where they join the Western Ghats where Pachamalai hills of Tiruchirapalli, is located with the highest peak at 1000m. The forest types include: (i) Scrub Jungle– upto 400m (foot hills); (ii) Deciduous forest –300 to 900m (slopes); (iii) Evergreen forest -800 to 1300m (Plateau). Pachamalai is an unexplored area with regards to research studies including biodiversity studies. The present study aims to estimate the biodiversity of birds at Pachamalai hills. Some rare and threatened species have been recorded. Their distributions have also been recorded. This is the first kind of study to enlist the birds of Pachamalai hills. This study would enable further research works and conservation efforts.





BIODIVERSITY OF ANOMURAN CRABS (ARTHROPODA: ANOMURA) OF KERALA COAST

01 139

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Phylum Arthropoda comprises a group of fascinating and attractive crabs in the infraorder Anomura, commonly known as Anomurans. Among anomurans hermit crabs represent an important portion of the intertidal and moderately deep benthic marine communities worldwide. Barring a few scattered reports, there have been no studies on the taxonomy and diversity of Anomuran crabs along southwest coast of India. This paucity of information coupled with taxonomic ambiguities with regard to Indian species of anomurans demands a thorough study on their taxonomy. The anomuran crabs were collected for a period of two years from the intertidal areas, mangrove swamps and the major fishing harbours of Kerala coast. The survey recorded the presence of 35 species of anomuran in Kerala coast classified under the families Diogenidae (24 species), Coenobitidae (2 species), Parapaguridae (1 species), Paguridae (1 species), Hippidae (2 species), Galatheididae (2 species), Chyrostylidae (2 species) and Procellanidae (2 species) were collected. Shannon diversity index of Anomuran crabs recorded a higher value of 2.595 in Kerala coast and the Margalef species richness index was 4.661. The distribution of the crabs showed dominance of some species (dominance index = 0.8985) and the evenness index was less (0.3828). The family Diogenidae represented the most diverse family of Anomurans in Kerala coast. The study revealed several new reports from India and eighteen new reports from Kerala coast. Two hermit crabs — *Coenobita brevimanus* Dana and *C. rugosus* H. Milne Edwards — are recorded for the first time from the Indian coast. These records confirm the extended distribution of both the species and suggest their possible continuous distribution from the east coast of Africa to the southwest Pacific Ocean. *Calcinus morgani* Rahayu and Forest and *Diogenes klaasi* Rahayu and Forest of the family Diogenidae are also recorded for the first time from Indian coast. *C. morgani* inhabits the intertidal rocky area along Thirumullavaram beach, Kollam, while *D. klaasi* was collected from the mangrove swamps in Ashtamudi Lake, Kerala. The new reports from Kerala coast are *Calcinus laevimanus*, *Clibanarius arethusa*, *Clibanarius padavensis*, *Clibanarius infraspinus*, *Clibanarius merguiensis*, *Dardanus lagopodes*, *Dardanus megistos*, *Dardanus hessi*, *Dardanus setifer*, *Diogenes avarus*, *Diogenes costatus*, *Diogenes custos*, *Diogenes manaarensis*, *Diogenes merguiensis*, *Diogenes planimanus* and *Diogenes violaceus* of the family Diogenidae and *Nematopagurus lepidochirus* and *Oncopagurus monstrosus* of families Paguridae and Parapaguridae respectively.



INVESTIGATING SEXUAL STATUS OF *COLEBROOKEA OPPOSITIFOLIA* SMITH (LAMIACEAE): A LESS KNOWN ETHNOMEDICINAL PLANT

01 140

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The sexual status of *Colebrookea oppositifolia* Smith (Lamiaceae) is a relic ethnomedicinal plant which is observed to be neglected in most herbal systems in spite of its medicinal potential. It has been investigated and found to be dioecious and sexually dimorphic. Male flowers have a small non-functioning ovary and long exerted stamens. Female flowers have small staminodes inserted inside the corolla, and a gynoecium in which only one mericarp matures. The corolla is smaller in female flowers and the calyx larger. The mericarp is released within the calyx. The fruiting calyx enlarges after pollination, with calyx lobes reduced to plumose teeth.





DIVERSITY OF PHYTOPLANKTON ALONG THE SOUTHWEST COAST OF INDIA

01 141

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Aquatic ecosystems are thought to be responsible for about half of the photosynthetic biomass production on our planet. Our knowledge of marine diversity as well as the patterns in marine phytoplankton is poor compared to terrestrial organisms. Planktonic microalgae form the major primary producers in any aquatic ecosystem and serve as the key synthesizers of primary organic matter. Due to a variety of oceanographic phenomenon, the highest primary productivity and standing crops of phytoplankton tend to be found in the coastal areas. The present study describes the diversity of microalgae and the role of various physico-chemical variables which influence its composition and distribution for a period of two years from 2006 to 2008 in the seven estuarine and coastal regions along the southwest coast of India. Based on the continuous seasonal sampling, 285 phytoplankton taxa under 89 genera have been identified. They represent a diverse assemblage of species with a dominance of diatoms and dinoflagellates throughout the year. Included among this flora were 11 potential harmful or toxin producing species. During this study, 17 species of diatoms have been reported for the first time from Indian waters. The mean Shannon–Wiener diversity index was ranging from 0.94 to 2.76. The lowest diversity index at station 3, (0.94 + 0.22) clearly corresponded to the highest standing crop ever recorded during the investigation. Significant correlations were found between the phytoplankton abundance/standing crop and chlorophyll *a*. It is evident that coastal and estuarine stations along the southwest India yielded a moderately high standing crop and chlorophyll *a*, which is well supported by the higher Si:N. ratios.





THE ROADSIDE TREE DIVERSITY AND ITS IMPORTANCE IN TIRUNELVELI CORPORATION AREA, TAMIL NADU

01 142

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An environment rich in biodiversity offers the broadest array of options for sustainable economic activity, for sustaining human welfare and for adapting to changes. Loss of biodiversity has serious economic and social costs for any country. The experience of the past few decades has shown that industrialization and economic development has resulted in the extinction of species. Trees must be made a mandatory part of the roadside. The study was conducted during December 2009- January 2010 covering the area of Tirunelveli Corporation, Tamil Nadu. Total number of vascular trees recorded from roadside is 49 species. Of these 49, dicots are 48 and monocot 1. In the present study documented 35 roadside plants were used for the medicinal purposes. In total 20 plants have very good timber. This study indicates the roadside trees have multibeneficial role as, medicinal plant, timber yielding plant, shade giving plant and ornamental plant.





DISTRIBUTION OF CELLULOLYTIC FUNGI DURING COCONUT HUSK RETTING IN KADINAMKULAM BACKWATERS OF KERALA

01 143

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The retting environment in the Kadinamkulam estuary is a unique one, where coconut husks submerged in the estuarine water starts decomposing gradually under the action of microorganisms. With the advancement of the retting process, coconut husks get decomposed slowly, releasing large quantities of pectin, phenols, tannin, hemicellulose etc. into the water. Cellulose, the most abundant abundant biological compound on earth, is highly resistant to degradation. fungi and bacteria that utilize this polymer has evolved a complex array of enzymes that decrystallise and hydrolize cellulose to liberate the individual glucose monomers. In the present study, nine fungal strains were isolated from the coir retting zone. The genera of fungi includes *Aspergillus*, *Cladosporium*, *Fusarium*, *Mucor*, *Penicillium* and *Rhizopus*. The maximum fungal diversity was observed during the second stage of retting (0.235). The highest diversity was observed in the middle layer during the final stage of retting (0.200). The fungal strains were screened for cellulolytic activity in congo red dye and the cultures showing clearance zone were taken as cellulase positive. Among the nine fungal cultures four were found to exhibit cellulolytic activity. The cellulolytic strains identified were *Aspergillus* sp. strain 2, *Aspergillus* sp. strain 3, *Fusarium* sp. and *Penicillium* sp. strain 1. The cultures were test verified for their cellulolytic potential *in vitro* with crystalline cellulose (1%) and filter paper (1%) as substrates. The activity of Exoglucanase, endoglucanase and cellobiase observed were higher in all four fungal strains when grown in filter paper. Highest endoglucanase activity was exhibited by *Fusarium* sp. (1.17-1.92 IU) in crystalline cellulose and *Aspergillus* sp. strain 3 (1.44-3.91IU) in filter paper. The Exoglucanase activity was found to be highest in *Fusarium* sp. (3.69-4.96 IU) in crystalline cellulose and *Aspergillus* sp. strain 3 (3.59-.3.96 IU) in filter paper. The cellobiase activity was found to be higher in *Fusarium* sp. (1.04-1.51IU) in crystalline cellulose and *Aspergillus* sp. strain 2 (1.02-2.80 IU) in filter paper. This difference in cellulolytic activity is attributed to the difference in particle size. The cellulase activity was high compared to bacterial strains because of the presence of hyphae. Coir ret liquor in Kadinamkulam backwaters was found to exhibit good cellulolytic activity. Hence, cellulolytic fungi is proved to have a major role in coir retting. The catabolic capacity of fungal strains capable of surviving in such unique ecosystem can be exploited and used commercially.



THE DIVERSITY OF THE GENUS MEMECYLON (MELASTOMATACEAE) IN WESTERN GHATS

01 144

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The Western Ghats is one of the richest area in India harbouring 6500 species of flowering plant and many plants found in the WGs are extensively with restricted distribution. The genus *Memecylon* is a paleotropical genus comprises about 250 species world over. It comes under the isolated tribe of Memecylaceae of the family Melastomataceae. It forms dominant in dry evergreen forest of costal planes and also occurs in deciduous, semi evergreen, evergreen and montane sholas with a wide range of distribution up to 2500mtr. In India as per the recent estimate the genus is represented by ca 39 species of which 21 are endemic. In WGs the genus is represented by ca 27 species of which 20 are endemic to the region. It is observed that the taxa of the genus *Memecylon* are highly complex often the morphological key provided by the conventional methods are limited in use due to overlapping morphological characters. Efforts were made to document observations on species distribution and nature of endemism of the genus in WGs. The species present in western ghats include *M. agastyamalaianum* Santhosh *et al.*, *M. angustifolium* Wight, *M. capitellatum* Linn, *M. depressum* Benth, *M. flavasence* Gamble, *M. gracile* Bedd, *M. heyneanum* Benth, *M. lawsonii* Gamble, *M. lushingtonii* Gamble, *M. randerianum* Almeda, *M. rivulare* Bremer, *M. sessile* Benth, *M. sisparensis* Gamble, *M. sivadasanii*. Mohanan *et al.*, *M. sylvaticum* Thwaites., *M. subramanii*. Henry, *M. talboltianum* Brandis, *M. terminale* Dalz, *M. umbellatum* Burn, *M. wightianum* Trina, *M. mundanthuraianum* Viswanathan, *M. variens* Thwaites, *M. manikamii* Murugan *et al.*, *M. tirunelvelicum* Murugan *et al.*, *M. courtalensis* Manickam *et al.*, *M. royenii* Blume, *M. grande* Retz. and *M. wightii* Thw. In this *M. lushingtonii* Gamble, *M. gracile* Bedd, *M. lawsonii* Gamble, *M. sivadasanii*. Mohanan *et al.*, *M. wightianum* Trina - are endemic to Kerala and *M. subramanii* Henry, *M. mundanthuraianum* Viswanathan, *M. manikamii* Murugan *et al.*, *M. tirunelvelicum* Murugan *et al.*, *M. courtalensis* Manickam *et al.* endemic to Tamilnadu. *M. sisparensis* Gamble. has an indeterminate status due to sparse distribution but now located in several places can be treated as vulnerable, *M. lawsonii* Gamble. and *M. flavasence* Gamble. has already been in endangered status collected from type locality. During the present investigation the authors are able to include 1 new species *M. wayanadense* Sivu *et al*, 3 new discoveries *M. clarkianum*, *M. procerum*, *M. parvifolium*. to flora of India. The members are very variable in nature and often the morphological key developed by the conventional taxonomy is of limited use in determining the species resulting in taxonomic ambiguity in many taxa. Since many species are of high altitude nature and with restricted distribution. Hence the present study is focused mainly on the morphological, chemical and molecular characters to unravel the existing species complexity.



TAXONOMY AND DIVERSITY OF OCTOPUSES (MOLLUSCA: CEPHALPODA) ALONG THE KERALA COAST

01 145

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Octopuses, represented by over 300 species are the cephalopod molluscs inhabiting primarily tropical waters around the world. They are known for their secretive nature, uncanny intelligence and the ability to use tools. Thus far 38 species of octopods, representing the families Octopodidae, Tremooctopodidae and Argonautidae, were recorded from Indian coasts and from the Andaman and Nicobar and Lakshadweep islands. The ongoing study on the taxonomy and diversity of cephalopod molluscs along the Kerala coast recorded the presence of 16 species of octopuses belonging to five genera (family Octopodidae). Shannon diversity index of octopods recorded a value of 1.956 in Kerala coast and the Margalef species richness was 2.593. The values of Pielou's evenness index 0.4421 showed lesser even distribution of species, with relatively more value for dominance index 0.7862. The study revealed the presence of two new species and several new reports from India. The newly reported species from Kerala coast are *Octopus cyanea*, *Amphioctopus marginatus*, *Amphioctopus neglectus*, *Amphioctopus rex*, *Callistoctopus lechenaultii*, *Callistoctopus luteus* and *Cistopus taiwanicus*. The present study revealed the abundance of the genus *Amphioctopus* along the Kerala coast. The paper discusses the revision of the taxonomy of octopuses collected from Indian coast.





PHYTOPLANKTON DIVERSITY OF VATTAKAYAL, KOLLAM DISTRICT, KERALA.

01 146

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Vattakayal, a part of Ashtamudi estuarine system lies within Panmana and Karunagapally Panchayats. It receives effluent from KMMML industry. The physio-chemical characteristics and phytoplankton diversity of the Vattakayal have been studied for a period of two years from September, 2007 to August, 2009. The water samples were analysed for 15 parameters viz. temperature, pH, phenolphthalein alkalinity, total alkalinity, free CO₂, dissolved oxygen, chloride, total hardness, calcium, phosphate, sulphate, nitrate, BOD, COD and total dissolved solid. The results revealed that the water had high values of chloride (42.6-1192.8 mg/l), total hardness (30-2200 mg / l), calcium (9.6-922.3 mg / l), phosphate (0.16- 2.4 mg/ l), sulphate (64.8-5611.6 mg/l), BOD (11-40 mg/ l), COD (260-380 mg/l), and TDS (143-3826 mg/l) coupled with low DO (0-8.2mg/l). A total of 95 taxa belonging to 40 genera were encountered from the kayal. They include *Spirulina* (1 sp.), *Oscillatoria* (7 spp.), *Phormidium* (3 spp.), *Lyngbya* (2 spp.), *Anabaena* (2 spp.), *Calothrix* (1 sp.), *Tolypothrix* (1 sp.), *Chroococcus* (1 sp.), *Pediastrum* (3 spp.), *Ankistrodesmus* (1 sp.), *Kirchneriella* (1 sp.), *Selenastrum* (1 sp.), *Dictyosphaerium* (2 spp.), *Scenedesmus* (5 spp.), *Pandorina* (1 sp.), *Eoudrina* (2 spp.), *Bulbochaeta* (1 sp.), *Oedogonium* (2 spp.), *Spirogyra* (3 spp.), *Gonatozygon* (1 sp.), *Closterium* (7 spp.), *Pleurotaenium* (2 spp.), *Euastrum* (4 spp.), *Micrastreias* (2 spp.), *Actinotaenium* (1 sp.), *Cosmarium* (9 spp.), *Xanthium* (2 spp.), *Staurastrum* (4 spp.), *Onychonema* (1 sp.), *Desmidiium* (2 spp.), *Spondylosium* (1 sp.), *Cyclotella* (1 sp.), *Melosira* (1 sp.), *Fragillaria* (1 sp.), *Navicula* (3 spp.), *Nitzschia* (4 spp.) *Surirella* (1 sp.), *Phacus* (3 spp.), *Euglena* (3 spp.), and *Trachelomonas* (2 spp.). The present paper deals with the systematic enumeration of 95 taxa belonging to 4 major groups of algae viz. Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae. All the taxa are illustrated in the text.





PTERIDOPHYTES OF WESTERN GHATS

01 147

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The Western Ghats is one of the 34 Global Biodiversity Hotspots and harbors a rich diversity of flora and fauna with many endemic and RET species. Along with the angiospermic plants, the Western Ghats is also a rich repository of pteridophytic plant wealth. The pteridophytes form a conspicuous element of the earth's vegetation and are important from evolutionary point of view as they show the evolution of vascular system and reflect the emergence of seed habitat in the plants. About 250 million years ago they formed the dominant part of earth's vegetation, but in present day flora have been largely replaced by the seed bearing plants. About 12,000 species of pteridophytes occur in the world flora of which around 1000 species are distributed in different biogeographical regions of India with the main centers being the Himalayas, the Western Ghats and the Eastern Ghats. The Western Ghats harbor about 320 species of ferns and fern allies with more species diversity in the southern part. The major families of pteridophytes found in the Western Ghats are Aspleniaceae, Polypodiaceae, Thelypteridaceae, Selaginellaceae, Pteridaceae, etc. Whereas on the generic level, maximum diversity is observed in the genus *Asplenium*, *Selaginella*, *Pteris*, *Athyrium*, *Diplazium*, etc. The Western Ghats also harbors endemic species like *Polystichum manickamii*, *Cyathea nilgiriensis*, *Bolbitis semicordata*, *Selaginella radicata*, etc. The habitat of the pteridophytes consists of microclimatic conditions with special preference for moist and shady places and a minor disturbance in their microclimate conditions can lead to loss of large number of species. They occur in abundance in tropical, sub-tropical, temperate and moist-deciduous forests of India and their life-cycle is based on the existence of the forests. However, large scale deforestation and increasing anthropogenic factors have caused the elimination of the habitats which is posing a serious threat to the pteridophytes of Western Ghats and many endangered pteridophytes like *Psilotum nudum*, *Tectaria zeylanica*, *Lindsaea malabarica*, *Cheilanthes rufa*, etc. may soon face the brunt of extinction. In the recent years, though the pteridological studies have picked up in various parts of the country, many questions regarding the pteridophytic wealth of the Western Ghats remain unanswered and hence, more studies are required for developing *in situ* and *ex situ* conservation strategies for this wonderful and important group of plants.



A CRITIQUE ON THE DOMESTIC TRADE OF ORNAMENTAL FISHES AT PATHANAMTHITTA IN KERALA : A PART OF BIODIVERSITY CONSERVATION

01 148

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Ornamental fishes are colourful fishes that are fancy for the people all over the world by virtue of their aesthetic value and as a result, fish keeping has turned out to be a common hobby. This hobby has had considerable growth and diversification in recent years and due to its popularity; the demand of ornamental fishes has considerably been raised. The growing popularity of fish keeping is reflected in the ubiquitous aquarium that features as an integral part of the modern interior decoration. The leading aquarium shop at Pathanamthitta town in Kerala was selected for the study. The species composition, pattern of sale, variation in price of ornamental fishes and its over all demand for aquarium purposes have been assessed in the study. Altogether 23 species of 17 genera and 8 families were available for domestic trade. Fourteen species were demanded by the people and actively involved in the trade. Prices varied from Rs. 10 to 600 per pair of fish. Domestic marketing of the ornamental fishes was largely associated with their prices and this factor seems to be influencing the over all domestic trade. Characteristic features of fishes like shape, size, colour and behaviour that also promote their domestic trade. The study showed that the demand and domestic trade of ornamental fishes in the present situation is a promising one at Pathanamthitta and the developments in this field depend on the promotion of the cultivation of different varieties of fishes in the various parts of the state. Aquarium fishes available in the trade of the present study revealed the fact that they are not indigenous to the water bodies of Kerala. Many of them are exotic species and introduced to India for ornamental fishery purpose. The introduction of beautiful wild fishes of the rivers of Kerala for aquarium purposes and its culture and domestic trade would have large scope and value in biodiversity conservation point of view and which deserves imperative attention. Research in various aspect of ornamental fish industry should be taken by the fishery departments to increase the domestic trade in the future. Some perspectives on the booming of the domestic trade of ornamental fishes incorporating the indigenous wild fish diversity of the rivers of Kerala are discussed. Suggestions for the improvement of ornamental fish trade in the state are also given in this paper. Similarly, the applications of the trade of ornamental fishes and its possible benefits in biodiversity conservation point of view are also explained.





FISH ASSEMBLEAGES IN DIFFERENT STREAM HABITATS IN A TROPICAL RIVER FLOWING THROUGH WESTERN GHATS

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Fish assemblages were examined at 41 sites within Kuttiyadi River in Western Ghats, biodiversity hotspot, India for a period of two years. Data were collected from typical stream habitats like cascades, step pools, bedrock, riffles, regime, braided and plain bed and an additional 'reservoir' habitat. A total of 60 species belonging to 39 genera and 22 families were collected. Highest species richness was observed in plain bed habitat (N=37) followed by regime (N=36) and reservoir (N=30). *Barilius* spp. observed in all the studied habitats and seven species limited their occurrence to only one habitat. Lowest diversity was observed in cascade (N=9) and step pool (N=11) habitats. Shannon diversity index of fishes showed significant ($P < 0.001$) difference between the eight habitats studied. The average taxonomic distinctness significantly ($P < 0.001$) differed with habitat. However, no significant difference was observed in the average taxonomic distinctness between riffles, regime, Bed rock, reservoir and plain bed habitats. When average taxonomic distinctness values were plotted against a confidence funnel of expected values, only braided, reservoir, regime and plain bed habitats fell within the 95% confidence limits for expected diversity. The taxonomic distinctness of cascades, step pools, riffles and plain bed were significantly below the expected limits based on the total observed diversity. The variation in species occurrence between habitats was illustrated by multidimensional scaling which contrasted markedly with a strong clustering structure, supporting the results of species richness and Shannon diversity index. The present study brought out distinct diversity in fish assemblages in different habitats of Kuttiyadi River





INFLUENCE OF LOTIC AND LENTIC HABITATS ON THE BIOLOGY OF *RASBORA DANICONIUS* (HAMILTON) (PISCES: CYPRINIDAE)

01 150

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The paper reports on the reproductive biology of *Rasbora daniconius*, a freshwater cyprinid from various habitats in Kerala. Sampling was carried out for one year from a pond ecosystem and Kallar River Thiruvananthapuram district of Kerala. Size at first maturation, gonadosomatic index (GSI), variation in their spawning frequency, fecundity and size at first maturity were determined. Analysis of maturity size, GSI, etc showed that the fish spawns only once a year which coincides with the rainy season. Spawning season lasts from May to June in lentic and April to May in lotic water body. GSI were high during May to October in lentic and April to May in lotic water body. The age at first sexual maturity for female and male were 81 and 79 mm (TL) for lentic and 83 and 74mm (TL) for lotic body respectively. Females in lotic water body mature earlier than those from the lentic body. Fecundity varied widely and was linearly related to the length and weight of the fish and length and weight of the ovary. Visual surveys indicated that abundance and sex ratio varied according to habitats with males predominating at the lentic and females at the lotic water body. The breeding in the species is characterized by unique specialization which permits successful adaptation to diverse environmental conditions.



