

# Bioremediation, Biodiversity and Bioavailability

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**Scope and target readership:** *Bioremediation, Biodiversity and Bioavailability* accepts reviews and original papers that apply ecological concepts, theories, models and methods to the management of biological resources (primarily plant), through the use of applied ecological problems to test and develop basic ecological theory, and primary fields of applied ecology: conservation biology, global change, pollution biology, wildlife and habitat management, land use and management, aquatic resources, restoration ecology, nuisance species, and the effects of genetically modified organisms. *Bioremediation, Biodiversity and Bioavailability* also welcomes papers in chemical ecology that integrate ecology and chemistry in an attempt to increase our understanding of the biological significance of natural products, embracing the evolutionary biology of chemically-mediated biotic interactions (mechanistic approaches and environmental aspects), biotic controls on the chemistry of the environment, geochemical control of the structure and function of ecosystems. Cycles – in particular their controls – are considered, either of individual elements or of specific classes of natural or anthropogenic compounds in ecosystems. Trophic relationships, intra- and interspecific communication, competition, and other kinds of chemical communication in all types of interactions between organisms will be considered, but preference will be given to plant systems. Mechanistic approaches should deal with the identification, biosynthesis and metabolism of substances which carry information and with the elucidation of receptor- and transduction systems, biochemical, molecular and physiological techniques. All aspects of biological diversity, its description, analysis, conservation, management, sustainable development in a conservation framework, and controlled rational use are welcome.

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#### Guest Editors

**Dr. Madhugiri Nageswara-Rao**  
**Dr. Jaya R. Soneji**

**Citrus Research & Education Center, University of Florida, USA**



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## The Guest Editors

**Jaya R. Soneji**



**Madhugiri  
Nageswara-Rao**



**Madhugiri Nageswara-Rao, Ph.D.** and **Jaya R. Soneji, Ph.D.** work in the areas of plant breeding and molecular genetics; functional genomics & biotechnology; plant cell, tissue & organ culture; population, conservation & evolutionary genetics; biodiversity & crop improvement. Currently they are at the University of Florida's (UFL) Citrus Research & Education Center, Lake Alfred, Florida, USA. Together their research work has made high-tech impact and has been appraised and highlighted by International academia and media. They both are authors, coauthors for a number of reputed international peer-reviewed scientific research articles, have contributed many elegant invited book chapters, popular magazine articles and edited international newsletters. They are members of many reputed international scientific organizations such as International Society of Horticultural Sciences, American Society of Plant Biologists, Society for Conservation Biology, The Science Advisory Board, Genome India International, Bioclues: Clues for Innovation, etc. They serve in the '*Executive Committee*' of Genome India International Organization, USA and as '*Young Advisors*' for the BioinfoIndia.org. As individuals, they have got recognized as '*Young Scientists*' by Bioclues: Clues for Innovation and in '*member-in-spotlight*' section of Genome India International. They both have also been featured in the American Society of Plant Biologist-News. The UFL/Institute of Food and Agricultural Sciences International Programs has also appraised their contribution by featuring their scientific achievements in their '*International Focus*'. They are also involved in outreach programs for educating the underprivileged as members of the Samatva Trust and in biological conservation as members of the Biodiversity Conservation and Research Trust. They have been invited to peer-review a number of manuscripts by various prestigious journals.

Dr. Nageswara Rao obtained his B.Sc. and M.Sc. from Bangalore University, India. He was awarded Research Associateship to work on projects funded by the Department of Biotechnology, New Delhi, at the University of Agricultural Sciences, Bangalore. He secured his Ph.D. from Forest Research Institute, Indian Council of Forestry Research and Education, Dehra Dun, India. He was nominated and featured as one of the '*Tomorrow's Principal Investigators: Rising Young Investigators*' by the *Genome Technology* international magazine, USA and was presented a commemorative plaque and travel grant. He received commemorate certificate and was biographed in Marquis '*Who's Who in America*' and Marquis '*Who's Who in the World*'. He also secured '*Silver Award*' as a team member from American Museum of Natural History, New York, USA, for a research project on conserving rare medicinal plants. He serves on the editorial board of six international peer-reviewed scientific journals.