BIODIVERSITY OF STORED GRAIN PESTS AND TRADITIONAL TECHNIQUES FOR THEIR CONTROL MEASURES – A CASE STUDY OF CHOPAL TEHSIL OF SHIMLA, HIMACHAL PRADESH

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Traditional agricultural practices and cultivars have profound effect on modern day agricultural and plant materials. Use of broad spectrum insecticides have lead to eliminate the eco-friendly species of commercial and economic important insects and thus resulted in the unbalancing of natural food chain. The increasing public awareness of the environmental contamination by toxic chemical residues has necessitated the research and development of non-chemical methods. In the present study different agricultural insect pests and relevant Indigenous Technical Knowledge (ITK) belonging to the different agro-ecological zones of Chopal subdivision of Shimla district, Himachal Pradesh, India have been studied. Rural folk designed their structure and methods for storing grains with locally available materials were unveiled. Various storage yarns like Kuthar, Kothi, Bara, Dobli, Khalda, Matka, Bijdi/ Peru etc. used for safer storage of agricultural produce have also identified. Different leaves having antimicrobial properties, ash, turmeric power, chilly, mustard oil, salt, sun drying, cow dung and urine, condiments etc. used by the local people as an additive for prolonged storage of seed grain were also explored.





BRANCHIOPODS: UNIQUE DENIZEN OF A DISAPPEARING AND NEGLECTED WETLAND

01 152

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Ephemeral wetland form when seasonal precipitation and impervious substrate lead to accumulation of variety of surface water pools with no inlet or outlet. These habitats support a small but predictable assemblage of animal species with specialised life styles and survival strategies and exclude most species of permanent waters. Fishes being absent these are predator free hence branchiopods and other invertebrates flourish there. The study included (a) intensive survey of temporary pools along a 50 km coastal belt of Thiruvananthapuram District and (b) sampling of pools in districts of Thiruvananthapuram, Kollam and Alappuzha. Physical and chemical parameters like temperature, oxygen levels, pH and salinity of the habitat were recorded. More than seventy four species of invertebrates were identified. Crustaceans dominate followed by insects, protozoans and rotifers. Branchiopods the quintessential inhabitants of this unique habitat were represented by two conchostracan species – *Eulimnadia colombiensis*, and *Lynceus alleppeyensis* (New species) Anostracans documented in 1977 were not found now. Rapid development, early maturity, high reproductive potential, parthenogenesis/ androdioecy and laying of resting eggs or cysts are the survival strategies adopted by the denizens of this distinct habitat. Kerala being a densely populated State, anthropogenic activities have led to acute habitat loss of all wetlands including the ephemeral wetlands. While many inhabitants like the branchiopodes are being listed as threatened and conservation measures being planned and implemented in several countries, here they are neglected with no documentation of these communities. It is hoped that the present study even though limited to study area and time will promote further studies of this neglected habitat and the inhabitants therein.





AQUATIC BIODIVERSITY PLAYS A ROLE IN THE DEVELOPMENT OF NORTH BIHAR

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Being a land of high recurring floods, north Bihar witnesses prolonged waterloggings and as such it has been a repository of aquatic biodiversity since ancient times. People are in the habit of adjusting their lifestyle depending upon the exigencies of the situation. Thousands of natural and man-made ponds help tackle the challenge of climate change by absorbing CO₂ at a rate faster than the larger lakes, often comparable with the oceanic absorption. The region provides home to the speciality crop Makhana which is grown in freshwater stagnant pools. Makhana ponds provide ideal habitat to the detritivorous air-breathing fishes and recent endeavour has witnessed its integration with culture fishery as well. Having a discontinuous world distribution Makhana has a localized cultivation in 8 to 10 districts of north Bihar. Known for its spermatogenic and aphrodisiac properties, Makhana finds a specific association with marital rituals. The fact that Makhana is a good source of anti-oxidants and essential fatty and amino acids makes it an ideal food for people suffering with age related problems. It could be held as a favourite choice of obese people on account of having meager fat content. A large number of other aquaphytes growing naturally in the diverse forms of wetlands address to the needs of food, fodder, fuel, biofertilizer and housing materials. Plants like *Nelumbo nucifera*, *Nymphaea* spp., *Scirpus articulatus*, *Trapa bispinosa* etc. play a role in the regional food security. The much maligned *Eichhornia crassipes* provides a basis to capture fishery and has the potential to provide raw material to the biomass industries alongwith a number of other invasive species. The region holds a promise for commercial cultivation of aquatic medicinal plants like *Acorus calamus*, *Cyperus rotundus*, *Vetiveria zizanioides* etc. Plants of *Sesbania rostrata* have emerged as a versatile lifeline in Kusheshwarthan wetlands in Darbhanga district in view of its growing utilization as fodder with no other alternatives left when there is water all around. It also helps contain the intensity of floods. Plants like *Vetiveria zizanioides* and *Aeschynomene* sp. support the local "Sikki" and "Korhila" art forms. The "Bans-Purain" theme (Bamboo & Lotus) depicted in the famous Madhubani paintings has caught the fancy of art lovers worldwide. Wetlands in this region are the seat of a number of resident water birds. Kabar and Kusheshwarthan wetlands identified as major potential "RAMASAR" sites of the state provide home to the millions of migratory birds which throng the area during winter season. The avian droppings help the addition of nutrients to these waterbodies. It is time steps were taken for proper documentation of the use of bioresources in the north Bihar wetlands. This is all the more essential in the Year of Biodiversity and also in view of the fact that India is likely to host the 11th CoP in October 2010. The paper takes into account the diverse utility practices as observed in north Bihar wetlands and traces the scope of prospective applications of biotic products in relation to future development in this area.



IMPACT OF ANTHROPOGENIC INTERVENTION ON THE MACROFAUNAL BIODIVERSITY OF GORAI CREEK, MUMBAI

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Mumbai has a coastal stretch of 603 sq km. Extensive changes have occurred along the coastal wetlands since these are the only places easily available and visible in and around a metropolis like Mumbai. The prime reason for our coastal zones being anthropogenically modified is the lack of monitoring mechanism for assessment of Climate Change and Impact of Human Activities resulting in decline in biodiversity of the ecosystems. Macroinvertebrates, by virtue of being relatively stationary, are constantly exposed to environmental changes, and hence respond very well to pollution. Present study deals with the assessment of macroinvertebrate biodiversity for the period from September 2006 to August 2007 in the intertidal zone of Gorai creek (Location: 19°10'2" N-19°20'2" N and 72°46'2" E-72°55'2" E) of Northwest coast of Mumbai, India. Sediment parameters were analyzed as per standard methods. Sediment samples containing Macroinvertebrate invertebrates were collected every month from station-1 and station-2 of Gorai creek. Since macroinvertebrates population is not uniformly distributed, replicates were taken from the same sampling site and data was pooled. Abundance was computed as number of individuals in square meter area of sediment of Gorai creek. Station-1, with exposure to anthropogenic activities was found to have 13 species of Macroinvertebrate fauna. It showed dominance of Polychaetes inhabiting in the soft fine sediment while station-2, comparatively less disturbed, showed presence of 29 species throughout the year, witnessing abundance of Molluscs in the sandy sediment. The population of macroinvertebrate fauna at station-1 was 2125 indi./m², while it was 1580 indi./m² at station-2; having little difference in density structure. Comparatively low abundance and specific as well as generic diversity of macroinvertebrates points to the alarming condition, which might have resulted due to human interference to the pristine status of Gorai creek.





MICRO-FUNGI ON HERBIVORE DUNG FROM CERTAIN REGIONS OF WESTERN GHATS, INDIA

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Herbivore dung is a partially digested organic matter. Ecologically, fungi on herbivore dung (= coprophilous) are interesting, in view of their specialized life cycle and certain adaptations undergone by this group of fungi. Incubated herbivore dung enables the study of appearance and entire spectrum of associative fungi. The fungi appear on dung in succession, viz. in an ascending order from members of Zygomycota, Ascomycota (with or without their anamorphs) to finally Basidiomycota. It is believed to be a nutritional fungal succession on dung wherein simple sugar-decomposing fungi (Zygomycota) appear first, followed by cellulose decomposers (Ascomycota) and finally with the lignin degraders (Basidiomycota). In this study, dung samples of various herbivore animals, viz. cow (*Bos Taurus*), bison (*Bos gaurus*) and goat (*Capra hircus*), deer belonging to chausingha (*Tetracerus quardricornis*), sambar (*Cervus unicolor*), spotted deer (*Axis axis*), elephant (*Elephas maximus*), rabbit (*Oryctolagus cuniculus*) and porcupine (*Hystrix indica*), were investigated. Moist chamber incubation and particle-plating techniques were used to recover the fungi from dung. Results on taxonomic diversity of fungi isolated from different dung samples, surveyed in Goa, Karnataka and Maharashtra have been presented in detail in this paper.





AGROBIODIVERSITY HOT SPOTS IN INDIA AND THEIR ROLE IN CONSERVING TRADITIONAL FARMERS VARIETIES

02 11

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Though the Biodiversity Hot spot concept of Myers is one of the most important useful paradigm for the conservation of threatened biota, giving primacy to endemism covering 49% of the global plant species the most important areas which support the food security of the world represented by the plant genetic resources are not accounted in the Biodiversity Hotspot concept. In looking for supplementary strategies, it is prudent to look for areas which support mankind ie agro-biodiversity in the farmlands, grasslands and woodlands. The "Agro-biodiversity Hotspots" areas give emphasize to genetic resources including varieties and variability under ecological, environmental and biotic pressures while "Biodiversity Hot spots" concept gives emphasize to highest concentration of endemics occurring in fragile ecosystems. A new paradigm is emerging which integrates protected areas with landscape ie. farm lands, grass land and woodlands. It includes the variety and variability of plants, animals and micro-organisms which help the functioning and sustaining the key functions of the agro-ecosystems including its structure and processes, assuring the food production and food security. The Indian gene center possess about 17000 species flowering plants of which 33% are endemic to India (Nayar, 1996). Of these 3000—3500 species are of economic value. In India there are about 166 species (Zeven and de Wet, 1982) which are of direct genetic resource value. The genetic resources of indirect value is about 320 specie and they are distributed in eight agro-ecological zones. India is a primary centre of diversity of crop plants like rice, black gram, moth bean, cucurbits, (Luffa), jute (capsularis), jack fruit, banana, sugar cane, mango, large cardamom, black pepper, several minor millets, several medicinal plants like *Rauvolfia serpentine*, *Strychnos nuxvomica*, *Cymbopogon*, *Saussaurea*, *Vetiveria*. India is also the secondary centre of African crops like finger millet, sorghum, pigeon pea, cowpea, cluster bean, sesame, niger, safflower and tropical American crops like maize, tomato, pumpkin, cucurbits, chillies and Amaranth. India is in the diversity belt of South Asian and East Asian crops like ginger, turmeric, tuber crops, taros, yams, bamboos, citrus, rice bean, mung bean, sword bean, small cardamom, sugar cane. It is considered that the important criteria for considering an area of agro-biodiversity importance is the rich presence of progenitors of cultivated plants which have evolved in time and space with varied landscape ecology and terrestrial heterogeneity along with the ethnic communities.



AGRO-BIODIVERSITY HOTSPOTS: IDENTIFICATION AND RECOGNITION OF FARMERS'/FARMING/TRIBAL COMMUNITIES UNDER THE PROVISIONS OF PPV&FR ACT, 2001

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As a member of the World Trade Organization (WTO), India became signatory to the Trade Related Aspects of the Intellectual Property Systems (TRIPS), which provided under Article 27.3.b that the plant varieties are to be protected either by patents or by an effective *sui generis* system drawing its essence from UPOV. Based on these provisions, The Protection of Plant Varieties and Farmers' Rights Act, 2001 was enacted and the PPV&FR Rules were brought in force in 2003. Simultaneously, India being a party to Convention on Biological Diversity (1992), which recognizes the sovereign rights of States to use their own biological resources, and expects the Parties to facilitate access to genetic resources by other Parties subject to national legislation and on mutually agreed terms, it became necessary to enact Biological Diversity Act in 2002. Both these Acts aim to protect the Biological Wealth of India and to regulate the IPRs involved at any stage. As per the provisions of the Rule 70(2), framed under section 45 of the PPV&FR Act which defines the manner of applying the Gene Fund created under section 45 of the Act, "The Gene Fund shall be applied for meeting the following purposes in accordance with the priority made hereunder: (i) To support and reward farmers, community of farmers particularly the tribal, rural communities engaged in conservation, improvement and preservation of genetic resources of economic plants and their wild relatives particularly in areas identified as agro-biodiversity hot-spots; (ii) For capacity building on *ex situ* conservation at the level of the local body, particularly in regions identified as agro-biodiversity hot spots and for supporting *in-situ* conservation; (iii) Dispersal of funds for benefit sharing; (iv) Under these provisions, the 'Plant Genome Savior Community Award' have been constituted (v) To support conservation and sustainable use of Genetic Resources; (vi) To define and demarcate the areas which are to be identified as Agro-biodiversity hot-spots, before the support and rewards can be framed for farmers/ community of farmers, PPV & FR Authority constituted a Task Force which after several rounds of discussions at different levels submitted its report which was published in the form of 02 Volume Book which have been widely distributed for creating awareness. The major recommendation of the Task Force was identification of 22 Agro-biodiversity hotspots distributed over 07 agro-geographical zones of India.





WILD AND WEEDY RELATIVES OF CROP PLANTS OF WESTERN GHATS, INDIA

02 13

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The Western Ghats being one of the two hot spots recognized in India for plant bio-diversity is a major part of the Hindustan Mega gene centre of genetic diversity and one of the twelve bio-geographical zones identified having 5% of India's total geographic area (1,50,900 sq. km approximately). The region holds 4000 higher plant species including 1800 endemic ones and 500 medicinal plants. Efforts to amass crop genetic resources by the station's scientists began 27 years back and a total of 129 collection trips have been mounted in southern region and few other regions in India and a total of 26783 accessions belonging to 300 species of crops and their wild relatives have been collected. With respect to wild relatives out of 624 species belonging to 93 genera, 49 families higher plants that are either genetically or taxonomically related to 101 crops reported from the Western Ghats region, 236 species, eight subspecies and 38 varieties belonging to 8 crop groups have been either collected or located. An attempt has been made to present the information on the diversity collected or located in the region by synthesizing the information available in literature on some of the species with respect to their genetic relationship and genetic potential along with information availed through the collection trips. A very brief introduction on the physiognomic features of the area covered along with a map (fig1) is provided. Attempt has been made to furnish consolidated crop and crop group wise lists in table 1 and 2 respectively. Comparison of the 624 reported and 236 located or collected species diversity is given in fig. 2. The overall picture shows that considerable gap exists in the crop genetic resources collection, characterization, evaluation, conservation and utilization work that has been carried out in the region till 2008 and hence there is a need to urgently plan systematic collection, characterization and conservation of these resources as these resources are being lost at a very fast rate. Also utilization point of view of the wild relatives so far in India is lagging much behind, as information on the useful genes available for crop improvement is very scarce. Problems and prospects of PGR conservation work in wild relatives of crops in relation to the emerging scenario of advanced biotechnological tools are mentioned.





DIVERSITY FOR SACCHARUM AND RELATED GRASSES IN INDIA WITH PARTICULAR REFERENCE TO KERALA

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Major breakthroughs in sugarcane varietal improvement had been achieved through interspecific hybridization involving the cultivated Sugarcane (*Saccharum officinarum*, *S. barberi*) and its wild relatives. The use of wild relatives is a vital component of sugarcane breeding and hence the collection and conservation of the wild germplasm is considered a priority. *S. spontaneum*, the wild sugarcane, is abundantly distributed in the country right from the Coastal Plains to the sub Himalayan Regions. *S. spontaneum* shows wide variation in plant form and cytotypes. Dwarf, medium and tall forms of *S. spontaneum* ranging in height from 0.5 m to 7 m are found to occur. Nearly 40 cytotypes in the range of $2n=40$ to 128 had been reported in the species. The distribution and diversity for *S. spontaneum* in North Eastern States is high. Some of the other species closely related to *Saccharum* like *Erianthus procerus*, *E. arundinaceus*, *E. rufipilus*, *E. longisetosus*, *Narenga porphyrocoma*, *Miscanthus nepalensis* and *Sclerostachya fusca* are also abundantly present in North East India. In the southern parts of the country the distribution of wild relatives of *Saccharum* is confined to *S. spontaneum* and *E. arundinaceus*. *S. spontaneum* is extensively distributed in Kerala while *E. arundinaceus* has limited presence along the banks of major rivers. The extensive river basins and numerous water bodies present in the state provide ideal environment for the growth and spread of *S. spontaneum*. The species is the major plant element along the course of the Bharathapuzha River from Palakkad to Ponnani. Extensive colonization of the river bed by *S. spontaneum* is taking place right from Palakkad onwards, choking the river at many places. *Erianthus arundinaceus* is found along the banks of the river from Pattambi to Ponnani. At Ponnani both *S. spontaneum* and *Erianthus arundinaceus* are found growing under saline conditions on small islets at the river mouth. *S. spontaneum* is also well distributed along the Gayatri River which flows through Palakkad and Thrissur districts. *S. spontaneum* is sparsely distributed along the banks of the Chalakkudi River at Athirappilly. New colonies of *S. spontaneum* are emerging along the southern bank of the Chalakkudi River at Vettukadavu and nearby areas near Chalakkudi. The distribution of *S. spontaneum* is relatively sparse along the Periyar River. The upper reaches of the river shows sparse distribution whereas moderate distribution of the species is observed at Kalady and Aluva, where the river beds are colonized by the species. The distribution is sparse along the lower course of the river, where *Erianthus arundinaceus* is far more common. The distribution of *S. spontaneum* is moderate along the banks of Muvattupuzha River at Muvattupuzha and Piravom. Down the course of the river at Velloor and Vaikom, *Erianthus arundinaceus* have colonized the river banks. Cytological studies carried on the *S. spontaneum* clones collected from the region revealed that there was only one cytotype present in the Bharathapuzha river basin ($2n=64$), inspite of its extensive distribution. Two cytotypes were present along the Periyar River basin viz., $2n=64$ and 72. The variability for *S. spontaneum* in Kerala is relatively less compared to the North Eastern states. Only dwarf and medium tall forms are distributed in the state. However the species was found to be highly adapted to the varied ecological situations prevailing in the state. The species was found growing under drought, saline, waterlogged and partly submerged conditions and could be an important source for breeding for tolerance these situations.

**BIODIVERSITY OF SPICES IN WESTERN GHATS AND CONSERVATION****02 15****Parthasarathy, V.A., Saji, K.V., Utpala, P, and Krishnamoorthy, B.***Indian Institute of Spices Research
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India is the land of spices. It grows over 50 different varieties of spices. While spices such as black pepper and cardamom originated in India, it is also a major production centre of many other spices like ginger, turmeric, chillies, vanilla and tree spices (nutmeg, clove and *Garcinia*). Among the seed spices, India is one of the centers of origin for ajowan and dill besides being a major producer of other seed spices such as coriander, cumin, fennel, fenugreek, celery and kalongi. With a total area of 2.5 million ha under spices cultivation, Indian spices production is around 2.8 million tonnes annually. However, in this paper we will be concentrating on major spices, namely, black pepper, cardamom, ginger, turmeric, vanilla and *Garcinia*. The major spices discussed in the paper are all distributed in Western Ghats and Eastern Himalayas in the forest ecosystem. Locating them and collecting them is a difficult task and hence Geographical Information System (GIS) has been used successfully to locate the available diversity with reasonable accuracy. There are about 16 species of *piper* available in the Western Ghats region of Kerala and adjoining States. Hotspots of species richness were identified in Western Ghats region. *Piper nigrum* and some of the related species originate in Kerala. DOMAIN and Bioclim models of DIVA-GIS were applied to map potential distribution sites of *Piper* species occurrence in Kerala. The sub - mountainous tracts of Western Ghats are believed to be the center of origin of black pepper – *Piper nigrum* Linn. More than 1000 species are included in the genus *Piper* of which 112 are of Indian origin. Cardamom (*Elettaria cardamomum* Maton) is indigenous to evergreen forests of Western Ghats in South India. At present about 50 ginger cultivars, possessing various quality attributes and yield potential are prevalent in India. The genus *Curcuma* belonging to the family Zingiberaceae, contains about 117 species of which about 24 are distributed in South India/ Western Ghats. Altogether 17 species are put under the group 'tree spices' (Table-6) of which most of them are grown in India. Nutmeg, clove, cinnamon, kokum and tamarind are the important tree spices grown in India. . Out of 35 species of *Garcinia* reported to exist in India, 7 are endemic to Western Ghats, 6 in Andaman and Nicobar Island and 4 in North East India. The conservatory of Cinnamon (*Cinnamomum verum* Bercht. & Presl.,) at IISR, Calicut includes 408 accessions. The current status of species biodiversity assessment and conservation indicate that the vast areas of the North East is yet to be fully explored to get an understanding of the variability available and the emergency to collect and conserve them.





EXPLOITATION OF BIODIVERSITY IN PULSE CROPS OF KERALA

02 01

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Pulses are the major sources of dietary protein in the vegetarian diet; they maintain soil fertility through biological nitrogen fixation. Besides, the pulse crops are very hardy and can sustain with residual moisture available in the dry areas. Hence the short duration pulses like cowpea and horse gram, constitute a major component in disaster management, particularly if there is a crop failure due to adverse climatic situations. Cowpea, horse gram, black gram, green gram and red gram are the important pulse crops traditionally grown in Kerala. Out of the area under pulses, more than 50 per cent is contributed by Palakkad district. Almost all types of pulse crops including red gram are grown here. Cowpea is the most important pulse crop of Kerala. This accounts for about 75 per cent of total area under pulses in the state. It is mainly grown as rotation crop in summer rice fallows, intercrop in coconut, tapioca, banana etc., fringe crop in rice fields and also in homesteads. The crop is highly variable in terms of morphological characters. There are trailing, semi trailing and bushy varieties depending on their growth habit. Based on the consumption purpose there are grain type, vegetable type as well as dual purpose types. Diversity is also observed in many of their pod and grain characters. Pods may be longer than 35 cm as in case of Lola, a trailing vegetable type cowpea and smaller as 13 cm for Krishnamony (PTB-2). We can observe a multitude of grain colours viz., reddish brown, cream, light brown, black, mottled etc. Kanakamony (PTB-1) the first released cowpea variety from RARS, Pattambi is semi trailing and dual purpose with reddish brown grains, whereas Krishnamony is a bushy and vegetable type with black grains. Bhagyalakshmi on the other hand is a bushy and vegetable type having mottled grains. Horse gram is one of the hardiest among the pulse crops. Two of our indigenous types Pattambi Local and Muthalamada Local are photosensitive varieties and suited to *rabi* seasons only. Varieties also differ in their grain colour as cream, reddish brown, brown etc. Though the State is rich in biodiversity of pulses, the area under the crops is showing a declining pattern. Hence need of the hour is to conserve the existing biodiversity available within the crops and its utilization to enhance the productivity. Proper exploration studies in the traditional areas are a pre requisite for collection and cataloguing of the biodiversity. The existing biodiversity can be exploited by way of various crop improvement programmes. Direct introduction of minor pulse crops like horse gram, black gram, green gram etc. to non traditional areas is an innovative method to popularise and conserve the diversity. Breeding techniques such as pure line selection, hybridization and mutation breeding can improve the characters of existing crops there by evolving photo insensitive horse gram varieties suited to all seasons, dual purpose cowpea varieties, bushy cowpea varieties with longer pods etc. We can employ these methods to utilize the existing diversity as well as create new variability, which in turn can enhance the farmer acceptance and yield.



50 MILE DIET: DIRECT FARMER PURCHASE, REDUCED CARBON FOOT PRINT AND PROMOTION OF LOCAL VARIETIES

02 02

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50 mile diet is a speciality dining operating in Spice Village resort Thekkady. This conceptual dining is a part of clean green and healthy core values of environmental sensitivity and benefit to the local community. This restaurant operates with the purpose of promoting the locally farmed produces in Spice Village. The produces are purchased directly from the farmer, with out a third party. This will help to give the money value directly to the farmer. The Chef do not have a preplanned menu for the day; what ever is available fresh for the day is presented to the guest. Thekkady (Kumily) is located at an altitude of 900 mts above sea level on the high road connecting Kerala and Tamil Nadu. The general tendency henceforth, is to purchase the produces in transit, through a middle man. In this operation however, when a produce reaches the consumer there is high carbon foot print due to transportation of the raw materials. The local farm produces with in half our reach of Kumily are the strict limit. The produces are brought by the farmer to the store and used fresh. Locally grown vegetables, meats and milk products are given importance. Farmers are given 20 – 30 % premium for their organic practices. Meat na d milk produes for this restaurant are purchased twice a day based on the requirement. This 35 cover restaurant has been operating for the past 2 years with this conceptual dining and has gained good traveler appreciation because the get to experience the locally farmed produces and the second thing that they are a participants in an environmental cause of dining.





INDIGENOUS LIVESTOCK BIODIVERSITY, FOOD SECURITY: | CHALLENGES AND FUTURE PROSPECT

02 03

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Biodiversity is a contraction of the synonymous phrase 'biological diversity'. Biodiversity is one measure of the health of biological systems. Biodiversity is the result of 3.5 billion years of evolution. Biodiversity is the degree of variation of life forms within a given ecosystem, biome, or on an entire planet. Life on Earth today consists of many millions of distinct biological species. This includes diversity within species, between species and of ecosystems. The year 2010 was declared the International Year of Biodiversity. Indian subcontinent is a rich source of diverse animal germplasm, and only very few countries have such a large number of breeds of farm animals with such a wide genetic diversity. Agriculture in general and livestock agriculture in particular is unique because of its diversity and location-specific requirements. Conserving the genetic diversity of crops and animal breeds, and its associated knowledge, in partnership with local communities, must receive the highest priority. Breed improvement of indigenous cattle must be undertaken to improve their performance since they are much better adapted to adverse weather than high-performance hybrids. Balancing feed mixtures, which research shows has the potential to increase milk yields and reduce methane emissions, must be promoted widely. Livestock play an important role in the economy, both at the farm and national levels. They provide: liquid assets, a hedge against inflation; a means of reducing the risks associated with crops, when used in mixed farming systems; a source of extra income (rabbits, poultry and pigs) for landless households; a source of regular income from sales of milk and meat; a source of sporadic income from the sale of live animals, hides, wool and meat; draught power, transport and breeding services, for the farmer himself and to rent out; and opportunities to increase employment through on- and off-farm processing. Livestock make an important contribution to the food supplies of developing countries. Over the past 20 years, cereal production in developing countries has increased by 78 percent and fish production by 113 percent while meat production has risen by 127 percent and egg production by 331 percent. The fastest increases in meat production have been for poultry and pigs. Even so, many people in developing countries cannot afford animal products, as a result of which per caput consumption of meat is only 17.7 kg/year compared to 81.6 kg/year in developed countries. About 60 percent of dietary protein is from animal products in developed countries, compared to only 22 percent in developing countries. There is, therefore, substantial room for expansion of livestock production. Poverty reduction is high on the agenda of both bi- and multi-lateral donors. Livestock is an important component for 70% of the world's rural poor. There is a strong correlation between poverty and high degree of genetic diversity both for livestock and crop plants. Livestock play important roles in farming systems in developing countries, helping provide food and income, draught power, fertilizer and soil conditioner, household energy and a means of disposing of otherwise unwanted crop residues. It is a major industry: 12 percent of the world's population depends solely on livestock for its livelihood.





CONSERVATION OF BIODIVERSITY IN ANIMAL GENETIC RESOURCES FOR SUSTAINABLE LIVESTOCK PRODUCTION

02 04

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Biodiversity in food includes the variety and variability of ecosystems, animals, plants and micro-organisms which is necessary to sustain human life. Biodiversity is the result of thousands of years of farmers' and breeders' activities combined with millions of years of natural selection as most of the human population lives in areas where food production and nature co-exist. Livestock are important elements of many agro-ecosystems which contributions to the livelihood security to millions of poor people whose main income is from livestock keeping. Many of farm animal breeds have been developed over thousands of years to thrive in specific locations. So far 35 animal species have been domesticated for use in agriculture and food production and are the primary biological capital for livestock development, vital to food security and sustainable rural development. Researchers estimates that industrial livestock operations are growing twice as fast as traditional mixed farming systems and six times as fast as traditional grazing systems. As a result, only a limited number of species and breeds now provide most of the world's livestock production. At the same time, the livestock industry is under pressure to manage animal wastes, decrease emissions from intensive livestock production and reduce the release of greenhouse gases. Due to unplanned crossbreeding with exotic germplasm and lack of proper implementation of government breeding policies; many indigenous breeds are threatened with extinction. These breeds are known for characteristics such as resilience to climatic stress and resistance to diseases and parasites, which make them well adapted to local conditions, and which are of great potential importance to future livestock production. According to The State of the World's Animal Genetic Resources for Food and Agriculture (2007), 20 percent of documented livestock breeds are at risk of extinction: 1500 of the 7600 breeds around the globe may be lost forever in the near future. The genetic resources are eroding and that local breeds are being underused or ignored in favor of exotic breeds and short-term economic growth has taken precedence over sustainable management of genetic resources for the future. Some countries have already developed national action plans. Others have increased their budgets for managing genetic resources. But there must be a coherent and coordinated effort to stop the erosion of animal genetic resources for meeting the future needs for food, fibre, fertilizer, draught power. National governments must balance their priorities. It is time to begin putting policies in place to protect the animal genetic resources remaining – before too many are lost forever.



**FODDER GENE SANCTUARY : A BIO DIVERSITY CONSERVATION EFFORT****02 05****Benjamin E.D*; Francis Xavier and Anju Paul**

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Enclosure of the commons, consequent to the enactments of ecology related laws combined with the changes in land utilization pattern in existing fragmented land holdings and restructuring of socio cultural labyrinth, led to scarcity of grazing lands and pastures leading to a sharp decline in dairy animal population in the state of Kerala in recent years. Cultivated green fodder is estimated at 7 million hectares in India and is gaining in importance. Moreover, the feed cost in Dairy enterprises range to 70 -75%. Fast shrinkage of cultivable land due to the erodes by commercial ventures and the increased pressure on the remaining cultivable land is a major agrarian crisis in all districts of Kerala making the agricultural by-products a meagre source of cattle feed material. 42 million ton is the feed concentrate availability in the country though the requirement is 79 million ton. The green fodder availability in the country is 574 million tones as against a need of 745 million tones. .It is also evident from the land utilization records of Kerala which shows that out of the 3885497 hectares of available area, grazing land is only 253 hectares at a time when the milk production of Kerala has touched a higher level of 26.01 lakh tones with its dairy cattle population of 2490707. There exists a large gap between the requirement and availability. Under this scenario an RKVY project at Cattle Breeding Farm Thumburmuzhy, has collected 30 varieties of hybrid fodder varieties both exotic and indigenous, 11 varieties of fodder trees, and 15 varieties of bamboo which may be developed into fodder and which can be effectively used for biological fencing, water conservation and improving biodiversity of different agro zones. Initiation of Gene sanctuary for fodder crops also paved the way for the selection of a fodder christened "Thumburmuzhy1". Laboratory analysis revealed 17% crude protein and 50% NFE. It performed very well under water scarce field trials. The selected and multiplied fodder has been field tried in farmers fodder lands in different districts of Kerala. The growth details and performance details of this fodder biodiversity are presented. The Thumburmuzhy fodder has on an average 125 tillers and the stem remained tender, pointing to the immense potential this fodder in the Dairy sector of Kerala. As a biodiversity advantage, propagation of this fodder has to be taken up. Another wild fodder which was collected from the forest tribal habitat of Wayanad, was propagated and named 'Sony Grass'(Thumburmuzhy 2). It grows to a height of 225 cm with a leaf length of 120 cm and a leaf width of 9 cm and this could withstand drought to a higher extent than other varieties of cultivated fodder. Two new fodder for the Dairy sector of Kerala is a major contribution to the biodiversity also



IN VITRO PLANTLET REGENERATION AND MEDIUM TERM CONSERVATION OF SOME ZINGIBERACEOUS SPECIES

02 06

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The family zingiberaceae is generally considered as spice family. It consists of 8 genera and more than 1200 species distributed mainly in tropics and subtropics. Many members of this group have been used in Ayurvedic and other native system of medicine. The genus- *Curcuma* and *Zingiber* are rhizomatous perennial herbs. It has a wide spread occurrence from tropical Asia to Africa. The plant has unique foliage and colourful long lasting inflorescences and is gaining importance globally as a potential source of drugs to combat a variety of ailments. The root stocks vary in colour which helps in identification of the species. Tissue culture has been applied as a potent method for multiplication and conservation of many crop species. *In vitro* clonal multiplication methods have been described for various species of the genus *Curcuma* and *Zingiber*. In the present study, a simple and reproducible protocol for plantlet regeneration, microrhizome induction and conservation have been optimised. The explants consisted of rhizome buds and immature inflorescence (*C. pseudomontana* and *C. albiflora*) which were collected from the wild and maintained at the shadenet house of Division of Crop Improvement at Central Tuber Crop Research Institute, Trivandrum. Initial media for establishment of *in vitro* cultures consisted of MS medium supplemented with 3% sucrose and 0.1% activated charcoal. Varying concentrations of sucrose (3, 5, 7, 9, 11%), growth regulators- Kinetin, BAP, TDZ and 2,4-D (1, 2, 3 mg/l) alone as well as in combinations were tested for plantlet regeneration and microrhizome induction in all the species. The period from the culture initiation time to the next subculture was considered as the conservation period for a given culture. Each treatment contained 10 replicates and was repeated thrice. All experiments were conducted in a randomised manner. Plantlet regeneration via immature inflorescence produced direct shoots in *C. pseudomontana* on MS medium supplemented with BAP while in *C. albiflora* callus mediated regeneration was observed on TDZ supplemented medium. Rhizome buds sprouted within a period of 7-14 days. Results indicated that medium term conservation as well as microrhizome induction were purely genotype-dependent and was influenced by growth regulators used. BAP, Kinetin and TDZ at higher concentration was found to induce more number of shoots with shorter subculture time while 2,4-D at 1mg/l was found superior to other growth regulators for conservation. *C. zedoaria*, *C. malabarica*, *C. pseudomontana* and *C. raktakantha* could be conserved for a maximum period of 200-240 days on MS medium supplemented with 2,4-D (1mg/l) followed by *C. aromatica* and *Z. nimmoni* in sucrose (11%) substituted medium. Microrhizome induction was also noticed in 1-8 month old cultures of *C. zedoaria*, *C. malabarica*, *C. aromatica*, *C. albiflora* and *Z. nimmoni*. Basal medium was found effective in *C. malabarica* and *C. albiflora*, while BAP and Kinetin at 2 mg/l produced microrhizomes in *C. zedoaria*. Sucrose (5,7,9%) favoured rhizome formation in *Z. nimmoni*. *In vitro* conservation of *Curcuma* and *Zingiber* for extended periods under condition as described above allows cost efficient plant regeneration and medium term conservation.



KAIPPAD RICE FARMING IN NORTH KERALA- THE FARMING SYSTEM AND THE CROP VARIETIES

02 07

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Rice is the most important cereal and staple carbohydrate source of Asia. Rice is cultivated in diverse ecological conditions and many such agro ecosystems are fragile and critically endangered. Conservation of such special methods of rice cultivation would invariably add both to sustainable availability of food and protection of the great genetic diversity of the species. In Kerala, in areas that are subjected to tidal action and hence with saline soil, a crop of rice is grown during the first crop season (*virippu*) taking advantage of the heavy south west monsoon which results in flushing out the salt content from the farmland. In Central Kerala the system is known as pokkali and in North Kerala as kaippad. The present study is an effort to analyse kaippad system of rice farming in North Kerala which is an integrated organic farming system in which rice cultivation and aquaculture go together in coastal brackish-water marshes, in relation to the speciality of the localities, soil and water conditions and the varieties used. Kaippad farms of Ezhome region of Ezhome village panchayath and Keezhara region of Kannapuram village panchayath of Kannur district of Kerala have been surveyed for the study in 2009-2010. Investigations were made to study the soil and water parameters of the area and the major rice varieties used. The specialities of the cultivation system were also studied. Fifty farming units in the region were frequently visited and the farming system were observed and analysed. Details of the commonly used varieties were collected. The crop of the *virippu* (first crop) season of 2009 was observed from land preparation and seeding to harvest. Soil samples were collected from 10 representative plots in April and water samples in July and analysed for different soil and water parameters. Soil salinity problems are encountered in almost all the coastal districts of Kerala and the area extends to about 0.03 million ha. The coastal saline soils are highly underutilized because the use of ground water for normal crop production is not possible due to the poor water quality. The area is mostly monocropped with rice being the only crop during the monsoon period and the land being fallow during the rest of the year due to lack of good quality irrigation water and high soil salinity. Ezhome and Keezhara regions are situated at the banks of Pazhayangadi and Pattuam rivers respectively. The acid soils called *kari* soils are mostly present in the mouths of streams and rivers in the low lying areas. They are silty clay in texture and subjected to sea inundation, black in colour and resemble peat soils (Swarajyalakshmi et al, 2003). Soil salinity of the area in summer varied from 10.9 mhos/cm to 19.9 mhos/cm and water salinity in summer varied from 23 ppt to 32 ppt and in the month of July from 1 ppt to 3 ppt. Soil pH during April ranged from 4.9 to 6.6 and water pH ranged between 6.71 to 7.45 during April and in July it ranged from 6.15 to 6.71. Dissolved Oxygen content in April ranged from 0.2853 mg/l to 1.712 mg/l. Availability of NPK in the soil ranged as follows: N: 1.12% to 2.0%; P: 7.2 kg/ha to 34.2 kg/ha; K: 480 kg/ha. The major varieties cultivated in the area are kuthiru, orkazhama, kuttusan, orthadiyan and choverian among which kuthiru is the most popular. Among the varieties used, kuthiru showed relatively higher adaptation to the area. The peculiarities of the farming system and the characteristics of the varieties will be discussed in the paper.



CONSERVATION AND EQUITABLE USE OF AGROBIODIVERSITY IN WAYANAD – AN INTER- AND TRANSDISCIPLINARY RESEARCH APPROACH

02 08

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This paper highlights the importance of conducting transdisciplinary research on agrobiodiversity while looking into the causes and consequences of land use change in rice based farming systems in the Wayand district of Kerala. Central to the transdisciplinary framework is the integration of both academic and practitioners' knowledge in order to find solutions to life-world problems. The erosion of rice agrobiodiversity in Wayanad will be analysed from the disciplinary domains of ecology, economics, and social sciences. The BioDIVA research team will work closely with the partners of practice, M S Swaminathan Research Foundation (MSSRF), German Technical Cooperation (GTZ), International Food Policy Research Institute (IFPRI) and local farmer- organisations to foster an understanding of rice-agrobiodiversity. The rice ecosystem is not only vital to provide the ecosystem services but also plays an important role for food security and livelihood means of the local inhabitants. Conversion of rice fields to grow other crops or even for non-agricultural land use is assumed to be one of the major reasons for the erosion of agrobiodiversity in Wayanad. Studies have shown that: factors such as cost of production, availability of agro-inputs and labour, family income, and marketing opportunities all influence cropping decisions. Moreover, existing social structures, gender relations, family setups, culture, and education are further interacting with farmers' decision making processes. In this context, the project will explore the social-ecological complexity of Wayanad's rice farming systems. The ecological research will improve the understanding of farmers' ecological knowledge, their seed system and the plant diversity associated with rice ecosystems along a gradient of agricultural intensification and land use change. The economic study will assess the factors that influence farmers' decisions in regard to alternatives to rice based farming systems. Furthermore, this includes an evaluation of rice ecosystem services in comparison with alternative land uses. The social science component aims to analyse gendered knowledge, changes in power structures within families and the societal relations with nature concerning land use change. Investigating rice agrobiodiversity from different disciplinary perspectives aims to foster the development of transformation knowledge towards sustainable and equitable use of agrobiodiversity in Wayanad. Such an approach in turn will help to set up conservation priorities in agrobiodiversity and enables to develop sustainable policy frameworks to allow the successful conservation of rice varieties.



CONSERVATION OF MULBERRY SPECIES - STRATEGIES FOR AWARENESS THROUGH SERICULTURE SERVICE CENTERS

02 09

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Biodiversity, particularly of plant species is the basic for plant improvement. Genetic stock conserved in specific ecological niches, unexplored areas, often harbour rare and unexploited genes for productivity as well as resistance to biotic and abiotic stresses. The choice of conservation strategies depend upon mainly on the nature of the material to be conserved. Mulberry (*Morus* species) is out breeding and highly heterozygous perennial tree and its high biomass production and protein rich foliage are used extensively for sericultural, agro-forestry and horticultural programmes. It is also used in the pharmaceutical industries due to its high anti-oxidant capacity (Singhal et.al.,2001). Mulberry grows more quickly than other woody plants and branches can be used as raw material for paper production. Mulberry stem found to be a good source of media for mushroom production. Working models for integrated, small scale, enterprise system utilizing mulberry genetic resources for the resource poor small farmers need to be developed. This can be achieved through network projects with Sericulture Service Centres of Central Silk Board for conservation through In-situ on farm and Ex-situ on farm which prevents the loss of Mulberry biodiversity. Trained extension staff of Sericulture Service Centre can motivate people on conservation of Mulberry through regular awareness programmes through Self help groups and Quality clubs in their command area. Group formation has promoted brotherhood/ sisterhood feeling among the people more so with women-folk which otherwise would have vanished in this materialistic society. These groups have become the platform for the members to share their happiness and sorrow besides the social, cultural and economical issues. Sericulture service centres can create awareness to the Self help groups and this great potential can be tapped with proper planning and with the help of committed extension staff. Strategies and action plan should be made for the awareness on conservation of Mulberry biodiversity into policy making, and to ensure the involvement of Sericulture Service Centres in the society, especially among the poor and marginal farmers of sericulture in the tribal and rural areas.





CITRUS DIVERSITY IN ARUNACHAL PRADESH

02 10

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Arunachal Pradesh, the land of rising sun is one of the most fascinating state of the Eastern Himalayas which is situated between latitude of 26° 30' to 29° 28' North and longitude of 91° 25' to 97° 24' East. The state of Arunachal Pradesh has lot of climatic variations because of its unique position in the Indian subcontinent. It has been blessed by nature with one of the richest flora and fauna on the earth and regarded as one of the 'Biodiversity Hot Spot' areas in the world. Its unique phytogeographical positions, topography and high degree of precipitation are some of the important factors which are mainly responsible for its enormous biological diversity. Arunachal Pradesh has rich diversity in citrus. In a naturally cross pollinated genus like the citrus, nature has eventually created different forms of citrus and the state has the conducive environment, suitable soil and topography for perpetuation of these various forms. It can be regarded as 'a live museum of Citrus'. The wide adaptability of citrus fruits of Arunachal Pradesh is reflected in its general distribution of topographical situations. Out of various species of citrus, Khasi Mandarin, Valencia and Assam lemon are some of the commercially traded variety of citrus in Arunachal Pradesh. The Khasi Mandarin of Arunachal Pradesh is unique in its quality. However the same fruits are under different names in different provinces. Even within the same district a variety may often be known by different names. Actually farmers' fields, forest of Arunachal Pradesh are the treasures of citrus species. Other than the commercial species, some of other species of citrus namely Rough lemon, Kamala Australia, Samphola, Citron, Singkin, various Limes and Lemons, Pummelos, Grapefruit etc. are available in various types either in homestead or in forests. In a recent study conducted, more than 50 different types of citrus were found under different citrus species. Considering this diversity, there is an urgent need to conserve them either in *situ* or in collective forms. The present paper will discuss about the citrus biodiversity of the region.





VARIABILITY IN ASH GOURD

02 11

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Ash gourd is an important cucurbitaceous vegetable of Kerala, grown both in homesteads and as a commercial crop. Also known as wax gourd, the crop is considered as a minor vegetable in India. The fruit is cooked and used as a vegetable; the thick flesh finds use in preparation of candy. It is highly priced for its medicinal value also. Ash gourd *Benincasa hispida* (Thunberg) Cogn. belongs to a monotypic genus of the family cucurbitaceae. It is considered as a native of Indonesia and Japan. It is domesticated in India in pre historic times. The crop is monoecious and is cross pollinated. Fruits have a waxy outer layer and hence can be stored in cool dry place for at least six months. Ash gourd exhibits large variability for morphological and quality characters. Considerable variability is reported in ash gourd for characters like time taken to flower, number of fruits per plant, protein content etc. Forty five genotypes of ash gourd collected from homesteads and cultivated fields from different locations of Kerala were characterized for both quantitative and qualitative characters at Regional Agricultural Research Station, Pattambi during 2004-06. Characterisation was done for vegetative and fruit characters based on the descriptor. Leaf margin of most of the accessions were multifid but in a few types it was either entire or serrate. Leaf size was either medium or large. First male flower emergence was noticed in 8th node to 17th node. First female flower emergence was recorded from 10th node to 27th node. Node of first female flower emergence indicate earliness of the crop. Fruit shape varied from cylindrical, to elongate and oval/elliptic. Both light green and dark green skin colour was observed. Peduncle length of fruits varied from 2.75cm to 9.7cm. Fruit length varied from 14.0cm to 30.0cm, fruit width from 9.0cm to 17.0cm, flesh thickness, the commercially important character, varied from 2.3cm to 4.5cm. Average fruit weight varied from less than 1.0kg to 10.0 kg. These genotypes are being conserved and utilized in breeding programmes.



ADAPTABILITY OF SCENTED RICE CULTIVARS SUITABLE FOR KERALA

02 12

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Scented rice fetches higher economic returns than coarse rice cultivated in Kerala. Scented rice cultivation requires a mild cool season for growth, aroma and yield. The performance of leading scented varieties available in the country were tested for its adaptability under Kerala conditions during the winter season, at the Cropping Systems Research Centre Karamana. The experiments were conducted in micro plots of two square meters each in a Randomised block Design with three replications during November to February 2009-2010. All the package of practices recommendations were applied uniformly to all cultivars. The length of crop growth period varies from 111 to 144 days. Among the cultivars GR-104, Pusa 1121, Pusa Suganda-5 and Pusa Basumati gave appreciably high yield with favourable yield attributing characters and can be tested for its wider adaptability. The popular scented rice cultivar Gandhakashala of Waynad tract of Kerala records 144 days for maturity with a duration of 70 days for attaining 50% flowering. Though the spikelet number per panicle was significantly higher than the other cultivars except GR-1 of Gujarat, the test weight was the lowest among the 19 cultivar tested. The cultivars showed wide variation in growth habits and grain size, colour and aroma. The cultivar 'Krishna Kamod' from Khedu, Gujarat was typical in its black coloured grain with early flowering trait and short duration. In suitable tracts the scented rice cultivars with varying growth habits can be popularized for better returns and food security.





DIVERSITY OF POLLINATORS AND THE IMPACT OF THEIR ABUNDANCE ON FRUIT PRODUCTION IN PUMPKIN (*CUCURBITA MOSCHATA* L.)