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## Forest Biodiversity: Issues and Concerns

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Forest biodiversity, a source of wonderment, social security and scientific curiosity, has been a cause of increasing concern. It is economically, ecologically, environmentally, culturally and aesthetically vital as it plays a crucial role in ensuring global food security, climate change, poverty eradication and improvement of human health. Forests sustain the livelihoods of hundreds of millions of people globally and studies estimate at least 80% of the developed world's diet originated in the tropical rainforests. Around 25% of western pharmaceuticals are derived from rainforests ([www.rain-tree.com](http://www.rain-tree.com)). However, the increasing pressures from burgeoning human populations, agriculture expansion as well as multitude of sources, direct as well as indirect, have made these forests the most threatened and highly vulnerable. The dependence on the forest genetic resources may have direct consequences on the global ecosystem. Deforestation has been taking place at a pace of about 13 million ha with few signs of a significant decrease over time. Annually, about 4 million ha are diverted for agriculture, construction of highways and other developmental projects. The total forest area has been estimated to be around 30% of the planet's land area, just under 4000 million ha (<http://www.fao.org/forestry/en/>). Many economically important, endemic forest species are highly fragmented and endangered with an incredibly low number of reproductive individuals. This may have far-reaching consequences on the rate of survival, adaptability and continued evolution of these species. Due to over-exploitation of the species, from their natural habitats, their native genetic diversity may also be irrevocably affected. Reflecting these concerns, this edition of special issue intends to review advances and current knowledge in promoting conservation and sustainable management of the world's forest.

In the manuscript '*Salient points on the assessment and monitoring of forest biodiversity*', the authors have emphasized on three main components, analysis, assessment and monitoring, to effectively conserve the forest biodiversity. Key factors and list of procedures for generating and maintaining the biodiversity have been presented as well. The imbalance in natural forest resource depletion, risk in quality production, susceptibility to many epidemic diseases and reduction in biodiversity due to monoculture plantation practices of major timber yielding tree species such as teak have been highlighted in the manuscript, '*Teak in mixed plantations: an appraisal of productivity, compatibility and ecological sustainability*'. Plantation of judicious mixture of species that are compatible, having highest possible yield and vegetation/environment stability, low risk of total crop loss and improved landscape aesthetics ideas with teak have been proposed. In the manuscript '*Assessment of biodiversity and strategies for conservation of genetic resources in mulberry (Morus spp.)*', concerns to protect genetic resources comprising both cultivated and wild relatives of *Morus* spp. have been raised. Efforts initiated to assess the biodiversity of this species, especially in south Asian countries, using both morphological and modern biotechnological methods along with the different conservation strategies such as *in-situ*, *ex-situ*, field gene bank, on-farm participatory and cryopreservation have been discussed.

Pines are among the most commercially important of tree species, valued for their timber and wood pulp throughout the world. In the manuscript '*Distribution of the genetic diversity of Pinus ayacahuite (Ehrenberg) at the communal forest of Totonicapán, Guatemala*' and '*Genetic variability in Pinus roxburghii Sarg. revealed by RAPD markers*', the genetic diversity of *P. ayacahuite* in communal forest of Totonicapán of Guatemala and *P. roxburghii* in Himalayan region of India were assessed using various high throughput molecular markers. The analysis along an altitudinal cline in *P. ayacahuite* showed a diverse pattern in both genetic diversity and genetic differentiation estimates. The low-perturbed stands with high genetic diversity indexes that are critical to ensure effective sampling with afforestation purposes have been presented. The diversity estimates in *P. roxburghii* revealed a fair amount of genetic variability in the existing forests of Himalaya. Such information is valuable to initiate conservation and genetic improvement efforts in any economically important forest species.

Fragmentation of natural habitats into smaller and non-contiguous patches is the most serious threat to the long-term survival of the biological diversity on earth. In the manuscript '*Are small forest fragments more heterogeneous among themselves than large fragments?*', the authors studied the genetic status of fragmented populations of *Litsea floribunda* in

natural shola fragments of central Western Ghats (one of the mega diversity centers of the earth), India, using molecular markers. While fragmentation has been shown to cause reduction in the levels of genetic diversity, the authors have highlighted that a collection of small fragments among themselves have a higher level of variability as compared to large fragments. In another study '*Conservation and management of endangered plant species: A case study from Northeast India*' the authors presented the population status and conservation requirement of three rare/endangered and endemic plant species from Northeast India (another global biodiversity hotspot in the world). They studied the impact of anthropogenic pressures on the forest genetic resources and suggested that *ex-situ* conservation/home garden plantations may be effective for their conservation.

In an unique study '*Ecology of the swampy relic forests of Kathalekan from central Western Ghats, India*', the authors highlighted the critical role of sacred groves in conserving rare, endangered and threatened plant species in the central Western Ghats, India. Their study emphasized the need for bringing to light more of relic forests for their biodiversity conservation, carbon sequestration and hydrology. In the manuscript '*Role of protected area in conserving the population and genetic structure of economically important bamboo species*', the authors examined the population structure and genetic diversity of two economically important bamboo species in the Biligiri Ranganathaswamy Temple Wildlife Sanctuary at central Western Ghats, India. Their study focused on addressing if indeed the protected areas (PAs) facilitate a better demographic and genetic diversity profile of bamboos within PA than outside. In both the bamboo species, the core and buffer regions of PA maintained better population stand as well as genetic diversity. Their results strongly indicated the relevance of PAs in maintaining the population structure and the genetic diversity of economically important plants such as bamboos that are otherwise prone to heavy extraction pressures.

The choice of superior quality seed sources is one of the main factors affecting the establishment and productivity of forest plant species plantations. Research on mapping putative biodiversity sources for seed orchards and to establish new hardwood plantations are less frequent. In the manuscript '*Juglans regia provenance research by molecular, morphological and biochemical markers: A case study in Italy*', the authors identified two *J. regia* (walnut) provenances for genetic, morphological and biochemical characters, and proposed promising source of seed for nurseries and hardwood plantations. In the manuscript '*Cytogenetic characteristics of weeping birch (Betula pendula Roth) seed progeny in different ecological conditions*', the authors examined the cytogenetic characteristics in seed progeny of weeping birch under stress and no-stress conditions. It is important for better arrangement of green spaces in cities and reforestation on anthropogenically polluted territories as it allows the selection of elite maternal trees producing seeds resistant to stress factors. Genetic diversity among 28 land races of banana was also assessed in north-eastern India in the manuscript '*Assessment of genetic diversity in banana (Musa spp.) of North-Eastern India by RAPD*'.

Although monitoring the loss of forest biodiversity is crucial, there appears to be no single measure that can assess all the aspects of biodiversity. For planning any kind of effective conservation and sustainable utilization strategies, it is critical to have consolidated information on parameters such as the levels of threats, the spatial patterns of population/species distribution, their interactions, genetic diversity, etc. It is hoped that these comprehensive studies presented in this special issue, by the group of elegant researchers from all around the world, will further promote more scientific research and provide better and in-depth understanding of the critical values that the forest biodiversity support in global ecological sustainability, economic development, food security, religious and cultural values and human well-being.

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## **Bioremediation, Biodiversity and Bioavailability**

**SPECIAL ISSUE: Tree and Forest Biodiversity (Guest Editors: Madhugiri Nageswara-Rao and Jaya R. Soneji, University of Florida, IFAS, Citrus Research & Education Center, USA)**

**Konstantinos A. Spanos (Greece), Alan Feest (UK), Panos V. Petrakis, Evangelia N. Daskalaku (Greece)** Salient Points on the Assessment and Monitoring of Forest Biodiversity (pp 1-7)

### **ABSTRACT**

**Invited Mini-Review:** A general analysis and overview of forest biodiversity is presented. Some important current topics will also strengthen the overall overview of assessment and monitoring of biodiversity. Emphasis has been given to the three main components related to biodiversity. Analysis, assessment and monitoring of forest biodiversity have been presented. A list of processes generating and maintaining biodiversity have been presented as well. Main key factors and indicators of forest biodiversity have been described. Silvicultural and management treatments creating disturbances and mimicking natural processes are highly important for preserving high quality of forest biodiversity. Management of biological diversity (including genetic diversity) has also been highlighted as an important part of silviculture and forest management. Finally, some important concluding remarks have been presented.