02 13

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Pollination system and insect pollination in particular remain threatened today in many agricultural areas, by an inadequate number or complete lack of sustainably managed pollinators. Inadequate pollination can result not only in reduced yields but also in delayed yield and a high percentage of inferior fruits. A global shortage of pollinators, which is destroying crops around the world, could lead to far higher prices for fruits and vegetables. So the value of pollination on the succeeding generation of crops is frequently overlooked. The study was conducted in farms at Madayipara (12°1'N and 75°15'E) in Kannur district of Kerala, India. The crop selected was pumpkin (*Cucurbita moschata* L.) and the experiment was laid out in a randomized block design with six replicates. To find out pollinator diversity, pollinator abundance and fruit production, observations were carried out in three diurnal phases of two hours each- initial diurnal phase (idp), middle diurnal phase (mdp) and late diurnal phase (ldp) and in three seasonal phases, Initial Seasonal phase (ISP), Middle Seasonal Phase (MSP) and Late Seasonal Phase (LSP) according to anther dehiscence, the longevity of flowers and peak time of pollinator visitation. During field study, pollinators were caught by sweeping with a long handled insect net and later identified. To test fruit production, bagging experiment was done. Individual plants of the test cultivars were chosen randomly each day for treatment. The number of fruits formed in different controlled, pollinated samples were recorded. Fruits were analysed according to the shape and size variations. Size was measured by measuring the length (l) and breadth (b) of fruits. The data from each diurnal phase and seasonal phase were pooled for analysis. Statistica '99 version was used to carry out all statistical analyses. A total of sixteen insects were recorded from 3 orders as pollinators. The most abundant order was the Hymenoptera followed by Coleoptera and Lepidoptera. The species *Apis cerana* was the most abundant pollinator. It was followed by *Halictus timidus*, *Ceratina heiroglyphica*, *Halictus taprobanae* and *Trigona iridipennis*. Fruit production was found varying with variations in pollinator abundance. Highest fruit production was recorded in middle diurnal phase of middle phase of season where higher frequency of visit of pollinators was observed. Lowest fruit production was recorded in late phase of late seasonal phase where lowest frequency of visit was observed. All non pollinated flowers were aborted. Majority of fruits formed in the initial and middle phase were normal shaped and in late phase were malformed. The high diversity of pollinators observed during the present study has resulted in better pollination of this crop. The results indicate a strong correlation between the abundance of insect pollinators and the fruit production as in other studies (Hodges and Baxendale, 1995; Stanghellini *et al.*, 1997; Gingras *et al.*, 1999). These studies also help in identifying new pollinators other than the species that are commonly encountered as pollinators of targeted crops. And the conservation concerns for pollination have started to take on a greater profile than ever before (Kevan *et al.*, 1990; Torchio, 1994). Pollinator conservation and management, thus is an important global concern in the context of agricultural and natural productivity.



COLLECTION AND UTILIZATION OF COCOA (*THEOBROMA CACAO* L.) GERMPLASM IN KERALA AGRICULTURAL UNIVERSITY

02 14

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Cocoa (*Theobroma cacao* L.) provides pleasure to millions across the globe by mouth luring chocolate. It is also vital to the economics of cocoa growing countries in humid tropics. Cocoa plantation around the globe faces severe threats from pests, diseases and climatic changes. Attaining sustainability over coming all the stresses is possible only through new hardy varieties with superior quality. Collection of a much diverse germplasm and its careful exploitation forms the basic step in this direction. In India cocoa is a new crop of just 5 decades old. So the genetic diversity is very narrow. Crop assumed commercial status and has emerged as one of the remunerative inter crop of peninsular India. Though cultivation was problem free during initial years problems started to arise one by one. At this junction the Kerala Agricultural University has initiated cocoa research in 1979 and its main focus was on breeding with establishment of germplasm, its evaluation and exploration. Then the KAU has established the biggest assembly of germplasm in India with 564 accessions, both by local collection and by import from the International Cocoa Quarantine Centre (ICQC), University of Reading U.K. The accessions are planted @ 4 plants each and catalogued based on economic characters and pest and disease resistance. In KAU the present breeding thrusts are yield improvement, vascular streak dieback disease, Phytophthora pod rot, bold bean size and quality attributes. Out of 564 types maintained in the germplasm, seven superior types were released a clonal varieties (CCRP 1 to CCRP 7). 51 were identified as better combiners and these have been utilized for planting in clonal garden. Among the 549 self incompatible types, 134 were utilized in breeding programme for yield improvement, 47 were exploited as parents in breeding for resistance to Vascular streak die back diseases and black pod diseases, 9 with bean size of above 2.5 g were utilized as parents in the programme for evolving bold bean type varieties. 17 criollo and criollo like accessions were utilized for breeding programme for improvement of processing qualities. The superior hybrids CCRP 8,9,10 have been released for cultivation.





GENETIC DIVERSITY OF RICE IN THE CENTRAL WESTERN GHATS: PROSPECTS OF CONSERVATION AND UTILIZATION

02 15

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The Western Ghats has been attracting the attention of researchers, conservationists, policy makers and amateurs for its diversity since two to three decades. Unfortunately however, not much light has been thrown on the agro-biodiversity of the region that is of immense value in the livelihood of the people inhabiting the area. Among many crops, rice is the most predominantly grown cereal in the Western Ghats and the rice ecosystem of the central Western Ghats is known for diversity of rice varieties that are cultivated by farmers of the region since centuries (Daniels, 2002). Though there is no accurate information on the kind and number of farmer varieties/land races grown in the Western Ghats, It is estimated that there are more than 1000 varieties being grown in the entire Western Ghats. The yield levels are low (12-15 quintals as opposed to improved varieties with a yield potential of 25-30 quintals/acre) in these varieties but they do provide shield against pest and diseases besides catering to the specific cultural and taste preferences of farmers. Moreover they have high adaptability because of long history of cultivation. For instance, in Coorg district of the central Western Ghats, farmers are growing varieties such as Doddi (red rice), BKB, Biliya etc. that have resistance to blast disease, high consumer preference, and high fodder yield and adaptability. However, with the introduction of high yielding varieties, the local varieties are facing the threat of complete replacement and irreversible loss across the Western Ghats. Further, in the current scenario, the productivity levels are stagnated and prospects of paddy cultivation in the central Western Ghats zone are decreasing due to multitude of reasons. Increased biotic and abiotic stresses, decrease in land area and irrigation facilities, market fluctuations and labor scarcity are some of the major barriers. These have far-reaching consequences in the livelihood of poor and marginal farmers of the zone and have particularly hit hard the on-farm agro biodiversity of rice. In other words, we are at the verge of losing highly adapted gene complexes in terms of local varieties and if efforts are not initiated, we may not be able to recover this domesticated biodiversity of immense value. Realizing this, at our center work is initiated towards collecting and characterizing rice diversity of the central Western Ghats spanning 8 districts and 22 taluks. Preliminary studies on characterization indicate that still considerable rice diversity exists in the farmer fields. Further the varieties have distinct vegetative and reproductive characters, and possess unique post harvest qualities. This was also evident when surveys were conducted in the field and collation of information from farmers. The yield levels of some of these varieties are comparable to that of improved varieties. In other words, it is very essential that we conserve this spectrum of diversity for the posterity. Most importantly these varieties have implications in IPR related issues and need to be protected. Hence in this paper, an attempt will be made to provide the results of collection and characterization studies of rice agro-biodiversity of the central Western Ghats along with associated indigenous knowledge. The potential and prospects of these varieties for the region and the country will be discussed.





COLLECTION AND MAINTANENCE OF CUSTARD APPLE GERmplasm FOR LIVELIHOOD SECURITY

02 16

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Custard apple (*Annona squamosa* L) fruit has become very popular as table fruit as also fruits pulp in high value preparation like ice-cream, kulfi, milkshake etc. It's flowering to fruit development period lies during rainy season ready for harvesting during the October - November. Plants tend to become dormant in later period, which makes it most ideal for cultivation in rainfed/ dryland areas because of high yield potential, hardy nature of tree and realization of need for crop diversification with livelihood security. Custard apple being a aggregate fruit, it has more numbers of seed in fruit which is most limiting factor for pulp extraction and in consumption also. Less seeded custard apple is required in market for pulp extraction and people are also like seedless or less seeded fruit. Pulp is the most important portion of fruit from commercial point of view and it is very difficult as well as tedious job for extraction of pulp from seeded fruit as pulp are available on the periphery of seed. Seeds contain anonin which is responsible for browning of pulp just after extraction. To meet out the above demand, survey were undertaken to find out the seedless or less seeded custard apple in Nagpur division which is available in the Kanhan and Wainganga river bank in Nagpur and Bhandara district of Vidarbha during 2007-08, 2008-09 and 2009-10. These plants are located at government waste land and forest area of this region with certain pockets on 100-120 ha area. In all, 36 genotypes were collected and its physico chemical analysis was done to identify the promising genotypes for commercial cultivation in the region. Significant differences was recorded among different genotypes in respect of fruit size, fruit weight, pulp content, seed content, rind appearance, pulp colour, TSS and acidity and yield. From this rigorous survey only two genotypes identified which have fruit weight above 300g i.e. CA-21(336g) and CA-15(318g) and only five genotypes which have fruit weight in between 250-300g i.e. CA-3(278g), CA-7 (270g), CA-11 (254g), CA-17 (282g), CA-22 (276g) and CA-35 (278g). As regard the TSS, maximum TSS was recorded by CA-10 (23.6 °B) and CA-18(23.2°B) which is most important character of custard apple. Less seed content is also one of the best characters of custard apple which found in CA-19 (4.00g per fruit).





BIODIVERSITY OF SPICES IN INDIA

02 17

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India is the land of spices. It grows over 50 different varieties of spices. While spices such as black pepper and cardamom originated in India, it is also a major production centre of many other spices like ginger, turmeric, chillies, vanilla and tree spices (nutmeg, clove and *Garcinia*). Among the seed spices, India is one of the centers of origin for ajowan and dill besides being a major producer of other seed spices such as coriander, cumin, fennel, fenugreek, celery and kalongi. During 2009-10, India had a total area of 2.47 million ha under spices with 4.02 million tonnes production. The major spices discussed here are all distributed in Western Ghats and Eastern Himalayas in the forest ecosystem. Locating them and collecting them is a difficult task. Hence, GIS has been used successfully to locate the available diversity with reasonable accuracy. IISR has a strong base for GIS application. The GIS has been used to successfully collect diversity in *Piper* and *Garcinia*. *Piper nigrum* belongs to the genus *Piper*, of the family Piperaceae. The distribution of *Piper* species ranges from sea level to the high ranges of Andes and the sub Himalayas. Trans-Gangetic region and the South Deccan are considered to be the two independent centers of origin of the genus *Piper* in India. The sub - mountainous tracts of Western Ghats are believed to be the center of origin of black pepper – *Piper nigrum* Linn. More than 1000 species are included in the genus *Piper* of which 112 are of Indian origin. Brazil, Central America, Malaysia, Mexico, Indian -subcontinent, Tropical Australia, East Africa, Malagasy Republic, West Indies, Pampas area and Siam-Burma region are considered to be the centres of world distribution of the genus *Piper*. Even though ecosystem diversity does not contribute much to biodiversity of black pepper, species diversity and varietal diversity are considerable. South Indian species are economically the most important, as they are closely related to the cultivated black pepper. The other economically important species is *P. betle* (L) which is mainly used for pan industry. Several species of *Piper* are used as important medicinal plants. *P. longum*, *P. cubeba*, and *P. retrofractum* are some of the important species used in indigenous medicine system. Presently, IISR is having large collection of black pepper germplasm with 2575 accessions. Cardamom (*Elettaria cardamomum* Maton) is indigenous to evergreen forests of Western Ghats in South India. It is a tall, herbaceous perennial with branching subterranean root stock belonging to the family Zingiberaceae. The cardamom of commerce is the dried mature capsules of the plant. The present germplasm holding of cardamom in IISR is 550 accessions collected from cardamom growing regions of South India. Ginger consists of the dried and digitately branched rhizomes of *Zingiber officinale* of the family Zingiberaceae. The *ex-situ* genebank of Ginger at IISR is having 659 accessions and consists of 508 cultivars, 92 accessions of related taxa and 59 exotic collections. All accessions are being maintained in cement tubs for protecting them from diseases and also to maintain the purity of the genotypes. The genus *Curcuma* is mainly Indo-Malayan in distribution. Species diversity, morphotype diversity and varietal diversity are characteristic of this genus. Among the related species *C. aromatica* is important in medicine and in the preparation of cosmetic articles. *C. amada* is used as a vegetable, while *C. zeodoaria*, the Indian arrow root, is a major source of starch in many parts of India, through *C. angustifolia*, *C. caulina*, *C. montana*, *C. leucorrhiza*, *C. decipiens*, *C. raktakanta*, *C. pseudomontana*, *C. erubescens*, *C. xanthorrhiza*, *C. malabarica* and *C. harita* are also reported to be useful for arrow root preparation. The turmeric conservatory of IISR consists of 1270 accessions including 1258 cultivars, 16 accessions of related taxa besides 6 exotic collections. Tree spices are spices originating from tree crops. Altogether 17 species are put under the group 'tree spices'. Nutmeg, clove and cinnamon, kokum and tamarind are the important tree spices grown in India. Allspice is another tree spice introduced to India recently but less popular. Tamarind and curry leaf are grown widely. *Garcinia* is mainly grown in the South West region of India. Tree spices conservatory at Indian Institute of Spices Research, Calicut includes 484 nutmeg, 226 *Syzygium*, 311 Cinnamon and 116 *Garcinia*.



TRADITIONAL CROP DIVERSITY IN COASTAL TALUKS OF UTTARAKANNADA DISTRICT IN KARNATAKA

02 18

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Uttara Kannada has various ecological zones and account for the tremendous domesticated diversity of the district. The forests and many other habitats of the district shelter several wild relatives of rice, mango, vegetables, banana and other horticultural crops. Driven by the losses due to diseases, farmers are increasing bringing wild varieties of pepper and other cash crops in to their farming system. These wild varieties offer tolerance and resistance to an array of pests and diseases. Unfortunately these valuable resources are in the real danger of becoming locally extinct. Hence it is important to document and conserve the wild relatives of cultivated plants, for future genetic improvements. Each coastal taluk is divided into three ecological zones i.e., Coast, Inland coast and foothills to validate crop response to microclimatic condition. Subject experts/knowledgeable farmers consulted in each zone to document domesticated crop diversity as traditional/local cultivar and improved crop varieties with their special characters. There are traditional varieties and modern high yielding varieties (HYV) in each of these crops, which are adopted by the farmers. Farmers generally grow traditional paddy varieties for their own consumption though they prefer HYV's for commercial purposes. Paddy, areca nut, mango, banana, vegetables, legumes, sugarcane and other horticultural crops are the important cultivated crops, which have played key role through ages in the prosperity of the district. Though higher number of traditional rice varieties (Traditional varieties 43 v/s Improved varieties 32) recorded along coastal region, Mango (38 v/s 14), Banana (18 v/s 8), vegetable crops (59 v/s 24) found to be higher per cent of traditional varieties than rice. Kumta and Ankola taluks are having highest crop diversity (189 and 184 varieties respectively, compared to 114 varieties of Karwar) among coastal taluks of the district. The diversity within each of these crops and several others is quite like different flavors, keeping qualities, size etc., among Appemidi varieties of mango, paddy and brinjal varieties due to varied edaphic and micro climatic conditions. These are on the decline due to decrease of diversity in adjacent forest. Developmental activities, commercialization of agriculture lead to disappearance of some of the important traditional varieties like scented rice varieties (Parimala Sannakki) from the cultivation.

The *in situ* conservation of different crop diversities in farmer's fields is better than a decentralized germplasm collection. Hence knowledge potential of rural people and agrobiodiversity are to be documented and conserved. The rationale was that diversity of germplasm provides insurance for crops against changes in climate, the impact of pests and diseases incidence.





DIVERSITY OF INSECT PESTS IN CASSAVA ECOSYSTEM

02 19

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Cassava (*Manihot esculenta crantz*), a woody shrub is widely cultivated in the tropical & sub tropical areas. The tubers are used as a staple or subsidiary food and also for industrial purposes to extract starch and related products. The pest problems of cassava gained attention of the research workers only on the 20th century. Almost all parts of the cassava plants during various stages of growth as well as post harvest stored products are infested by pests. Cassava is attacked by more than 200 species of arthropods besides some non insect pests like millipedes, nematodes etc. Observations were taken from the cassava field of Central Tuber Crops Research Institute, Thiruvananthapuram for a period of one year and the insect complex was studied. Distribution of the insects were classified according to place of the plant where the insects is seen. Pests that attack the stem of the cassava plant are soft scale (*Aonidomytilus albus*) mealy bug (*Pseudococcus filamentosus ckl*), stem borers (*Pterolophia melanura*, *Sybra praeusta*) etc. They desap the stem and destroy the latex content leading to quick drying up of planting material. The infestation in the field spread through the contaminated planting material & the infested setts do not sprout properly. The planted setts & young seedlings are attacked by termites (*Odontotermes* sp.), the Cockchafer grub (*Leucopholis coneophora*), and millipede (*Harpurostreptus* sp.), which leading to poor germination & survival. Arthropods like aphids, whitefly, grey weevil, spider mites grasshoppers, and thrips are pests damaging foliage of cassava in India. Among them whitefly, thrips & spider mites are pests of economic importance & others are minor pests. The white fly, (*Bemisia tabaci*) is economically important as a vector of Cassava mosaic disease. Tubers in the field are destroyed by white grubs, millipedes, and ground beetle different species of rats. Stored cassava chips and flour are damaged by different species of insects. Among them the major ones are coffee bean weevil (*Araecerus fasciculatus*) Cigarette beetle (*Lasioderma cerricorne*) black borer (*Denoderus bifoveolatus*) red flour beetle (*Triboleum castaneum*). Proper control is necessary for management of these pests for better yield and good quality foods.



PARTICIPATORY APPROACHES FOR SUSTAINABLE *IN-SITU* CONSERVATION OF GERMPLASMS AND PGR

02 20

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In spite of all our family welfare efforts at government and non-governmental levels, the population of India is still increasing at rate of 2.17%. In view of this fact, we have to increase the quantum of our food, feed, fibre and agro-product supply at a matching rate. There are two techniques to enhance the biological/agricultural production: first, by manipulations of the genetic materials (hereditary); second, through the manipulation of non-genetic (environmental and management) factors. Participatory crop improvement (PCI) is a new approach in genetic improvement, first developed to respond to the demands for improved varieties from small farmers situated in poor or marginal areas, for whom conventional breeding had generally failed. The approach aims to deepen the involvement of farmers and other actors (in the crop's production chain) in the different stages of variety development. Moreover, the method has a decentralized approach; it takes into account the specific environmental conditions of targeted sites such as climate, soils and farming practices to better control the genotype-by-environment interactions that are frequently very strong in traditional, low-intensity, production systems. Plant breeding has been beneficial to farmers who enjoy favorable environments or those who could profitably modify their environment to suit new cultivars. It has not been so beneficial to those farmers (the poorest) who could not afford to modify their environment through the application of additional inputs. Farmers in favorable environments using high levels of inputs are now concerned with the adverse environmental effects and the loss of genetic diversity. Poor farmers in marginal environments continue to suffer from chronically low yields, crop failures and, in the worse situations, malnutrition and famine. Because of its past successes, conventional plant breeding has tried to solve the problems of poor farmers living in unfavorable environments by simply extending the same methodologies and philosophies applied earlier to favorable, high potential environments. An attempt was made to study the sustainability of *In-situ* conservation approaches in the present context.





BIODIVERSITY OF TAPIOCA (*MANIHOT ESCULENTA* CRANTZ) IN KERALA

02 21

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Tapioca (*Manihot esculenta* Crantz) is an important tuber crop of Kerala, grown in an area of 87,000 ha. It is a crop of South American origin, introduced to Kerala about 505 years back. As this area is having similar agro-climatic conditions as the centre of origin of the crop, it got established well in the region. It came as a boon to poor people inhabiting the hilly regions of the state where paddy, the staple food, could not be grown. Its importance became all the more evident during the world wars, when import of rice was restricted. Considering the importance of the crop, planned introduction was made by the local Rulers. Now it is grown not only as a subsidiary crop but also as an industrial raw material for production of starch. Even though only a few varieties were introduced in the beginning, a large number of hybrid varieties evolved in the region as the climate is ideal for flowering and seed setting of the crop. This was accelerated by organized research initiated under the Kerala University and then by the establishment of the Central Tuber Crops Research Institute at Sreekariyam, Thiruvananthapuram. Local varieties were hybridized with those introduced from other tapioca growing countries and a number of improved varieties have been developed and released for cultivation. As germplasm is the raw material for crop improvement, the local varieties were collected, characterized and evaluated for economic characters. This paper is based on a study of the diversity available in the land races collected from different areas of Kerala. The maximum varieties were collected from Central region, comprising of Pathanamthitta, Alapuzha, Kottayam and idukki, followed by South Kerala (Thiruvananthapuram' and Kollam) and the least from North Kerala. Tapioca grows in varied agro-climatic regions of Kerala, right from Thiruvananthapuram to Kasargode and also from the coastal areas of Alapuzha to the high ranges of Idukki. Data on morphological characters were recorded in the germplasm accessions collected from different areas and wide variability was noticed. The tuber yield per plant ranged from 2.00 to 10.00 kg in CI-576, a collection from Kottayam. Many varieties with very good cooking quality have also been evolved over the years (CI-72, 102, 702, 722 859, 882). This forms an ideal breeding material for further improvement of the crop. Details are given in the paper.





INTRASPECIFIC VARIABILITY STUDIES IN *TERMINALIA CHEBULA* RETZ. ACCESSIONS COLLECTED FROM VARIOUS AGROCLIMATIC ZONES IN SOUTH INDIA

02 22

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Terminalia chebula (Combretaceae) is a large tree with dark brown, often longitudinally cracked, exfoliating in woody scales, ovate or elliptic leaves with a pair of large glands at the top of the petiole, yellowish-white flowers, in terminal spikes and ellipsoidal, obovoid or ovoid, yellow to orange-brown fruits. It is distributed in India, Sri Lanka, Nepal, Myanmar, Bangladesh, Thailand and Malaysia. Fruits are useful in wounds, ulcers, inflammations, gastropathy, anorexia, helminthiasis, flatulence, haemorrhoids, jaundice, hepatopathy, splenopathy, pharyngodynia, hiccough, cough, asthma, uropathy, vesical and renal calculi, cephalalgia, ophthalmopathy, abdominal diseases, helminthiasis, delirium, pharyngitis, dyspnoea, coryza, scrotal enlargement, urinary disorders, soft chancre, seminal defects, narcosis, fainting, epilepsy, intermittent fevers, cardiac disorders, filaria, obesity, rheumatoid arthritis, whitlow, dandruff, skin diseases, leprosy, stomatitis, neuropathy and general debility. Bark contains B-sitosterol. Fruits contain chebulin, anthraquinone glycoside, terchebin, tetrachebulin vitamin C, chebulinic acid and tannic acid. Kernel oil yields arachidic, palmitic, stearic, oleic, linoleic and behenic acids. Flowers contain chebulin. Leaves yield 2-alpha-hydroxymicromeric acid, maslinic acid and 2-alpha-hydroxyursolic acid. Present study was carried out to elicit information on the diversity of various clones assembled at the Field Gene Bank of Centre for Medicinal Plants Research, Arya Vaidya Sala, Kottakkal. During the present study random collections of *Terminalia chebula* from different agroclimatic zones of south India were analysed. Thin Layer Chromatographic analyses of the dried fruit extracts were performed on silica gel 60 F254 TLC plates (10 X 20 cm; Merck, Darmstadt, Germany). Aliquots (10 μ l) of the extracts were applied on the plates as bands. Plates were developed in TLC chamber previously saturated (30 min) with the mobile phase, toluene: ethyl acetate (9:1 v/v). Dried fruit (1g) was refluxed with 10 ml chloroform for 6 hours at 50°C. The extract was filtered and concentrated under vacuum until dry and used for the profiling. Solvent system was Toluene: Ethyl acetate (9:1). Accessions of *T. chebula* were collected from various agroclimatic zones of south India. There were significant variations in the morphology of fruits of the different accessions. Different mobile phases for the separation of *T. chebula* extracts were tested, using silica gel TLC plates. The mobile phase that had the best resolution and separation was toluene: ethyl acetate (9:1 v/v). The TLC fingerprint profiles of all the accessions were compared (Fig. 2). The extracts were separated into individual components using appropriate solvent systems after performing trials with a wide range of solvents. The solvent system for TLC separation was selected based on the efficiency of separation and degree of resolution of the system. The comparative TLC profiles reveal the variations between the accessions. HPTLC studies conducted in *T. chebula* using gallic acid as the marker compounds revealed substantial quantitative variation within different accessions (Fig. 3 & 4 and Table 2). Among the different accessions studied, the sample from Bandipur forest, Karnataka is found to contain maximum gallic acid content (3.28%). The present work concludes that the morphological and phytochemical variations observed in *T. chebula* can be used as a lead for undertaking further studies towards identification of superior chemotype for future use in the industry.