**Sanjay Singh, Rameshwar Das, Ravindra Krishnamurty (India)** Teak in Mixed Plantations: An Appraisal of Productivity, Compatibility and Ecological Sustainability (pp 8-14)

### **ABSTRACT**

**Invited Mini-Review:** Timber yield is generally the primary objective of monoculture plantation of forest trees, which leads to imbalance in natural resource depletion from the sites, renewed risk of productivity loss resulting from some catastrophic events such as disease epidemics or insect-pest outbreak and reduction in biodiversity. Although plantations do not fully match with goods and services provided by natural forests, a judicious mixture of species might supplement them to a great extent. Hence, it is possible to design mixed stands of compatible species having highest possible yield and vegetation/ environment stability, low risk of total crop loss and improved landscape aesthetics. The benefits accrued by mixed plantations can further be multiplied several folds by deployment of superior clonal material. Teak is one of the most valuable timber species of the tropics accounting for about 15% of all forest plantations. Mixed plantations of teak have been tried throughout the tropics with varying degrees of success. Promising combinations of teak include *Swietenia macrophylla* (Fiji, Sri Lanka), *Schleichera oleosa* and *Dalbergia latifolia* (Indonesia), *Leucaena leucocephala* (Malaysia, Sri Lanka), *Pterocarpus macrocarpus* (Myanmar), *Khaya grandifolia* and *Cassia siamea* (Nigeria). However, teak plantations mixed with *Swietenia macrophylla* (Indonesia), *K. grandiflora* and *K. senegalensis* (Nigeria) and *Copaifera officinalis* (Trinidad) met with limited success. In India, successful mixed plantations with teak have been those of *Artocarpus hirsuta*, *Dalbergia latifolia*, *D. sissoo*, *Xylia dolobrifformis* and some bamboos (e.g. *Melocanna bambusoides*, *Cephalostachym pergracyle*). But inclusion of *Gmelina arborea*, *Acacia catechu*, *Pterocarpus marsupium* and *Bambusa tulda* with teak suppressed growth of each other. The present paper is a critical ecological appraisal of growing mix plantations consisting of various species with teak as the major component.

**Amalendu Tikader, Kunjupillai Vijayan (India)** Assessment of Biodiversity and Strategies for Conservation of Genetic Resources in Mulberry (*Morus* spp.) (pp 15-27)

### **ABSTRACT**

**Invited Review:** Mulberry (*Morus* spp.), an important tree cultivated in most Asian countries, is a vital component of the sericulture industry as the silk-producing insect *Bombyx mori* L. feeds only on its leaves. Mulberry is believed to have originated in the northern hemisphere and spread to the tropics of southern hemisphere. More than 150 species of mulberry have been reported, though their identities are still a matter of great debate. Since most of the cultivating varieties were developed from *M. alba*, other species were mostly neglected; as a result the gene pool of the cultivated mulberry has drastically reduced. As it is essential to protect all whole genetic resources comprising both cultivated and wild relatives, efforts have recently been initiated to assess the biodiversity of this crop in different countries, especially in south Asian countries. In this review, the genetic resources of mulberry available in different countries and the measures being taken for its conservation are discussed. Biodiversity analyses with both morphological and modern biotechnological methods along with the conservation strategies such as *in-situ*, *ex-situ*, field gene bank, on-farm participatory and cryopreservation are reviewed and discussed.

**H. S. Ginwal, Priti Chauhan, Shalini Singh Maurya, Vikas S. Jadon (India)** Genetic Variability in *Pinus roxburghii* Sarg. Revealed by RAPD Markers (pp 28-34)