IMPLICATIONS OF RICE BIODIVERSITY IN THE ECONOMIC EMPOWERMENT OF TRIBAL COMMUNITIES IN KORAPUT DISTRICT

02 23

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Jeypore tract in Odisha state is considered as a centre of secondary origin of rice .It is home for a rich diversity of landraces. Sixty percent of the total population belongs to schedule tribes with as many as 52 tribal communities .The inhabitants mostly belong to farming community with intense belief in tradition and rich cultural heritage. They are very poor and many are extremely poor, but they hold rich biodiversity in a range of crops including rice which is their staple food. They preserve rice germplasm from time immemorial at their personal cost which is available for public use. Rice varieties, which are used in various occasions like festivals, ancestral ceremonies, family functions and rituals, receive top priority in conservation. The local tribal communities have a registered body "Panchabati Gramya Unayan Samiti (PGUS)" which works on biodiversity conservation and development at village level and a cooperative society named "Kalinga Kalajeera Rice Growers Cooperative Society (KKRGCS)". These local bodies, facilitated by M.S.Swaminathan Research Foundation, mainly focus on large scale production, popularization and market promotion of rice landraces. Out of the different types of rice landraces *Kalalajeera*, *Machakanta* and *Haladichudi* are now identified for popularization, value addition and market promotion. As per the present market demands *Kalajeera* rice (a scented, long duration rice landrace, having small oval grain with black husk colour and yielding 20-22q/ha) is sold @ ¹ 40/kg . *Machakanta rice* (a long duration variety having white slender grain and good taste, yielding 20-22q/ha) is sold @¹ 28/kg and *Haldichudi* rice (a medium duration landrace having white medium slender grain with deep yellow husk colour and yielding 18-20q/ha) is being sold @ ¹ 25/kg. Value added products like *puffed rice*, *fried rice*, *pappad* and *fried flat rice* are being prepared and marketed locally by the self help groups . The value added products have good demand in the local markets as it has good taste. The strong and long straw of these varieties are suitable for mushroom production. The additional earning of ¹ 800-1200 per month from the value added products helps to improve their socio- economic condition. Through encouragement and empowerment by MSSRF, the tribal communities of Jeypore was selected for an International level award Equator Initiative Award – 2002, *Johannesburg, South Africa* and a National level Genome Saviour Award - 2006 , *PPVFR Authority, New Delhi* for their commendable efforts on conservation and promotion of rice landraces in the tribal villages of Jeypore. This paper describes the strengthening and facilitating process of the local institutions on rice landraces conservation motivated through value addition and proper market linkage. Thus the 4 "C" chain approach (Conservation, Cultivation, Consumption and Commercialization) enables the communities to improve their socioeconomic conditions.



MAINTAINING DIVERSITY OF TRADITIONAL AGRICULTURAL CROPS- A CASE STUDY FROM KORAPUT DISTRICT IN ODISHA, INDIA

02 24

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Traditional Agricultural crops exhibit a wide range of species and genetic diversity in various marginal agro ecosystems. This diversity is the outcome of continuous natural and human selection, which took thousands of years to choose the present day crops. Traditional crops play a significant role in household food security and income generation, provides nutritional support and better health to tribal and rural poor. The Koraput district in Odisha, India is taken as a case study to highlight the conservation and cultivation of a wide range of food crops in multiple farming systems. Tribal communities dominate the district and carry out traditional agricultural practices specific to dry and wet system of cultivation. The noteworthy practices include shifting cultivation, multiple crops cultivation, *Jhola* cultivation and *Myda* System of cultivation. Of these, multiple crops cultivation provides cereals, millets, pulses and oil seeds from a single piece of land over a period of 4-6 months. These crops are well adapted to local agricultural conditions and are able to tolerate biotic and abiotic stress conditions. Tribal communities fulfill their dietary diversity from these crops, which is a source of good nutrition, and thus better health. It also maintains inter and intra specific diversity on farm which is an important aspect of sustainable agriculture and food security. Despite this the yield is poor compared to modern high yielding crops. Gradually tribal and rural communities giving up the practice of multiple cropping and uplands are leased out for plantation of commercial tree species leading to species and genetic erosion. Hence M.S.Swaminathan Research Foundation, Chennai started its field intervention in 1998 in tribal villages of Koraput to revitalize and conserve the traditional food crops with enhanced productivity in a participatory approach. Field experiments carried out in three villages with eighteen tribal and non tribal farm families. The farm families selected finger millet or traditional rice as one of the core crops for multiple farming. Little millet, pop sorghum, black gram, arhar and niser were mixed in desired proportions looking at the individual family food need. Line sowing was introduced and practiced in place of broadcasting of seeds. Space was provided between the lines and within the lines for proper growth of the plants. It was seen that the core crop production had increased by 50%. The benefit: cost ratio was 2:1 if family labour was also included. Little millet and pop sorghum fulfilled the socio cultural and religious needs. Pulses helped in increasing the soil fertility. Current work in Koraput is helping to reverse the trend of replacement of traditional crops with modern varieties in the working and adjoining villages. Such efforts have not only enhanced the nutritional status and food security of farm families, but also increased their income.



BIODIVERSITY OF INSECT PESTS ON STORED TUBERS OF ELEPHANT FOOT YAM, *AMORPHOPHALLUS PAENIIFOLIUS* (DENNST.) NICOLSON

02 25

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Elephant foot yam, *Amorphophallus paeniifolius* (Dennst.) Nicolson, an important tuber crop of 220-350 days maturity, has a relevant scope as a cash crop in the tropical countries. Due to its production potential and popularity as a vegetable and pharmaceutical uses, this crop is widely grown in Kerala, Andhra Pradesh, Maharashtra and Orissa. On harvest tubers are either marketed or stored as the seed material for next planting season. Infestation by a spectrum of insect pests at the time of storage is an emerging problem, as these cause qualitative and quantitative loss to the tubers. The study aims to make an account of the insect pest diversity on the tubers throughout the year. After the harvest of elephant foot yam, tubers were stored in seed storage shed. Observations were taken at weekly intervals and the insect biodiversity was recorded. Microscopic observations were done with a stereo zoom microscope to study the populations and diversity of the insects associated with stored tubers. The important insects observed on the tubers within one year were mealy bug *Rhizoecus amorphophalli* Betrem (Hemiptera: Pseudococcidae), Coffee Bean Weevil *Araecerus fasciculatus* Degeer (Coleoptera: Anthribidae) and scale insect *Aspidiella hartii* Cockerell (Hemiptera: Diaspididae). The incidence of mealy bug and scale insect was high during the warm conditions especially from the month of March to May. The life cycle of this mealy bug is around 22-30 days, indicating their high reproduction potential. Microscopic observation of infested tubers revealed that the population flourished during this period and huge colonies were observed in the crevices and depressions on the tubers. Mealy bugs produce a white waxy coating and gave the tuber a whitish appearance. Scale insects were fast spreading even though the adult ones were sedentary in nature. Often both mealy bug and scale insects are seen on the same tuber. The weevil *Araecerus fasciculatus* appeared when the tuber lost its moisture content and got dried up. This insect attacked mainly the cut and damaged areas of the stored tubers where moisture content is less than normal. This weevil lays eggs on the tubers and the emerged grubs bore into a zigzag galleries by feeding the contents. The study of population dynamics of insects associated with stored tubers revealed that the mealy bug population is greater in almost all seasons. The crawlers of scale insect settle on the tubers, and cover under a hard coating. Their population is found less compared to mealy bug. Of all the insects observed on the stored tubers, the mealy bug was the noxious pest which reduces the vigor and affects the appearance of the tuber.



THE INFLUENCE OF SOIL ON THE OCCURRENCE AND DISTRIBUTION OF *AGARICUS* SPECIES IN KERALA

02 26

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The diversity of climatic conditions prevalent in India made this country a natural habitat of a number of mushrooms. However the deliberate efforts made for the detailed study of natural agaric flora is less in different part of the country till today. Kerala with its congenial conditions is found to be the abode of a vast variety of mushrooms. Given the daunting fungal diversity in tropics, we need to optimize methods for assessing the species richness in catchment areas which are unexplored. A study was conducted to identify, preserve, document and catalogue the highly priced mushroom - *Agaricus* sp. in Kerala. The study was carried out in the 20 agroclimatic zones of the state. The periodicity of occurrence, soil type, locality, date of collection, relative humidity and maximum and minimum temperature on the day of collection etc. were noted. 42 species were collected from different agroclimatic zones of the state. Among the species collected *A. squamuliferous* was seen abundantly throughout the state during North East and South West monsoon irrespective of soil type and vegetation. Majority of the collections were obtained from laterite soil viz., semi dry laterite, subhumid laterite, humid laterite, per humid laterite, wet laterite and also on semi dry red loam. Few species were collected from alluvium soils, semi dry alluvium and sub humid regions. No collections were obtained from saline soils. Five species were observed from sandy soils of Onattukara region. Observations showed that *Agaricus* species preferred open grassy areas to woody areas. Majority of mushrooms were collected from open areas.





CONSERVATION AND EVALUATION OF UPLAND VARIETIES SUITABLE FOR INTERCROPPING IN COCONUT GARDENS

02 27

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The paddy farming sector is experiencing a myriad of problems and consequently the wetlands are getting converted into nonfarming uses or other crops. Kerala has the potential and suitable agroecologies including upland, rainfed lowland, irrigated lowland, kole, kaipad and kuttanad areas and has immense scope as far as food security is concerned. Intercropping paddy in coconut gardens can offer a means to the ever cherished dream of food security, conservation of biodiversity and self sufficiency of the state. Intercropping one third of the area under coconut with upland rice can alone double the area under rice and can bring revolutionary change in rice production scenario of the state. Traditional farmers and tribals of northern regions of Kerala claim to have varieties suited to shaded situations and the collection and evaluation of shade tolerance of the local and released varieties is the basic requirement of initiating research in promoting upland rice cultivation in coconut gardens and it has been attempted. Two experiments were conducted for this purpose. Firstly, thirteen different varieties (8 local and 5 varieties released by Kerala Agricultural University) of Paddy were tested for their performance as intercrop in coconut gardens of Kannur district. The results showed the superiority of Vaisakh and Karuthadukkan as intercrops. But as there exists differential shade levels in coconut gardens of varying age, latter experiments were undertaken by cultivating different varieties of paddy under six levels of shade (0, 26, 43, 64, 73 and 81%). Multilocational trials were conducted in Kannur district by creating the shade levels through the use of shadenets in order to avoid the interference of soil and climatic changes. Biometric and yield parameters were observed. In general, the performance of the intercropped paddy declined with increasing levels of shade. Vaisakh, Karuthadukkan, Chomala and Paramban kayama were superior with respect to their performance under shade. These varieties were found to thrive well even under 81% shade. Paddy cultivation in non conventional areas in general and coconut gardens in particular, can offer means for achieving food security and the identified suitable varieties can add to the sustainability of the agricultural and food production scenario of the state.





BIODIVERSITY OF UNDER UTILIZED TROPICAL TUBER CROPS

02 28

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The major tropical root and tuber crops like cassava, sweet potato, yams and aroids contributes substantially to the daily calorie intake due to their high calorific value and carbohydrate content. In addition to the major crops, there are many types of rhizomatous and tuberous root crops which are grown and used in different parts of India. Some of them are already cultivated, but others are grown as a neglected group of economic plants. They are often used as food or serve as a source of raw material for the production of alcohol and animal feed. Many wild plants form an important starchy food for the tribals inhabiting near to forest tracts. Some of these crops not only enrich the diet of the people but also possess medicinal properties to cure ailments or check their incidence. However, these crops have not spread farther than their native habitat due to physiological constraints or lack of adaptability. In order to explore the potentialities of some of these under utilized minor tuber crops, an intensive research programme was initiated at the Central Tuber Crops Research Institute, Thiruvananthapuram. Several exploration trips were made separately and jointly in collaboration with National Bureau of Plant Genetic Resources, Trichur to different parts of Kerala, Tamil Nadu, Karnataka, Bihar, Jharkand, Madhya Pradesh, Uttar Pradesh, Orissa, Assam, Meghalaya and Nagaland. A total of 183 accessions belonging to 9 crops which included 90 accessions of Chinese potato, 63 accessions of Yam bean, 7 accessions of Arrow root, 5 accessions of Canna, 11 species of Curcuma, 3 species of Typhonium, 2 species of Costus and one accession each of Tacca and Vigna were collected and maintained in the field gene bank. All these crops were evaluated for tuber yield. Biochemical characters like dry matter starch, sugar were estimated according to the standard methods. Starch was extracted from the tubers to study the rheological properties. The evaluation of under utilized crops showed that some of these crops have high potential (>30tha⁻¹) and can act as a carbohydrate reserve to support the food security of the country. Canna starch resembles yam starch in most of the functional properties. The starch has good potential in food application due to its high viscosity, gel strength and paste stability. Chinese potato is extensively used as a vegetable. Arrow root starch is commercially used in the preparation of different types of biscuits and other bakery products. All the Curcuma species are used by the local people for the starch extraction because of its medicinal properties. Even though flowering was observed in some crops, majority of them do not produce any seeds which obviously limit the scope for breeding and further improvement. In the present context of rapid increase of population and consequent shortage of food grains, collection and utilization of various types of under utilized tuber crops are considered very essential. Ample scope exists in the exploitation of these crops as food.





SOIL BIOTA AND NUTRIENT DYNAMICS IN THE PADAYATTI AGRO WETLAND ECOSYSTEMS, KERALA

02 29

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Wetlands are among the most productive ecosystems in the world encompassing diverse biodiversity repositories, especially the agro-wetlands. Various cultivation practices have changed the soil environment by altering the physico-chemical and biological properties in turn affecting the carbon decomposition and nutrient cycling processes leading to significant impact on ecosystems. Recent studies have focused on traditional farming practices to enhance the soil fertility input thereby fostering agricultural sustainability. In this context Kerala Biodiversity Board in 2008 with the support of State Agriculture Department executed organic farming practices in Padayatti-Erumayur, Palakkad having four hundred acres of micro-watershed wetland ecosystem. The data collected on the soil chemical, benthic and microbial parameters in selected organic farming zones (Sts-1-3) in comparison to chemical fertilizer application zone (Sts 4) from July 2009 to July 2010 formed the basis of this paper. Soil pH showed slight variations between the study stations. It was generally acidic in the months July to November (7.8–5.31) and the lowest pH (5.31) was observed in the month October in the organic zones. The Eh values showed a reducing trend in most of the study sites, showing a highest value of -124 mv in the fertilizer applied zone. Such reducing nature of soil could favour anoxic conditions, leading to complex sequence of methanogenic events resulting in the production of green house gas, methane. The organic carbon, total nitrogen, phosphorus and calcium values showed higher concentrations in organic fields. The mean organic carbon value in the organic farming zones ranged from 0.36 to 0.35 mg/g in fertilizer applied fields. Average phosphorus availability ranged from 0.498 in organic farming zone to 0.977 mg/g soil in organic St.2. Elevated calcium concentration was observed in all stations with highest average value in St.1 (4.648mg/g) and lowest average value of 1.582mg/g in St. 3. Study stations with organic amendments showed enriched microbial biomass and nutrient availability than fertilizer applied fields. The heterotrophic microbial count showed an average highest value of 20×10^6 cfu/g soils in organic station; whereas it was 90×10^4 cfu/g soils in fertilizer applied station. Macrobenthic community in the study area was mainly constituted by nematodes, crustaceans and insects. Studies also indicate that chemical fertilizers have beneficial effect on the heterotrophic microbial community, which in turn may exert a positive effect on soil structure, nutrient availability and soil humus content.



EVALUATION OF BANANA-VEGETABLE CROPPING SYSTEM UNDER HOMESTEAD SITUATION IN KOLLAM DISTRICT

02 30

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Homestead farming or home gardening is the most common farming system prevalent in Kerala. These are the agricultural heritage of Kerala which consists of a highly complex and dynamic arrangement of crops, livestock and related activities arrived at by our farmers through generations of experience, observation and experimentation. The coconut based farming system is the most common farming system occupying more than 90 percent of the homesteads surveyed. It is a well known fact that the growth characteristics and planting pattern of coconut palms facilitate successful growing of other crops in between or under them. The common annual crops cultivated are shade tolerant varieties of banana, tuber crops like cassava, yam, dioscorea and arrowroot, fruit plants like pineapple, spices like ginger and turmeric and a variety of vegetables like Amaranthus, bhindi, brinjal, bittergourd, cowpea, chillies are grown. Homestead gardening is thus an important agro-ecological system which provides subsistence and cash income for the farmer and also acts as a repository of biodiversity. Hitherto a study was carried out to evaluate banana-vegetable cropping system under partially shaded conditions and to study the effect of substituting chemical nitrogen with vermin-compost in vegetables during the year 2009-10 in a typical laterite soil of the Farming Systems Research Station, Sadanandapuram. The experiment was designed in a 5 x 2 factorial randomized block design with ten treatments replicated thrice. The treatments were T₁- Banana, T₂- Banana + Cucumber, T₃- Banana + Bush cowpea, T₄- Banana + Sweet potato, T₅- Banana + Bhindi. Soil samples were collected and analysed for the available NPK before and after the experiment. The intercrops were supplemented with the nutrients as per the requirement specified in the Package of Practices as one of the treatments and the nitrogen substituted with vermin-compost as the other treatment. From the study it was observed that the suitable intercrop for banana (Njalipoovan) was found to be bush cowpea (Bush) with a yield of 8 t/ha, followed by Bhindi, Sweet potato. The treatments with banana and bush cowpea recorded a highest bunch weight of 14.9 kg/bunch with 12 hands/bunch and 10-12 fingers/bunch. This might be due to the complimentary effect of legume crop grown along with the main crop in increasing the availability of nutrients, especially nitrogen. It is also inferred that the performance of sweet potato was affected due to partial shading in the field condition. The performance of vermin-compost as a source of N is better and plots with the application of vermin-compost for nitrogen recorded a better yield than the plots treated with chemical fertilizers though the former is required in large quantities. This could be ascribed to the slow and steady rate of nutrient release into soil solution to match the required absorption pattern of the main crop. Similarly, an increase in the soil nutrient status was noticed after the experiment. Further, higher uptake of Nitrogen, Phosphorus and Potash was noticed in the plots treated with vermin-compost in the case of intercrops which might be due to the higher availability of nutrients from the soil reservoir and also from the added sources of nitrogen.



NUTRITIONAL AND ANTINUTRITIONAL FACTORS IN A WILD LEAFY VEGETABLE FROM WESTERN GHATS- DIPLAZIUM ESCULENTUM

02 31

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Diplazium esculentum (Reyzt.) belongs to family Dryopteridaceae, is an edible fern of Western Ghats commonly used by tribal people. Wild leafy vegetables remains underutilized due to lack of awareness and promotion of appropriate technologies for their effective utilization. Identification of nutritional and anti-nutritional factors and multiplication of this wild plant will help to solve nutrition deficiency problem and also helps to maintain biodiversity. Different biochemical parameters like crude fibre, reducing sugar, total carbohydrate, free fatty acids, proteins etc were quantitatively estimated using standard estimation methods. Various micronutrients and anti nutritional factors like phytic acid, oxalates and tannins were also tested. Results showed that this wild leafy vegetable has important nutritional factors. It is rich in micronutrients, beta- carotene, folic acid and minerals such as Ca, Fe and P. Anti-nutritional factors like phytic acids, oxalates, tannins were present but in quiet safe quantity. So *Diplazium esculentum* with rich nutrient factors opens the possibility of the potential utilization of this plant in food system or in nutritional/ food supplement programs.





PHYTOCHEMICAL INVESTIGATIONS ON THE ENDANGERED MEDICINAL PLANT *NERVILIA ARAGOANA* GAUD.

02 32

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Nervilia aragoana Gaud., well known in Malayalam as *Orilathamara* is a medicinally important small tuberous terrestrial orchid plant with wide therapeutic potentials. The plant belongs to Orchidaceae family. It is reported to be near threatened in Karnataka, endangered in Tamilnadu and vulnerable in Kerala and is included in the negative list of exports notified by Govt. of India. It is found in India especially in the higher altitudes of Western Ghats. Naturally grows in humid shady localities of dense forests, rarely in wet grassy slopes of moist deciduous forests at 300-900 m altitude. *Nervilia* blooms between January and April and the leaves are kidney to heart-shaped, concave with erect wavy edges. *Nervilia* leaf paste is used in folk medicine against head ache. Some tribe women drink leaf decoction as tonic. Tubers are used in postnatal care and also to induce lactation. But rare scientific demonstrations are available, which is a primary requirement for clinical implications. Linking of the indigenous knowledge to the modern research will definitely help for better utilisation of our many valuable plant resources. In the present study, phytochemical investigations were carried out on the tubers and leaves, the medicinal parts of this important plant. TLC (Thin layer chromatography) profile study was also carried out. The aqueous extract was subjected to standard chemical tests for detection of various compounds present and the studies revealed that the plant mainly contains flavanoids, glycosides and tannins. Fluorescence studies revealed that aqueous extract shows a milky green fluorescence under UV 365 nm and a good yellowish green fluorescence under UV-254nm. The salient features observed in the study are documented as means of authentication. The specific TLC fingerprint developed in the study will be help in the correct identification of the genuine drug samples and also help to distinguish the plant bark from its related adulterants.





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BAMBARA GROUNDNUT- AN UNDERUTILIZED DROUGHT HARDY CROP

02 33

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With compelling climate change scenarios, water availability will be most significant constraint that would affect agricultural productivity. Global efforts have been initiated to evolve water saving strategies in agriculture through breeding for more drought tolerant crop cultivars. The other noteworthy strategy has also been to identify underutilized crop species to either complement or even to replace several conventionally cultivated crops. Bambara groundnut (*Vigna subterranea* $2n = 22$) is an under utilised African legume grown primarily in sub-Saharan Africa. This crop holds great potential as a food crop in the arid and semi-arid regions of the world due to good drought tolerance and a remarkable ability to maintain cell turgor even under prolonged drought conditions. It is also able to produce a yield of pods in dry environments when peanut (*Arachis hypogea*), the widely introduced and morphological similar South American species, fails. It is an attractive crop because of the high edible protein content (16- 25%) rich in lysine and methionine. Therefore has a beneficial complementary effect when consumed with cereals that are low in lysine. Furthermore, due to a very low to negligible levels of lipids, Bambara has the potential to substitute conventional legumes like peanut. Its pods can be used to produce vegetable milk that is comparable to soy milk. Protein functionality test on the ground seed indicate that it can compete with or replace with other flours in a range of processed products. The seed makes a complete food as it contains carbohydrate, proteins and lipids. Though Bambara groundnut is a drought hardy crop species, from the agronomic point of view, drought tolerance should be linked with superior growth rates and productivity under water limited conditions. Therefore, assessing the relevant physiological traits that improve growth under stress is extremely essential. Despite the availability of genotype and land races, the genetic variability in several traits have not been fully enumerated or exploited. Among several traits that determine growth, total water use and the efficiency of water use for biomass production have great relevance. Selections for total water use and WUE have lead to improved crop performance in cereals. In leguminous crops like peanuts also such possibilities have also been reported. Therefore, it would be important to assess the variability in these traits among Bambara accessions before attempting further improvement in productivity of this crop. The theory linking the carbon isotope discrimination with WUE has been well developed and is extensively being used as a surrogate to assess the genetic variability in this trait among several C_3 species. Therefore, the major objective of this investigation was to assess the genetic variability in WUE and root traits among the seven Bambara land races. We demonstrate that the land races studied exhibited a significant genetic variability in WUE, root traits and other physiological traits associated with drought tolerance. Furthermore, we provide experimental evidences in support of the use of carbon isotope discrimination as a surrogate for WUE among Bambara accessions.



HOST RANGE, PATHOGENICITY AND CULTURAL CHARACTERISTICS OF PINK DISEASE PATHOGEN- *CORTICIUM* *SALMONICOLOR* BERK & BROOM

02 34

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Corticium salmonicolor Berk & Broom, is the causative organism of pink disease which mostly affects trees of agricultural and forestry importance. This basidiomycetous fungus appears to thrive best in tropical and sub-tropical climate. *C. salmonicolor* produces four stages viz., cobweb, pustule, pink encrustations and necator. Characteristically, the fungus appears as a pink or salmon-colored, smooth mycelial mat on branches of its hosts. Progressive development of the fungus may lead to an envelopment of the branch, accompanied by a brown discoloration of the cambial layer, and wilting and dying of the leaves and presence of epicormic shoots below the infected area. Late symptoms of the infection occur as canker on the main stem as well as on the branches which leads to the die back of the portion above. The fungus has a wide host range affecting *Eucalyptus*, *Acacia*, *Casuarina*, *Anacardium*, *Mangifera*, *Hevea*, *Polyalthia*, etc. Genetic diversity is widely recognized as the key component for long time survival of the species. It is the foundation of sustainability because it provides raw material for the adoption, evolution and survival of species and individuals especially under changed environmental and disease conditions. Hence, the present work was initiated with an objective to find out the diversity of *C. salmonicolor* from different host, test their cross infectivity and pathogenicity as well as cultural characteristics in artificial medium. An inoculum study was conducted on *Eucalyptus* clones using nine isolates of *C. salmonicolor* from different hosts. Mycelial plugs of equal sizes were placed into each wound with the mycelium facing the xylem and. After 12 weeks, development of symptoms was examined by measuring the length of disease development area on inoculated clones. Cultural characteristic study was done in four different media- two general purpose media viz., Potato Dextrose Agar (PDA) and Malt Extract Agar (MEA) and two chemically defined media viz., Czapeks Dox Agar and Richards media substituted with rose bengal. Data were scored for growth rate, colour of colony, colour imparted on the medium, texture, colony shape, margin and zonations. All the isolates experimented were able to produce infection in the clones tested. Cobweb stage, pustule formation and formation of epicormic shoots were observed on the tested clones thereby confirming pathogenicity. No distinct differences were observed for disease development between the isolates from different host. Re-isolation trails revealed that the isolated fungi from diseased seedlings are found to be identical with those used for artificial inoculation. Growth characters of *C. salmonicolor* studied on different media indicated that the growth was maximum on the general purpose media followed by chemically defined media. PDA and MEA supported maximum growth of fungal colony. The morphology of the isolates varied significantly with the media used. However, no host specific variation was observed in the study. Cultural characteristics study of the isolates also did not reveal any grouping of isolates between the host, thereby specifying that the pathogen was not host specific and variability or diversity occur within the isolates.



GENETIC VARIABILITY AND MORPHOLOGICAL CHARACTERIZATION OF CMS LINES OF PIGEONPEA (*CAJANUS CAJAN* L.) DERIVED FROM WILD SPECIES *CAJANUS SCARABAEOIDES*

02 35

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Pigeonpea (*Cajanus cajan* L.) is one of the important grain legume (pulse) crop of India. Despite the importance of pigeon pea as an important legume crop in the semi arid tropics, its production has remained static over the last several years. Therefore, in order to break the yield plateau of this crop, many crop improvement programmes have been initiated to enhance yield potential of pigeon pea including development of hybrids by taking the advantage of pollination behavior and potential of heterosis breeding. Cytoplasmic-genetic male sterility (CMS) system is considered to be the feasible approach to develop highly heterotic hybrids. Hence, the present investigation on pigeon pea crop was conducted to identify best CMS lines and morphological markers for further maintenance of genetic purity of CMS lines derived from wild species *Cajanus scarabaeoides*. The plant material was comprised of eleven CMS, their corresponding maintainer lines and three checks. The observations were recorded for yield and yield contributing characters in addition to morphological traits like plant, stem, leaf, flower, pods, seeds, etc as per national guidelines of DUS testing. The genotype AKSMR-736B produced highest seed yield per plant followed by genotype AKSMR-736A in addition to highest pod setting percentage. Longest flowering span was noticed for CMS line AK-120-1A. On the basis of morphological characterization study, some of the genotypes in present investigation could be identified individually from other genotypes i.e. AKSMR-736A and AKSMR-736B based on anthocyanin colouration of epicotyle and stem colour; further, AKWR-627A and AKWR-627B could be identified on the basis of prominent pod constrictions. The genotype GT-288A and GT-288B were characterized with typical erect growth habit. The genotype AKWR-627A and AKWR-627B need to be further purified as it shows some variation for flower colour and seed colour. All the CMS lines and their respective maintainer lines were identical with each other except for fertility and sterility.



MATURITY STUDIES IN RED BANANA (*MUSA AAA GROUP*)

02 36

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Among the tropical fruits of India, bananas and plantains are very important and the oldest cultivated fruits in the country having great socio-economic significance. It is interwoven with the national heritage and with its multi-faceted uses, is referred as 'Kalpataru' or 'Plant of Virtues' (Chadha, 2001). India is the largest producer of banana in the world and premier fruit crop of Kerala that shows great genetic variability from culinary, dessert and ornamental bananas. Among the different bananas, Red Banana is known for its characteristic flavour and taste and it belongs to *Musa AAA* group. It is popularly known as Chewazhai or Chenkadali. The plant is robust and tall with a characteristic deep red coloured pseudostem. The purplish red peel colour and the special aroma of the fruits attract the consumers and fetches higher price in the market. Red Banana is geographically distributed in southern parts of Kerala and Tamil Nadu. The problem with Red Banana is its short shelf life owing to the highly perishable nature. The maturity stage for harvesting the fruits is one of the key factors that influence subsequent shelf life, ripening behaviour and quality of fruits. So many maturity indices like degree days, caliper grade, angularity and shoot to harvest days are in use. The flower emergence to harvest duration is the main reproductive index of banana development. The best practical and objective method of standardizing harvest maturity is phenology (flowering to harvest duration) and caliper measurement of finger diameter (Robinson, 1996). Hence fruit development studies in Red Banana was conducted at College of Agriculture, Vellayani, Thiruvananthapuram to determine the correct maturity stage in order to minimize post harvest losses. Red Banana plants were selected and tagged at the time of bunch emergence (opening of the first hand) to ensure the selection of fruits with uniform chronological age. Fingers from the second hand were harvested at 4 weeks, 6 weeks, 8 weeks, 10 weeks, 12 weeks, 14 weeks and 15 weeks after bunch emergence and at harvest (16 weeks) in five replications, were subjected to various physical and chemical analysis. The fruit is said to be mature and ready for harvest when it is at the end of physiological development. Fruit development studies of Red Banana have shown that the growth of fruits by way of increase in finger weight, length and girth continued till the fruit attained full maturity at 16 weeks after bunch emergence. Pulp constituted the major portion of the fruit both during development and maturation except at the early stages of development. The specific gravity of the fruits increased up to 15 weeks after bunch emergence and decreased towards full maturity. Peel colour changed from Dark Red Purple at four weeks after bunch emergence to Purple Brown at harvest maturity. The cross section of the fruits at early stages of fruit development showed sharp angles of the fruits, which decreased and smoothed towards maturity. TSS increased sharply during maturity from 14 to 15 weeks after bunch emergence and attained the highest value at harvest maturity. It did not show any marked change between 15 and 16 weeks after the bunch emergence. Total sugars, reducing and non reducing sugars were very less at the initial stages of fruit growth, but increased towards the full maturity. At 15 weeks after the bunch emergence, starch attained the highest value of 14.90 per cent in the pulp and with more advance in maturity, starch concentration decreased. The findings of the present investigation indicated that number of days required for attaining harvest maturity of Red Banana ranged from 105 to 120 days after bunch emergence with a mean of 112.96 days. Fruits attained optimum stage of maturity at 15 weeks after bunch emergence and full maturity at 16 weeks after bunch emergence during the month of January to May. There was no significant difference in fruit quality between 15 and 16 weeks maturity harvests. Optimally matured Red Banana fruits harvested at 15 weeks after bunch emergence could be used both for long distant domestic and export markets.





PHENOLOGICAL CALENDAR OF BASMATI RICE VARIETIES IN THE SOUTHERN AGRO CLIMATIC REGION OF KERALA

02 37

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The leading aromatic fine quality rice (*Oryza sativa* L.) in the world trade popularly known as basmati is traditionally grown in the Indian sub continent for centuries. Traditional basmati varieties processes excellent aroma and quality but the level of productivity is quite low. The maximum productivity has been reported to be achieved by planting the crop at the optimum time at any specific location which may vary from variety to variety. The prevailing weather conditions also play a major role in the final yield of rice. So basmati rice varieties viz. Pusa Basmati 1, Haryana Basmati, Kasthuri and Basmati 370 were evaluated under four different dates of planting viz. October 10th, Oct 23rd, Nov 5th and Nov 18th for assessing their varietal performance with respect to grain and straw yield under different weather conditions. Grain yield was significantly influenced by varieties and dates of planting. The variety Kasthuri recorded the highest grain yield with the maximum harvest index of 0.32 at early planting on October 10 and also matured within short period. Delayed planting lowered the grain yield significantly. Varieties and dates of planting failed to produce any significant influence on straw yield. Degree day based phenology of the different varieties was studied and a phenological calendar was developed for the varieties studied, under different dates of planting. The ideal date of planting of basmati rice crop is October 10th for early maturity and for getting higher yield.





ADAPTABILITY AND PERFORMANCE STUDY OF SAFED MUSLI (*CHLOROPHYTUM BORIVILIANUM*) UNDER KERALA CONDITIONS

02 38

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Safed musli (*Chlorophytum borivilianum* Santapau & Fernandes), a herbaceous plant of Liliaceae family, is a popular crop of central India. The roots of this crop are highly medicinal due to its aphrodisiac property and form a major constituent of various Ayurvedic preparations. The current demand of safed musli in India is estimated to be 3500 tonnes as against the supply of 500 tonnes per annum. During the past four or five years safed musli cultivation has gained momentum in Kerala. But scientific footing on introduction of safed musli and standardization of its agro techniques are lacking. Hence in the present study the optimum size of planting material was standardized and the efficacy of different organic manures were studied. Field experiment was conducted with combination of two planting weights of tuber P1 – 10 g unit⁻¹ and P2 – 15 g unit⁻¹ and six levels of organic manures, M1 – FYM @ 30 t ha⁻¹ (farmers practice), M2 – Vermi-compost alone, M3 – 50 per cent FYM + 50 per cent vermin-compost, M4 - 50 per cent FYM + 50 per cent groundnut cake, M5 - 50 per cent FYM + 50 per cent neem cake and M6 – FYM@10t ha⁻¹ as basal + NPK@100;80;80 kg ha⁻¹ (control). The dry matter yield was highest in the treatment M4 where 50 per cent FYM + 50 per cent groundnut cake was applied as organic manure and was significantly superior to other organic manure sources (3,896.74 kg ha⁻¹). Planting weight of tuber also significantly influenced the dry matter production. The dry matter yield was highest in P2 where 15 g unit⁻¹ weight of planting material was used. Application of organic manure as 50 per cent FYM + 50 per cent groundnut cake reduced the period of crop emergence, suckering and flowering and registered the highest tuber bulking rate (TBR) at different tuber growth stages.





STUDIES ON BIODIVERSITY OF MEDICINAL LEGUMES OF PATAN DISTRICT, NORTH GUJARAT

02 39

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Patan District is located in the Northern part of Gujarat, which is having rich floral diversity. In present survey work emphasis is made upon the types of medicinal legumes present in the study zone with the usage of several of plant species. In spite of dry and sandy soil of this region there were many members of all the sub-families viz, Caesalpiniaceae, Papilionaceae and Mimosaceae. The information on distribution ,status of each plant species of above mention sub-families along with it Botanical Name and Vernacular Name were included in this work. Patan District has rich biodiversity of medicinal legumes.





INTERVENTION IN MICROENVIRONMENT FOR ALLEVIATING SUMMER STRESS IN MILCH ANIMALS

02 40

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Exotic animals with high production potential when brought to tropical climate undergo a stress followed by process of adaptation. During this stage they sacrifice a portion of their production potential as they are detached from the biodiversity web, which is a comfort zone for them. Crossbred animals with increased exotic inheritance reared in tropical climates are subjected to severe summer stress during the hot summer months of the year. Heat stress result in a significant drop in pregnancy rate, poor body condition due to reduced feed intake, decreased dry matter intake by more than 35%, rumen acidosis and drop in milk production. Summer stress lead to high cortisol level which cause drop in milk production and poor letting down of milk which has grave economic implications. Hence, a study was conducted to assess the effect of modifying the microenvironment of cross bred dairy animals for alleviating summer stress by observing their physiological parameters. A group of six lactating cows reared at University Livestock Farm and Fodder Research & Development Scheme (ULF & FRDS), Mannuthy, were provided with and without sprinkler – mist system for one hour during the period between 12 Noon and 2 PM for 12 days and 6 days respectively. The physiological parameters like respiration rate, pulse rate and body temperature were recorded before and after the use of sprinklers. The over all results indicated a significant reduction in respiration rate and rectal temperature during peak hot hours on the days with sprinkler system in contrast to an increased respiratory rate and rectal temperature during peak hours on days without sprinkler system. No significant variation in pulse was observed. The study indicated that appropriate interventions in the microenvironment of animals can decrease the environmental stress which makes the animal physically and physiologically comfortable and a resultant increase in production and reproduction status.





CONSERVING THE AGRICULTURAL BIODIVERSITY FOR FOOD SECURITY

02 41

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Since agriculture began some 12,000 years ago, approximately 7000 plant species and several hundred animal species have been used for human food. Today, certain traditional and indigenous communities continue to use 200 or more species in their diets but the general global trend has been towards diet simplification, with consequent negative impacts on human food security, nutritional balance and health. Biodiversity, essential for agriculture and food production, is threatened by urbanization, deforestation, pollution and the conversion of wetlands. It offers key options for sustainable livelihoods. Environmental integrity is critical for maintaining and building positive options for human well-being. Agricultural biodiversity is a sub-set of general biodiversity. It includes all forms of life directly relevant to agriculture: crops and livestock, but also many other organisms such as soil fauna, weeds, pests and predators. Agricultural biodiversity has spatial, temporal and scale dimensions especially at agro ecosystem levels. Seventy percent of the estimated 1.1 billion people in poverty around the world live in rural areas and depend on the productivity of ecosystems for their livelihoods. Within these ecosystems, biodiversity not only provides the components of food, but also supports agricultural production and sustainability. By promoting ecosystem services such as nutrient cycling, pest control, and pollination, biodiversity assists in creating the conditions needed for food security. Immediate action is warranted to promote the sustainable use of biodiversity in food security and nutrition programmes, as a contribution to the achievement of the Development Goals. There are virtually no ecosystems in the world that are "natural" in the sense of having escaped human influence. Most ecosystems have been to some extent modified or cultivated by human activity for the production of food and income and for livelihood security. Three-quarters of the genetic diversity found in agricultural crops have been lost over the last century. However, most attention in this field is given to crop varieties and to crop wild relatives. Cultivated varieties can be broadly classified into "modern varieties" and "farmer's or traditional varieties". Modern varieties are the outcome of formal breeding and are often characterized as 'high yielding'. Biodiversity is important to maintaining agricultural production. Wild relatives of domestic crops provide genetic variability that can be crucial for overcoming outbreaks of pests and pathogens and new environmental stresses. Many agricultural communities consider increased local diversity a critical factor for the long-term productivity and viability of their agricultural systems. For example, interweaving multiple varieties of rice in the same paddy has been shown to increase productivity by lowering the loss from pests and pathogens. The continued loss of cloud forests and the destruction of watersheds reduce the quality and availability of water supplied to household use and agriculture. The availability of clean drinking water is a concern in dozens of the world's largest cities. The use of agricultural biodiversity can contribute to food security and livelihood security.



AGARIC DIVERSITY OF EASTERN GHATS

02 42

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The Eastern Ghats are a Tors of geological antiquity with isolated mountain ranges lying between Mahanadi and Vaigai rivers. A survey of the agarics from Kolli hills and Tirumala Hills was undertaken in the Eastern Ghats region. Floristically this region is very rich with more than 2000 species known so far of flowering plants which constitute about 13% of the flora of India. A total number of 169 species of agarics in 37 genera belonging to 13 families are identified and described from this region. The descriptions are based on were based on the mushroom survey made in the six consecutive years from 2002-2007. The macro fruit bodies of this fungus was collected and identified by using their macroscopic and microscopic structures recorded by photography, visual annotation and Camera Lucida diagrams respectively. The measurement of microscopic structures was made using micrometric technique. Among the total identified (169) agarics out of 263 specimen collected, only twenty were identified as edible, twenty four were non edible, twenty two species were known for usefulness in medicine for various purposes and eight were known to be poisonous based on the previous available literature. The rest of species were unknown with respect to human knowledge. Twenty eight taxa are being described as new to science and fifty two taxa are new additions to the Indian agaric flora. When compared with the species of Western Ghats the species similarity of Eastern Ghats is very low.





EFFECT OF PRE-TREATMENT ON SEED GERMINATION AND SHADE ON POD YIELD OF *MUCUNA PRURIENS* (L) DC.

02 43

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Mucuna pruriens (L) DC. commonly known as *Atmagupta* belongs to the family Fabaceae and it is called by various names viz., mucuna, velvet bean, cowitch, cowhage etc. The plant is endemic to India and other parts of the tropics including Central and South America. A climbing legume with abundant, long stinging hairs on the pod and human contact results in an intensely itchy dermatitis, caused by mucunain. In Ayurvedic system of medicine, the plant was used for the management of male infertility, nervous disorders and also as an aphrodisiac. In Guatemala and Mexico countries, *Mucuna* seed has for several decades been roasted and ground to make a coffee substitute; the seed is widely known in the region as 'Nescafe', in recognition of this use. Its seed powder contains high amount of L-dopa, which is a neurotransmitter precursor and effective remedy for the relief in Parkinson's disease. In the present study, Due to the paucity of information about the standard propagation techniques, the attempt has been made to know the seed germination per cent under various pre treatments and also to understand the effect of different shade levels on pod yield of *M. pruriens*. Graded and selected seeds were subjected to 10 different treatments and sown in two conditions viz, polybag and nursery bed. In both the cases scarification on dorsal surface gave highest germination per cent and germination energy followed by soaking seeds in con. H₂SO₄ for 20 minutes, whereas cold water treatment for 24 hours gave least germination per cent. Selected seedlings were transplanted to different levels of shade condition, prepared by using shade net of 0 per cent (Open- T₁), 25 per cent (T₂), 50 per cent (T₃), and 75 per cent (T₄). Number of flowers converting into fruits/pods under different shade levels differed among T₁ and T₂ and no effect was seen between T₃ and T₄. Time taken for the formation of pods under different shade levels also varied significantly. Pod yield was positively correlated with light intensity in which, T₁ (28.33), T₂ (24.66), T₃ (16.66) and T₄ (13.00).





EX-SITU CONSERVATION OF PLANT GENETIC DIVERSITY- AN OVERVIEW

02 44

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The spread and scaling up of successful conservation of plant genetic resources are heavily dependent on the existence of an appropriate macro-economic and policy environment. Strengthening the conservation strategies calls for the design of programmes that stimulate increased incomes and productivity without relying on the displacement of land races by improved cultivars. Some national policies may influence the success and sustainability of conservation, for example, subsidies on agricultural inputs, price control on inputs and outputs, and intellectual property rights. In the past, many protected areas prohibited human activities. It is now widely accepted that there is a need to link environmental protection to social and economic development. Indeed, humans are an integral part of a natural system. Many protected areas are heavily populated with residents depending on the resources therein for their livelihood security. Environmental protection without economic development cannot be secure or sustainable. Today, significance of conservation of the fast eroding genetic resources is well recognized. Even the developing countries, which must deploy their scarce resources first to meet the food demands, have recognized the need and have established or are in process of establishing infrastructures necessary for collection, conservation, evaluation and utilization of crop genetic resources. The seed gene bank is the most commonly used method for germplasm conservation. However, it cannot be used for all plant species. In view of the advantages and disadvantages of different conservation methods, the use of a single conservation method is not appropriate to conserve genetic diversity of all plant species. The different methods are like pieces of a jigsaw puzzle. When they slot together in a right combination, they can form the overall conservation picture.





IDENTIFICATION AND CHARACTERIZATION OF AN ANTIFUNGAL CHITINOLYTIC STREPTOMYCES SP. FROM KERALA

02 45

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In an exploration for isolation of Antifungal actinomycetes from the soil samples of Palode forests we got a strong chitinolytic Antifungal Streptomyces TBG-ALA4-7. The strain had wide range of pH tolerance and shows chitinolytic property from 4-12 pH. It can tolerate a temperature ranging from 10-50°C. It can utilize different chitin sources like chitin flakes, colloidal chitin, glycol chitin, chitin azure, chitin from crab and shrimp shells and fungal mycelium. The chitinase from this strain shows no lysozyme activity and can degrade fusarium mycelium, Aspergillus mycelium, colletotrichum, Botris alli mycelium etc. In addition to these properties the chitinase produced by this strain can inhibit the growth of four *Candida* species. The quantification of enzyme by Nelson method (1976) showed a maximum production of chitinase on 6th day with 681.8µM/ml. Maximum production of Chitinase from this strain was against colloidal chitin and glycol chitin substartes. This strain can be used as a biocontrol agent in agriculture fields against the fungal pathogens. The taxonomic identification by standard ISP and 16srDNA analysis shows that it is a streptomyces strain.





AGRO-BIODIVERSITY AND FOOD SECURITY

02 46

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Agro-biodiversity is a component of biodiversity which is the combination of life forms and their interactions with one another, and with the physical environment which has made the earth habitable for humans. Ecosystems provide the basic necessities of life, offer protection from natural disasters and disease, and are the foundation for human culture. Biodiversity in agricultural ecosystems provides for our food and the means to produce it. The variety of plants and animals that constitute the food we eat are obvious parts of agricultural biodiversity (Jarvis, Padoch and Cooper, 2007). It is important to take note that biodiversity in agricultural landscapes has powerful cultural significance, partly because of the interplay with historic landscapes associated with agriculture, and partly because many people come into contact with wild biodiversity in and around the farmland. Farmers especially in developing countries are responsible for managing agricultural biodiversity in agricultural ecosystems as a critical resource for providing them with food security, nutrition and sustenance of their livelihoods. It is only recently through the Convention on Biological Diversity that the world recognized the importance and significant contributions of agro-biodiversity in the functions of agro-ecosystems. Of particular importance is Article 15 which outlines the objectives of the CBD as that of encouraging sustainable use and ensuring equitable sharing of benefits arising out of its utilization. In the international policy arena, agricultural biodiversity was addressed for the first time in a comprehensive manner by the conference of parties of the CBD in 1996 (Jarvis, Padoch and Cooper, 2007). The CBD programme of work on agricultural biodiversity, which was subsequently developed and adopted in 2000, recognizes the multiple dimensions of agricultural biodiversity and the range of goods and services provided. Existing knowledge therefore warrants immediate action to promote the sustainable use of agro-biodiversity in food security and nutrition programmes, as a contribution to the achievement of the Millennium Development Goals (MDGs), in particular goal number 1 on poverty eradication. Such action would counteract the simplification of diets, agricultural systems and ecosystems, and the erosion of food cultures. Considering the difficulty in clearly identifying optimal diets, a diversity of foods from plants and animals remains the preferred choice for human health. The Convention on Biological Diversity (CBD) Millennium Ecosystem Assessment report of 2006 that was undertaken by over 1 300 experts working in 95 countries confirmed the overwhelming contributions made by natural ecosystems to human life and well being. However, with the rapid extinction of terrestrial ecosystems around the world, the natural habitats of wild relatives to our agricultural plant varieties are disappearing at a fast pace (Andersen, 2007). This provides a significant challenge to the future and sustainable contribution of plant genetic resources for food and agriculture to many farming communities whose livelihoods are derived from their use.





PROMOTION AND PROSPECTS OF VERMICULTURE PRACTICE IN BANGALORE

02 47

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This study concerns to the promotion of vermiculture practiced by some organisations and organic farming enthusiasts in Bangalore, thereby understanding the prospects of the practice in the region. Waste biomass from domestic, agricultural, urban and industrial sources is used in the vermiculture units at the University of Agricultural Sciences, Khodays private limited and by other organic farming enthusiasts. Issues related to vermicomposting economics, management of natural enemies and growing demand for quality vermicompost were analysed during the study.





IMPACT OF DAMS ON BIODIVERSITY AND RIVER DEPENDENT LIVELIHOODS

03 I1

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Global Biodiversity Outlook 3 cites *habitat loss and fragmentation* as the top most among the five principal pressures on biodiversity. Among the 292 large river basins world wide, two – thirds have been moderately or highly fragmented by dams and diversions. Fragmentation is detrimental to freshwater biodiversity in the river and the connectivity between different sections of a river basin from origin to the sea. More than 40 % of river discharges world over are trapped by dams and one third of sediments do not reach the seas. These large scale disruptions are impacting fish migration, life cycles of aquatic species, riparian biodiversity and habitats, flood plain connectivity and even nutrient discharges that support marine biodiversity. Large dams have been equated to economic development of a nation. Today more than 50,000 dams dot river basins the world over. India has crossed 5000 dams mark being the third largest dam builder in the world. Dams create direct loss of prime forests, riparian tracts and farm lands by submergence. While extent of forests and farm lands lost to dam projects are documented to some extent, the extent of biodiversity loss is poorly assessed. Very little documentation exists on the pre - dam biodiversity status of rivers either. The impact of damming and altered river flows on downstream freshwater biodiversity and dependent livelihoods at a river basin level is totally missing in EIA assessments. Recent estimates reveal that out of the 472 million river dependent people all over the world who have been affected by the blocking and altering flow patterns created by dams downstream affecting fisheries, flood plain farming and delta dependent livelihoods; 122.6 million alone are from India! Environment Impact Assessments used as tools to assess the potential impacts of a dam on the river biodiversity, ecosystem and river basin communities and to arrive at the best checks and balances in development choices have proved a failure. EIAs have been mostly restricted to immediate project related impacts and rely on false and fabricated data. Biodiversity impacts are downsized. EIA studies seldom involve or include river dependent communities in the impact assessment. While the EIA process and the EIA Notification are being challenged in the courts and public forums, it is yet to make major impacts at policy level. The need for river basin level EIAs, cumulative impact assessments, inclusion of loss of livelihoods also as displacement apart from physical displacement alone which in turn is related to loss of biodiversity and inclusion of environmental flows as a critical component while assessing the feasibility of dam projects is highlighted. There is a need for reviewing new dam projects within the larger framework of the biodiversity and catchment status of the river basin, the development pressures already operating in the river basin and the downstream impacts and dependence. An economic assessment of river and biodiversity dependent livelihoods that will be impacted by dams needs to enter into the overall cost – benefit analysis of dam projects. For already dammed rivers, allowing environmental flows for the sustenance of the river biodiversity and dependent livelihoods needs to be included in the policy framework.





HUMAN-WILDLIFE CONFLICT IN WWF-INDIA LANDSCAPES: PRESENT SCENARIO AND WAY FORWARD

03 12

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In largely human dominated landscapes, the interaction between human beings and wild animals has become hostile in the recent years. The reason is attributed to a rise in human populations and degradation of wildlife habitats. Often wild animals which are somewhat safe in the Protected Areas come out in search of food or for migration and come in conflict with human beings. The animals in question include large mammals like tiger, lion elephant, rhino, leopard, snoleopard, nilgai, gaur to smaller mammals like macaques, wild boar, porcupine and even squirrels and birds. Tiger and leopard attacks on humans or livestock cause anger and resentment and lead to retaliatory killings that not only decrease these big cats' populations but also heighten negative perceptions of wildlife conservation in general. Crop depredation by elephant, rhino and other large herbivores and accidental killings of human beings by elephants have the same effect. WWF-India is working for mitigation of human-wildlife conflict through its species and landscapes programme. More than 1200 cattle have been reportedly killed by tigers and leopards around the Corbett Tiger Reserve in the Terai Arc Landscape during 2010. A total of 135 cattle lifting by tigers have been reported from the Kanha-Pench corridor. The intensity of cattle death is less around the Dudhwa Tiger Reserve in the same landscape. However, the share of human deaths is greater around the later. Reportedly two people are attacked by big cats per month around the Katerniaghat Wildlife Sanctuary that is located within this Tiger Reserve. Fringe areas of Kaziranga Tiger Reserve reports more than 100 cattle lifting per year. Study of snow leopards in Kargil, J&K by a WWF field biologist showed that domestic cattle comprise 45% of the diet of snow leopard. In the Terai Arc, Satpuda Maikal, North Bank and Kaziranga-Karbi Anglong landscapes and, around Ranthambhor, WWF is paying immediate financial compensation for cattle deaths due to big cats' attacks. A bigger threat is coming in the way of human deaths in the hands of big cats, as people have become impatient. Various methods to mitigate conflicts have been tried - including vigil, walls, electric fencing, cattle proof trench, kunkis, chilly rope, blinds, insurance, improved animal husbandry measures have been tried and have their pros and cons. Of late, controlling mob in conflict areas has become a headache for both district administration and forest department; NGOs can do very little in these cases. There needs to be policy level decisions adopted nationwide to tackle this over long term.





DIVERSITY AND COMMUNITY ABUNDANCE OF DIPTERANS (INSECTA: DIPTERA) IN THE POLLUTED VELI-AKKULAM LAKE

03 01

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The drastic impact of sewage such as domestic wastes and municipal wastes in the water quality, diversity, distribution and abundance of the aquatic insects of the Class Diptera was investigated in the polluted Veli-Akkulam lake, Trivandrum city, Kerala from November 2008 to October 2009. Six sampling stations were selected along the lake for monthly analysis. Water quality parameters such as water temperature, pH, dissolved oxygen, conductivity, Total hardness, Total alkalinity, dissolved carbon-dioxide, nitrates, nitrites and phosphates for all the six stations were analysed according to standard methods of APHA. The fauna was collected with D-Frame dip net and kick net. The samples were hand picked and preserved in 95% ethyl alcohol and identified. The diversity and distribution of Dipterans were dominated throughout the lake represented by the organisms coming under 9 families such as Culicidae, Chironomidae, Enphydriidae, Stratiomyidae, Syrphidae, Tipulidae, Sciomyzidae, Tabanidae and Empididae. Of these, Culicidae and Chironomidae were abundantly found in station 5 and station 6 followed by Stratiomyidae and Syrphidae indicated the deteriorating water quality in Akkulam lake. Both these stations recorded the lowest value of oxygen and highest amount of dissolved carbon-dioxide. The presence of faunal similarities among the stations showed that the regions of the Veli lake close to the bar mouth with the Arabian Sea were comparatively less polluted than the other stations associated with Akkulam lake. This was supported by multivariate comparison of species abundance and water quality parameters. The majority of Diptera associated taxa predominated in the system favoured extreme pollution throughout the whole sampling period changing the lake from eutrophic to hypertrophic condition.





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Many indigenous and local communities live in areas where significant biodiversity resources are found. They are custodians of biodiversity and have the inalienable right and responsibility to continue to manage, save, exchange and further develop the biodiversity under their custody, over and above any external commercial interests. Biodiversity based and sustainable agricultural systems which are under the control of local communities and should be adopted and promoted as the principal mode of agricultural and other food production. The community rights over biodiversity and indigenous knowledge are collective in nature and therefore cannot be privatized or individualized. Governments should have the central responsibility to develop and implement policies, legislation and research and to redirect these towards a holistic approach to development, the promotion of local control over resources and the active participation of local communities, farmers and indigenous peoples in decision making. Protection of human subjects in genetic research is a human rights issue, requiring carefully crafted social policies and laws which are stringently monitored and enforced to protect individuals and groups from exploitative research and practices. Reminding everyone that the current dominant models of development driven by economic liberalization and corporate control which reinforce social inequalities throughout the world and undermine the sovereignty of nation states to take care of their peoples.

Therefore, we need a new vision for biological diversity in health planet and sustainable future for mankind. Biodiversity and ecosystem changes could be prevented or significantly reduced or even reversed if strong action is initiated urgently, comprehensively and appropriately at international, national and local levels. Hence, the present article highlights the various implications for biodiversity development in India.



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The Convention on Biological Diversity (CBD), 1992, is the first-of-its-kind comprehensive approach to the conservation of earth's biodiversity and sustainable use of biological resources. In pursuance to the CBD, India enacted the Biological Diversity (BD) Act in 2002, and notified the Biodiversity Rules in 2004. The process of drafting the BD Act took ten years from the time India signed the CBD in 1993. The Act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable and just manner. Under the Act, a three tiered structure is formed at the national, state and local level: a National Biodiversity Authority (NBA) based in Chennai at the top tier; State Biodiversity Boards (SBBs) in every state occupying the second tier; and Biodiversity Management Committees (BMCs) at the panchayat/municipality levels – the third tier. One of the mandates of the SBBs is to prepare People's Biodiversity Register (PBR) for each Panchayat involving the local communities. India, an identified mega-diverse country, is rich in biodiversity and associated traditional knowledge. The Indian peninsular region, including the four states of Karnataka, Kerala, Tamil Nadu and Andhra Pradesh, have a great wealth of biodiversity in its forests, wetlands and marine areas. The paper will review the current status of biodiversity in the aforementioned Indian states, and assess the management of biodiversity conservation in the region. It does not seek to critically assess the law, but will examine the implementation of the BD Act and BD Rules in the four southern states since its introduction in 2002. The study will facilitate a larger process of tracking the implementation of the BD Act. In order to put this document together, information has been gathered through primary and secondary sources. The methodology includes accessing information from the websites of the NBA and SBBs. Gaps in information is filled in through direct correspondence with representatives of the authority/boards. The paper will concentrate on the status of biodiversity conservation in the study region as mentioned above, and will highlight on the following aspects: Status of implementation of BD Act and BD Rules, NBA – expert committees, status of approvals, SBBs – formation, agenda, major concerns, BMCs - composition of BMCs, documentation of PBRs, status of species diversity (endemic species, threatened species, etc.), Protected Areas Network, case study on access and benefit sharing to local communities, status of conservation of agro biodiversity, implementation timeline of the BD Act and BD Rules, enforcement of international biodiversity programmes and conventions where India is a party. Evidently, the management of biological resources and related knowledge, by the southern states, is assessed in this paper. This was deemed necessary because the neoliberal paradigm of 'development' often happens to ignore the concerns of communities or even biodiversity conservation. This paper in many ways is a critical part of a process of systematic tracking of the BD Act in the aforementioned region over the last eight years of its existence.





IBC 2010 - India Biodiversity Congress

BIODIVERSITY STUDY AND RESCUE PROGRAM OF HOCIM LANKA LIMESTONE EXCAVATION SITE IN ARUWAKKALU, PUTTALAM DISTRICT IN SRI LANKA

03 04

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The biodiversity survey at the Hecim excavation site (HES) was undertaken to fulfill the objective of reducing impacts on natural ecosystems. The present survey conducted in the proposed areas of the quarry site prior to excavation and blasting, intended to systematically record the biotic elements within it, which is critical for the management of the HES. Specific objective of the project was also to rescue certain plants and animals, particularly the less mobile species such as herpetofauna and rare species, during the survey and to release them into other suitable areas within the HES. Through this rescue programme it was attempted to minimize damages to the local faunal populations. This survey and rescue programme of the proposed quarry site was conducted during the months of October to December 2009. The survey was conducted over 20 field days. Five strip transects each of 100 × 5 m² size were then randomly located within this area and animals primarily surveyed using the Visual Encounter Survey method conducted during both day and night. The Quadrant Cleaning Method, where the litter is systematically cleared and searched. Additionally, two pit-fall traps were placed along each transect and were checked twice a day for captured animals. The HES mainly consisted of the typical dry mixed evergreen forest dominated by the two species *Mimosop hexandra* and *Drypetes sepiaria* trees. However, results revealed that *Mischodon zeylanicus* was the most common tree out of the 26 species. A total of 157 species of vertebrates and 51 species of butterflies were recorded from HES. According to the results, 16 species are endemic, whilst 7 are nationally threatened. Vertebrates comprised 15 amphibians, 41 reptiles, 74 birds and 27 mammals. Also large numbers of animals (226 individuals) were rescued during this operation. That the survey has indicated the HES has great significance in terms of biodiversity since it supports a rich assemblage of both flora and fauna. Nevertheless it should be noted that this survey was only a preliminary study, which was based on rapid assessment techniques. Therefore we recommended long-term surveys good assessment of the biodiversity in the area. Habitat destruction and disturbance caused by blasting and excavation remain the predominant threats to the biota of the HES. Settlers in buffer zone areas, security personnel and local governmental authorities have little awareness of the biotic richness of the quarry site and are hence insensitive towards the need to conserve it. The integration of awareness programmes into conservation and management plans will without doubt facilitate better management of the HES and its biodiversity.



2010 International Year of Biodiversity



IMPLICATIONS OF TRAWLING ON MARINE ECOSYSTEM OFF WEST BENGAL

03 05

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Commercial fishing plays an important role in the economy of West Bengal providing a profitable source of employment and an indispensable animal protein to Bengali diet. Great marine ecology along the coastal strip of West Bengal including largest mangrove foodweb of the world in 'Sundarbans' (World Heritage Site, 1989) exhibits an excellent breeding ground of uncountable varieties of macro and micro marine species. Growing population has caused intensification of trawling by commercial fishermen, MNCs and even local poor all along West Bengal offshore. This paper highlights a case study of Shankarpur-Digha fishing zone where modern bull trawlers use to drag bigger trawl nets through ocean bottom to obtain huge commercial catch destroying under-sea habitat of many micro-species. Methodology followed experimental sampling of benthic fauna at the depth of 35 and 38 feet offshore of Shankarpur and Digha, identification of discards by Z.S.I and assessment of impact on marine foodchain. As the result of case study, commercial trawling has destroyed many ecologically important marine juveniles belonging to primary and secondary trophic levels of marine food chain i.e. sting ray, cat fish, flat fishes (flounders, soles), silver belly, clupeid fish, halibut, skate, gastropod (*babylonia spirata*), sepia, loligo, squid, mud octopus, nudibranch, sea urchin, sea anemone, squilla (mantis shrimp), protunus crab, gobid fish and marine crab (*doclea ovis*). Loss of these species seems to have already created big crisis of food for a large number of predators in tertiary trophic level whose sustenance is suspected to be at stake i.e. sea snail, sea spider, gray sea slug, starfish, sea otter, cuttlefish, ocean pikes, eel, commercial fish & prawn, finfish, barracuda, pinnipeds and marine birds. Resultantly, top consumers or apex species of marine food chain i.e. shark, dolphin and seal too face food crisis. Finally, the humans solely depending on seafood will be the worst sufferer. Thus, this ecological implication opens up the biodiversity and development paradigms proving the economic development gained at the cost of biodiversity loss. Millions of poor aborigines of coastal Sundarbans living far below poverty line, specially females and minors have no other way of sustenance than the massive year round collection of wild prawn spawns from tidal influx unscientifically by mosquito-nets, destroying instantly huge number of spawns of non-target species simply by throwing those on open coastal sands (M.Das, 2002). Wild spawn collection illegally by digging *chouko* (meaning 'square') along coastal Freshergunj has also been recorded (M.Das, 2010). These have proved poverty and biodiversity inversely related in coastal Sundarbans off West Bengal showing significant social implication of biodiversity. This massive destruction of seedlings seems to be the root cause of total extinction of commercially valuable fish species, i.e. *Chandana Hilsa*, last appearance recorded 20 years back by all experienced fishermen, sea conch, *pangas*, *chiruni*, shark becoming endangered and local estuarine species, i.e. *nados*, *khalisa*, *pabda*, *tapse* becoming commercially depleted very fast (M.Das, 2002). This paper also discusses about an effective Environmental Management Plan to implement restrictions on trawling, substitution with trammel net, ban on wild collection of spawns, proper economic rehabilitation to local aborigines, etc. in order to make balance between ecology and economy ensuring conservative use of marine resources towards sustainable development of littoral and infra-littoral habitat ecology of West Bengal.



JATA, A NEW TROPICAL TASAR BIODIVERSITY OF *ANTHERAEA MYLITTA* DRURY (LEPIDOPTERA: SATURNIIDAE) – IN NEED OF CONSERVATION TO SAVE FROM LOCAL EXTINCTION

03 06

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India is known for the production of mulberry, eri and muga silks, besides a unique tasar vanya silk of high global demand. The tasar silk is produced by *Antheraea mylitta* Drury, a wild tropical sericigenous insect, (Lepidoptera: Saturniidae) commercially exploited in central India having its distribution 11-31°N latitude & 72-96°E longitude touching the Himalayan range in North, Kerala in South, Rajasthan in West and Nagaland in East, covering tropical forests of Andhra Pradesh, Bihar, Chhattisgarh, Jharkhand, Orissa, Maharashtra, Madhya Pradesh, Uttar Pradesh and West Bengal states. This polyphagous insect feeds primarily on *Terminalia tomentosa* (Asan), *Terminalia arjuna* (Arjun) and *Shorea robusta* (Sal), besides a variety of secondary and tertiary food plants. The sericigenous species with continuous generations have adapted to different eco-geographic niches and formed in to forty four ecoraces with varied phenotypic traits and behavioral characters. The nature grown cocoons of Raily, Modal, Sarihan, Laria, Bhandara and Andhra local wild ecoraces, besides reared cocoons of semi-domesticated and commercially exploited Daba and Sukinda ecoraces are contributing for silk production, employment, livelihood and alleviating socio economic status of two and half lakh tribal families in the country. Apart existing ecoraces, a new wild univoltine race, *JATA* with superior cocoon traits, noticed under *in-situ* habitat of Thakurmunda, Simlipal biosphere of Orissa state. The extensive collection of its nature grown cocoons for profitable gain with better cocoon price has depleted the race population. Further, the deforestation, anthropogenic encroachment of tasar habitats for land use, induction of alien species, controlling related pests and predators for commercial advantage, polluting the ecozones through mining and faster climate change in recent years have endangered this ecorace and even few others. So, the imperative need is to educate the native tribal rearers for rational collection of cocoons from the *in-situ* habitats with simultaneous stabilization efforts under *ex-situ* to conserve this vulnerable tasar biodiversity from local extinction, as the tasar activity being their cultural heritage. The sericulture departments, rural development and tribal welfare schemes of tasar practicing states, central silk board and some NGOs, although promote conservation of tasar ecoraces, it could upkeep the tasar insect biodiversity only to limited extent. Further, the impact of conservation, population expansion, constraint detection and rectifications found inadequate due to several limitations in approaching conservation sites as per need. However, by involving the Vana Samrakshana Samithi (VSS), a self help group, with their better indigenous knowledge and access to tasar habitats, as many of its members being tasar rearers, can facilitate conserving *JATA* ecorace biodiversity as valuable forest resource. This conservation not only sustains the levels of tasar insect population but also augment the forest biodiversity and ecological equilibrium by default.



MAINSTREAMING BIODIVERSITY CONSERVATION: ISSUES AND PERSPECTIVES

03 07

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Today with enhanced focus for biodiversity conservation, environmental health and sustainable ecosystems, the context and relevance of forest & wildlife management has metamorphosed itself into a larger concept of an 'inclusive' management agenda. The management of these immensely valuable resources spread over 23% of the geographical area of the country cannot be efficient in fragmented landscapes under isolated domains of a few agencies. The new dimensions of management in the changed scenario prompt to revisit the existing policies, mandate, role, responsibilities and institutional frameworks of key agencies affecting and or influencing the outcome of the management. The cause & effect attributes of biodiversity conservation and sustainable use of natural resources are crucial to enhance the level of understanding of critical issues confronted and resolving persistent conflicts among key stakeholders. The imperatives of inclusive agenda may not be realized merely through the simple co-ordination mechanisms for inter and intra stakeholders co-operation as being currently emphasized. The alternative approach may be to empower the stakeholders to manage natural resources in equal partnership of governments and local level institutions with defined level of responsibility both for management action and results. The prospects for an integrated and adaptive management action at a larger scale of management under this approach can be significant than the business as usual. It may be a slow process to initiate but continued involvement will make the stakeholders including the forest departments to develop a shared vision, decide goals for conservation and formulate a road map for achieving the goals through mutually agreed plans and joint implementation. Management capacities of stakeholders for joint planning and implementation will need a priority focus. The policy prescriptions may need revisions to support bold decisions for establishing unified line of direction, co-ordination and control mechanisms at appropriate levels of the evolved frameworks presently lacking in many multi sector participatory biodiversity conservation initiatives. This in turn will enable these arrangements to deliver beyond advisory action and graduating to a transparent, flexible and innovative institutional model for mainstreaming biodiversity conservation.





SEA LEVEL RISE: A HOLOCAUST TO MIGRATORY SHORE BIRDS

03 08

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The rapid changes of tidal flats have resulted in a direct impact of coastal life forms as declining the bottom substrates and trophic structures. Initial surveys made in the six tidal flats of east coast of Tamilnadu and Pondichery state during 1999 and reported 26 migratory shorebird species and subsequent continuance of survey during 2000, 2001 and 2002 reported shorebirds species richness of 21, 19 and 17 respectively. But in recent months from September 2008 to March 2009, bird censuses were made in the same tidal flats and the result is shocking and in which only 7 species of migratory shorebirds were recorded during 2009. The main observation was that many migratory shorebirds avoided these tidal flats, but in the earlier, it was reported as one of the stop over site and intensive foraging grounds for migratory shorebirds during migratory season. Furthermore, current benthic sampling had just 2-5/m² benthic forms, whereas in earlier report it was 80-320/m² benthic prey forms. There was a strong correlation between the density of shorebirds and quantity of benthic forms ($P < 0.05$). This indicated that within ten years, there were rapid changes occurred in these tidal flats and shorebird population. Our study indicated that the remarkable changes occurred in the tidal flats due to the degradation of coastal wetlands with the effect of global climatic changes.





SPATIAL DROUGHT ANALYSIS FOR NORTH-EASTERN DRY ZONE OF KARNATAKA

03 09

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The identification, monitoring and characterization of drought are of great importance in water resources planning and management. Drought is considered by many to be the most complex but least understood of all natural hazards affecting crops than any other hazard. Drought is a normal feature of climate and its recurrence is inevitable. However, there remains much confusion within the scientific and policy making community about its characteristics. Drought can be characterized using different drought indices, among them Standardized Precipitation Index (SPI) was one index to identify drought which was calculated from the probability distribution of precipitation, using a two-parameter gamma function. The SPI methodologies were applied for daily rainfall data for the period from 1976 to 2003 for 56 rain gauge stations coming under the zone. SPI was used to calculate extent of degree of dryness/wetness by using daily rainfall data for the study period and calculated SPI values were categorized as extremely wet, very wet, moderately wet, near normal, moderately dry, severely dry and extremely dry. Area of influenced by different rain gauge stations coming under north eastern dry zone are demarcated by employing Thiessen Polygon Method. A set of four exclusively maps of northeastern dry zone for the month of June, July, August, September were derived by showing frequency of occurrence of SPI categories for specified months from 1976 to 2003. The values of degree of dryness or wetness which occurred over the period of 28 years were worked out as per SPI and these result values obtained during these years of analysis were categorized as per the SPI. By examination these maps, it was found that areas of influenced by Raichur (54.0km²), Raichur RARS (187.2km²), Yadgir (140.4km²) and Gurumitkal(378.0km²) rain gauge stations were more seriously affected by drought randomly. The SPI as drought index, which is used by most of the research workers, can give better representation for quantifying in terms of spatial and temporal scales. The drought severity in terms of frequency were identified for area of influence by different rain gauge stations using SPI as index can give a better understanding of spatial characterization of any region. Drought mitigation measures based on the severity of dry spells over the study period in different sectors demarcated by this study were also prescribed for different regions of the study area like *in situ* moisture conservation in moderate to severely drought areas by land shaping, construction of bunds, farm ponds etc., as well as arranging rubbles across the slope at a vertical interval of 0.3 m in medium and deep black soils.



PEOPLE PERCEPTION ON GENETICALLY MODIFIED FOODS IN KARNATAKA

03 10

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Technologies for genetically modifying (GM) foods offer dramatic promise however with some risks, known and unknown, related human and environmental safety. The service were held in the environs of large groceries stores, shopping malls and market places from people of both sexes representing different economic and social strata belonging to 25-30 years of age and working in Govt./Private sector and housewife/ students. The results reveal that younger generations concerns on environmental concerns flexible to give up traditional values. Since these food products are uncertain impact on nutrition, health and environment, majority of the respondents wish to go for non-GM Indian food products and strongly recommend to label the GM food, if they entered the Indian market. Though, there is no scientific proof of any negative impacts of GM foods, respondents strongly willing to have environmental friendly produced nutritionally rich, quality products. If the GM products with good quality entered the market with low price than the regular food, men in lower income group oriented to procure than women respondents. If the GM food produced with nutritionally rich, long shelf-life and produced with lower use of chemical fertilizers and pesticides, respondents are ready to buy at same or higher/lower price than normal food.





ANTHROPOGENIC THREATS TO FISH BIODIVERSITY OF PERIYAR LAKE, A WESTERN GHATS HOTSPOT

03 11

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The Periyar lake stream system, spanning an area of around 26 sq.km is one of the hotspots for fish biodiversity in the Southern region of Western Ghats. For past few decades, Periyar lake has turned out to be a chosen tourist destination. The present study was conducted to study the status of fish biodiversity in Periyar lake with a view to delineate the possible impact of human interventions in this rather fragile ecosystem. Six stations in Periyar Lake were fixed for bimonthly sampling surveys giving representation for the three seasons (Monsoon, Post Monsoon and Pre-monsoon) during September to February. Stations 1 to 4 were in the main boat channels through which indiscriminate plying of motor boats are taking place for facilitating sightseeing for tourists. Station 1 was also where the domestic sewage from the urban areas at the west end of the lake is getting discharged. Stations 5 and 6 represent undisturbed regions, at the remote areas of the lake, and were treated as control stations in order to compare and quantify the extent of pollution caused due to tourism. Various physico-chemical parameters such as temperature, pH, dissolved oxygen, Turbidity, Acidity, Hardness, Alkalinity, Total dissolved solids, BOD, nutrients, trace metals, pesticide and total faecal coliform in water was measured periodically. Primary productivity, estimation of phytoplankton and zooplankton were also done. Experimental fishing was done in all the stations. Catch per unit effort of the commercially important fishes caught in gillnets were estimated. Individual length, weight and gut content analysis of fishes caught were also performed. Schoener Index of Proportional Overlap was employed to statistically quantify diet overlap. Results showed that among the 36 species of fishes recorded from the water body, seven (*Lepidopygopsis typus*, *Hypselebarbus micropogon periyarensis*, *Puntius ophiocephalus*, *Crossochilus periyarensis*, *Nemacheilus periyarensis*, *Nemacheilus menoni* and *Garra periyarensis*) are strictly endemic to this water body. However, results of present study showed these species were facing endangerment due to various types of human interventions the lake is prone to. While evaluating the status of the above species as per IUCN criteria, all of these were categorized as critically endangered species. Results of food overlap showed high possibilities of competition for food among *O. mossambicus*, *L. typus* and *H. fossilis* and between *C. carpio*, *H. curmuca* and *T. khudree*. The major biodiversity threats identified in the Periyar lake were ever increasing levels of various pollutants arising from plying of tourist boats, dumping of sewage from Kumily town, invasion of exotic fishes such as *Cyprinus carpio* and *Oreochromis mossambicus*, perennial draught and the consequent water shortage, fish diseases etc. The proposed paper also throws light on various means for the conservation of these rare fish fauna, facilitating the policy makers to draw a master plan specifically to Periyar lake for mitigation of pollution and other anthropogenic interventions and thereby to maintain the unique aquatic biodiversity of the lake.



BIODIVERSITY ASSOCIATED WITH ARTIFICIAL SEA WALL – A CASE STUDY AT VIZHINJAM, KERALA

03 12

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The artificial sea wall built for the purpose of protection of shores as well as for protecting ports and other structures in the coastal zone, may be capable of supporting a significant proportion of regional aquatic biodiversity. Artificial structures may support various assemblages of organisms as they act as a mimic natural habitat. Detailed studies were not done in India to realise the biodiversity supported by artificial sea wall as alternative to natural coastal habitats such as rocky shores. Vizhinjam Bay in Thiruvananthapuram district of Kerala ($8^{\circ} 20' 30''$ N and $76^{\circ} 59' 15''$) is protected by the break water system which is made of granite stones and concrete tripods. The biodiversity associated with the artificial sea wall was surveyed by regular weekly sampling during the year 2009 by quadrat method. The biodiversity associated with the artificial sea wall at Vizhinjam was represented by 86 species, including 13 species of sea weeds, one species of sponge, 2 species of cnidarians, 2 species of bryozoans, 1 species of platyhelminthes, 22 species of molluscs, 6 species of annelids, 6 species of isopods, 10 species of amphipods, 8 species of brachyuran crabs, 2 species of alpheid shrimps, 1 species of barnacle, 6 species of echinoderms and 2 species of ascidians. *Phidiana militaris* Alder & Hancock (Mollusca, Gastropoda; Nudibranchia), *Cyathura rudloei* Kensley (Arthropoda, Isopoda, Anthuridae), *Liomera erythra* (Langhester), *Micropanope obtusidens* (Sakai), *Pilumnus tomentosus* (Latreille), *Hyastenus diacanthus* (de Haan), *Sargassocarcinus cristatus* (Bass) and *Eurynome orientalis* (Sakai) (Arthropoda, Branchyura) and *Synalpheus cf stimpsonii* De MaN and *Alpheus lottini* Guérin-Méneville (Arthropoda, Decapoda, Alpheidae) were reported for the first time from Kerala coast. The Shannon index of diversity recorded a total value of 3.26; algae recorded higher diversity values, followed by various groups of arthropods (isopods, amphipods and crabs). The richness index was 8.64, with Cnidaria, Isopoda, Amphipoda and Brachyura recording higher richness index values. The dominance index recorded was high (3.81) and dominated by sea weeds, followed by Porifera, Mollusca, Annelida, Isopoda, Amphipoda, Anomura and Brachyura and Tunicata. The evenness index recorded was 0.76. The results of the study showed that the artificial structures in marine environment may support higher diversity. In India the artificial structures built in the marine environment are not designed or managed for the habitat they provide, and are built without considering the communities of marine organisms that could colonize them. The need for improving the design and layout of the artificial structures for enhancing biodiversity that they can support is discussed in the paper.





AN 'SOS' FROM THE BIRDS OF PICHAVARAM MANGROVE WETLANDS

03 13

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The Pichavaram mangroves and associated wetlands (11°26'N, 79°48'E) are situated at the mouth of Vellar, Coleroon and Uppanar rivers in Cuddalore district on the Coromandal coast of Tamil Nadu. It is the second largest mangrove in India which has more than 100 years of natural history. This mangrove wetland supports unique wildlife, especially the migratory birds. Unfortunately the literatures regarding the birds of Pichavaram wetlands are scanty till date. The first long term avian ecology study was carried out by Sampath (1984 -88) after two decades mine is the second long term study (2004-2007) in this area. I compared the results of Sampath with mine and found that, there was a striking decline (43%). In terms of number of species in families, 100% decline was noticed in Podicipedidae, Phoenicopteridae, Falconidae, Haematopodidae, Glareolidae, Capitonidae, Pittidae, Lanidae, Campephagidae, Irenidae and Dicaedidae. On the other hand, Anatidae (89%), Muscicapidae (75%), Threskiornithide (67%), Ploceidae (66%) are the other families which showed major decline. During my course of investigation I noticed several anthropogenic pressures prevail in these wetlands including habitat conversion, poaching, cattle grazing, overfishing and ecotourism. Moreover every alternative year the Pichavaram mangrove is affected by tropical cyclones. The combination of anthropogenic pressures and natural calamities might cause the decline of bird species in this area.





IBC 2010 - India Biodiversity Congress

IS NATURE TOURISM OPTION AS A POSSIBLE TOOL FOR DOCUMENTING AND CONSERVING LOCAL BIODIVERSITY?

03 14

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The priority of humans of any developing country is source of income. Every planning and strategy will prove to be successful only if it generates income for the local community. The natural setups of many developing countries are becoming a source of income for local people through nature tourism. India is one of the 17 megadiverse countries and there is lot of scope of nature tourism in this country. There are many sites, not covered under protected area network, harbor diverse flora and fauna. It is very difficult to document the diversity of such a large country without involvement of local community. Nature tourism could prove to be one of the effective tools for documenting and conserving the local biodiversity. It is necessary to recognize those spots and prioritize as according to their regional, state, national and international importance for the conservation. Presence of local species of flora and fauna at the place was considered at the priority level for promoting nature tourism. The rarity of the species would be great advantage. Beside these, the easy sighting of species of interest at the same place could be another factor deciding the importance of place for nature tourism. The matching of timings of maximum tourist influx with the comfortable accessibility and sightings of important fauna were added feature for identifying the site for nature tourism. The place which is identified as one of the potential site for developing nature tourism in Rajasthan, viz., Abu Hills, Sirohi (Rajasthan, India) has diversity of habitats which harbor variety of fauna especially avifauna. The paper presents the case study of one the initiative taken by young members of Rajputana Society of Natural History (regional NGO), to conserve the habitat of globally threatened bird species Green Munia (*Amandava formosa*) and document the local species through mass involvement. On the basis of approach used by the RSNH team at Abu Hills to conserve the habitats of globally threatened species, the impacts of tourism promotion were discussed along with the strategy and methodology used for the training of local youth for documentation of species and conservation of the habitat. Every NGO has the potential to work effectively to achieve successful results; it depends on its networking and the depth of the grass root actions. Involvement of the local community is the most important factor in achieving the goal of conservation. The conclusions were drawn on the basis of this study that conservation of any species and/or habitat through mass involvement is possible only when it is associated with employment and income generation source for the local community.



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IMPACTS OF DAM CONSTRUCTION ON PISCINE FAUNA – A CASE STUDY OF KAKKAD RIVER.

03 15

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Along its entire 1600 km length, the Western Ghats hill range has one discontinuity, the Palghat gap, which divides it into two parts south and north of the Palghat gap in Kerala. Natural topographic features such as mountains and valleys divide the Southern Western Ghats into a number of divisions. The important geographic divisions are . 1. Agasthyamali range 2. Pandalam hills, 3. Palghat hills, 4. Cardamom hills, 5. The High Ranges, 6. Nelliampathy, 7. Nilgiris, 8. Wayanaad and 9. Brahmagiries. The Kakkad river is in the Ranni forest division under Pandalam hills. Pampa is the third longest river in Kerala and is formed by the confluence of the river Pampaar, Kakkiar, Arudaia and Kakkad river. Pampa takes its origin from the watershed areas of Sabarimala. Sabarigiri hydro- electric project is constructed across this river. For this, water from pampa river is collected by Pampa dam. Water from Pampa dam is carried to a flank dam at Anathodu through a tunnel. This water as well as water from the Kakki dam constructed at Kakkiyar is carried to Moozhiyar power station, which was commissioned in 1963, through 3 penstock pipes. After generating electricity, formerly the water was released to the Kakkadar which flow through Angamoozhy, Seethathodu, Perinadu and joins Pampa river at a place called Poovathummoodu. Studies on water quality and production parameters were conducted during January 2005-February 2006. Seasonal sampling based on pre monsoon, monsoon and post monsoon were carried out at the 4 Stations in the river. A total of 17 species belonging to five genera were received, out of which 5 were endemic and 7 were threatened. . The most abundant species was *Puntius fasciatus* followed by *Gara mullya*. Fishes belong to Cyprinidae, Bagridae, Balitroidae, Mastacembelidae and Siluridae The loach found in Kakkadar is endemic to Western Ghats. Among the 11 cyprinids 4 are endemic to Western Ghats. The spiny Eel *Mastacembeles armatus* is a threatened fish. *Puntius melanampyx* is found in shallow, slow flowing waters. *Puntius curmuca* is another endemic species. Still water fishes usually found in hill streams of Western Ghats such as *Aplocheilus* and *Channa* species were not encountered in the present study. Cat fishes were generally scarce. A general species reduction along the length of the river and an impoverished ichthyofauna in the present study area can be related to the presence of Moozhiyar dam and diversion of water that comes out from the dam to Kakkad Power Station through huge pipes. This diversion of water that comes out of the Moozhiyar dam to Kakkad Power Station resulted in deprivation of water along this stretch of the river. Construction of dam also might have affected the migratory patterns of fishes but more studies are required to establish it.





CONNOTATION OF MINOR MILLET BIODIVERSITY AND INDIRECT PAYMENTS IN TRIBAL HOMESTEADS IN THE BACKDROP OF CLIMATE CHANGE

03 16

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Unscathed agrobiodiversity remaining in-situ today is found on the small-scale farms and homestead gardens of poorer and developing countries. The indigenous traditional farming of Muthuvan tribe as the case of Ragi (*Eleusine coracana*) a minor millet cultivated in the Western Ghats in Kerala in the Indian South is a classic example for in-situ agrobiodiversity management based on organic farming systems. On such fields, the use of labour intensive, traditional production techniques have persisted throughout the period of controlled state farming and the market based large-scale farming. The Homestead gardens close to fringes of 'South Western Ghats-the hotspot of biodiversity' also play a crucial role in tribalistic context, by contributing to the rural livelihoods in time periods and locations when markets or state institutions do not. This paper attempts to analyse the opportunity costs of organic minor millet cultivation incurred by indigenous tribe in scheming compensations for biodiversity conservation. It further discusses possibilities to deliver a tangible and hopeful alternative towards sustainable livelihood in the backdrop of climate change. The methodology involves understanding the relevance of opportunity costs involved for organic farming of underutilised minor millets in the tribal homesteads and is equated in terms of (incentives by organic certification) indirect payment for biodiversity conservation. The analysis of results concludes the importance of creating incentives for the conservation of agrobiodiversity, especially the on-farm diversity of underutilised crops and supporting poverty alleviation, and preventing welfare losses among vulnerable communities.





A STUDY ON DETRIMENTAL EFFECT OF DEVELOPMENTAL ACTIVITIES ALONG COAST AND OFF-SHORE WATERS OF ORISSA - AN OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) SEA TURTLE PERSPECTIVE

03 17

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Olive ridley is an endangered species and nests in mass on coastal beaches of Orissa. There are three mass nesting grounds such as Gahirmatha, Devi and Rushikulaya in India are all located in the State of Orissa. There are several coastal developmental activities (chemical industry, ports) including oil exploration in the offshore of Orissa initiated in the recent past. In connection to this, study was conducted to understand the detrimental effect of these coastal developmental activities on the long term conservation of Olive ridley sea turtles along Orissa from October 2006 to November 2010. We fixed 62 platform terminal transmitter (PTTs) on ridleys to track their movements and habitat use in and beyond off coast of Orissa. We also studied the extent of various coastal developmental projects on the coastal land near nesting beaches. We found that the breeding population of olive ridley turtles arrive to the Orissa coast in December and remain in the off-shore waters off Orissa from December to April every year in multiple congregation patches along Gahirmatha, Devi and Rushikulaya within 20 kms from the shore with the highest concentrations within 5kms. Their post-nesting migration to the foraging areas from the Orissa coast begins by the month of May with majority of turtles scattered along all along the Bay of Bengal. During June and July they were largely along the Andhra coast but scattered throughout the Bay of Bengal and during August-September they reached the Tamil Nadu and Sri Lankan coasts. Most of the turtles moved within a range of 30 km to 400 km from the shoreline with a mean distance of 214 ± 176 km from shoreline. There are various developmental activities including major ports that are coming up along the Orissa coast which may adversely affect the critical habitat requirements of olive ridley sea turtles. Associated activities of these ports are also bound to influence the turtles and their nesting habitats along the coast. Along with it there are also risks of oil spill and water pollution in these critical turtle areas. Therefore, we have tried to create a 10 km radius core and 15 km radius buffer zones using geospatial tools around three major rookeries to earmarking the area as eco-sensitive and should not to be used for major industrial activities. These buffers are made in compliance to a 2002 directive of the Ministry of Environment, based on the government of India's National Wildlife Action Plan the area falling under these zones should be utilized with utmost caution and care. Our study also identified the temporal and spatial movement pattern of Olive ridley in the Bay of Bengal and these informations would be used while taking up any hydro-carbon related projects in the region.





STANDARDISED PRINCIPAL COMPONENTS FOR VEGETATION VARIABILITY MONITORING ACROSS SPACE AND TIME

03 18

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Vegetation at any given location changes through time (e.g., annual and seasonal changes) and in space (in response to climatic or landscape factors). Knowledge of the change in vegetation, not only *how much* has changed but also *where* and *when* changes have occurred, can help land managers identify sources of ecosystem stress, as well as prioritize management efforts. The present study considers the dynamics of savanna vegetation across spatial and temporal scales in Kruger National Park (KNP) through the use of satellite remote sensing for the time period 1984–2002. Spatial variability of vegetation is a key characteristic of savanna landscapes and its importance to biodiversity has been demonstrated by field based studies. Stronger understanding of the nature of change requires information to be obtained at regional scales and over longer periods of time. The data used for the study were sourced from the U.S. Agency for International Development where AVHRR derived Normalised Difference Vegetation Index (NDVI) images were made available at a spatial resolution of 8 km and at dekadal scales. The study area was extracted from these images available for southern Africa, for the time period 1984–2002. Maximum value composites were derived for individual months resulting in an image dataset of 216 NDVI images corresponding to individual months. Vegetation dynamics across spatio-temporal domains were analysed using standardised principal components analysis (SPCA) on the NDVI time-series, where each individual image's contribution to variability in the time-series is considered. Results demonstrate the variability of vegetation in the study area across space and time. Furthermore, the landscape changes that have taken place in KNP over the 1984–2002 time period can be mapped on to individual principal components (PC). PC1 alone explains 98.57% of the variance and can be considered as the time integrated NDVI response for the study area. Despite the higher loadings for individual NDVI images to PC1 it is possible to distinguish a longitudinal zonation for the study area. This can be taken to support the accepted geological division of KNP into the granitic west and the basaltic east. PC2 illustrates the second most prevalent element of variability that is uncorrelated with the characteristic pattern shown by PC1 and accounts for 0.35% of the variance. PC3 accounts for 0.23% with loadings alternating between positive and negative values, a firm indication of the seasonality component in the data set. PCs 4, 5 and 6 together account for 0.35% of the variance and highlight individual processes operating in the landscape. From the park management perspective, the results demonstrate the utility of SPCA in isolating the influence of ecosystem agents so that site-specific interventions can be initiated. Furthermore, the results highlight the diversity of landscape conditions in the park where vegetation changes in operation in a given zone differ from other zones not only in magnitude, but also in pattern. The results support the ecological zonation of the park and indicate that the park is a constantly changing and evolving ecosystem.



A CASE STUDY ON ATHIRAPPILLY HYDRO-ELECTRIC PROJECT

03 19

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Much havoc has been created over the very controversial “athirappilly hydro-electric project”, which has been debated several times in and outside Kerala. Though it has been proved undoubtedly, that this project would create considerable destruction to the bio diversity and environment of athirappilly, the proposal of the state government to move forward with this project has disheartened the minds of the masses. The proposed dam of 23 metres height and 311 metres length, half a kilometre above vazhachal falls would definitely affect the water flow in the Chalakkudy River and would result in the death of one of most beautiful waterfalls in India. There would be two power houses producing 163MW of electricity and the availability of power per annum would be 233 million units, which the central electricity commission has observed as only 16% of the total established capacity. At present if the project is tendered the expenditure calculated is 800 crores and by the time of commissioning of the project the amount would increase to 1200 crores. People have been protesting against the project the and the chalakkudy river protection forum is now leading the agitations. Two public hearings were conducted and the people have expressed their dissent to the project in these hearings. The Environmental Impact Assessment report has out rightly rejected the implementation of the project as it is hazardous to the biodiversity and ecosystem of athirappilly. About 8 lakh people visit the waterfalls every year. The project will destroy the natural beauty of the falls and it is also important to take into consideration the carrying capacity of the river which has already got 6 dams in it. The implementation of the project would affect 615 lift irrigation projects and 30 drinking water projects situated in Ernakulam and Thrissur districts and moreover adversely affect agriculture spread in 15000 hectares of land. About 75 tribal families will have to be rehabilitated. The 140 hectares of forest land required for the project will be badly affected. The elephant passage and rare riverside forests will become extinct. The rare twittle, 4 kinds of hornbill, tiger and lion tailed macaque are found here which are critically endangered animals according to IUCNN. The Chalakkudy River is an identified fish sanctuary with more than 104 species of fishes and the river is also a crocodile bank. The forests of athirappilly are rich in biodiversity with a variety of species of flora and fauna. It is essential to protect this bio diversity for generations to come and to maintain the ecosystem and ecological balance. The fate of this project now lies with the Gadgil Committee and let us hope that this project, which is socially, economically, technically and above all environmentally not viable would never become a reality.