#### ABSTRACT

**Original Research Paper:** RAPD (Random Amplified Polymorphic DNA) markers were used to reveal genetic variation in 55 geographically distinct populations of *Pinus roxburghii* of the Himalayan region, covering the entire natural range of distribution of the species in India. Populations vary between the longitude range of 71° 1' N to 92° 23' E, latitude 27° 19' N to 33° 22' N within an altitudinal range of 520 m to 2205 m. A total of 50 decamer primers were used, out of which twenty primers were selected based upon the polymorphism and reproducibility of results. Primers generated a total of 231 amplification products, out of which 191 amplicons were polymorphic. Amplification products obtained per primer ranged from as low as 5 to a maximum of 18, with an average of 11.55. The extent of polymorphism varied with the primer. Divergence in respect of percent polymorphism ranged from 76 to 100% with an average of 84% in the species. The similarity coefficient ranged from 0.36 to 0.78 and the genetic distance varied from 0.23 to 0.53 between the populations. Based on the UPGMA dendrogram and genetic similarity pattern, the populations of *P. roxburghii* were grouped into five major clusters. Genetic similarity analysis showed considerable variation among the populations ranging from highest similarity between the populations of Una, Badasar (Himachal Pradesh; HP) and Jamta (HP); Una, Badasar (HP) and Manikaran (HP) with 78% similarity. Highest dissimilarity was observed between the populations of Gaucher (Uttarakhand) and Akhnoor (Jammu and Kashmir) with only 36% similarity (64% dissimilarity). The results reveal that there is a fair amount genetic variability in the existing forests of Himalayan chir pine (*P. roxburghii*) and as such the information is valuable with regard to initiate conservation and genetic improvement efforts in this species.

**Aranzazu Gómez-Garay (Spain), Silvana Masselli (Guatemala), M<sup>a</sup> Angeles Bueno (Spain)** Distribution of the Genetic Diversity of *Pinus ayacahuite* (Ehrenberg) at the Communal Forest of Tonicapán, Guatemala (pp 35-41)

#### ABSTRACT

**Original Research Paper:** The genetic diversity of *Pinus ayacahuite* from six stands at the Communal Forest of Tonicapán (Guatemala) was evaluated with chloroplast microsatellite markers. The analysis along an altitudinal cline showed a diverse pattern in both genetic diversity and genetic differentiation estimates. Three areas were established: 1) a lower area, located near human establishments that includes a forest nursery, is characterized by the highest genetic diversity (He: 0.7-0.8) and differentiation ( $D^2$ : 0.22-0.44) detected. Human impacts are frequent and the introduction of foreign plant material could have caused alterations in the genetic composition, 2) an intermediate area is characterized by a moderate anthropogenic perturbation (familiar-small agricultural farms). It has experienced a recent reduction of their effective population size and exhibit a reduction of haplotype richness and 3) a higher area showed elevated genetic diversity and differentiation values. The latter, has been revealed as a genetic diversity reservoir thanks to a low human impact. This study shows several important data that can contribute to the management of this forest area in the future. The low-perturbed stands with high genetic diversity indexes are critical to ensure effective sampling with afforestation purposes.

**Rajanikanth Govindarajulu, Madhugiri Nageswara-Rao (USA/India), Bahusaheb Tambat, Ramanan Uma Shaanker, Kotiganahalli N. Ganeshiah, Chepudira G. Kushalappa (India)** Are Small Forest Fragments More Heterogeneous among Themselves than Large Fragments? (pp 42-46)

#### ABSTRACT

**Original Research Paper:** In the present study of shola forest fragments of central Western Ghats, India, two predictions of Ganeshiah *et al.* (1997) were tested: (a) whether the gene assemblages among a set of larger forest fragments are more similar to each other than among a set of small fragments? and (b) are the coefficient of variation for the similarity in the genetic status of population higher for smaller than the larger forest fragments? However, whereas Ganeshiah *et al.* (1997) observed the evidence from species assemblages, we looked at the evidence from the genomic DNA of a single widespread tree species, *Litsea floribunda* Gamble, found abundantly in all the shola fragments of central Western Ghats. We argue that just as a set of co-adapted species might be selected in an island, a set of co-adapted genes in a species may also be selected in an island. By studying the RAPD-PCR amplification products in the populations of *L. floribunda* Gamble we tested our prediction. Our results show that populations in small forest fragments tend to be more genetically dissimilar to each other than do large fragments among themselves. These results have important implications for the conservation of genetic resources in fragmented habitats.

**Baharul Choudhury (Canada/India), M. Latif Khan (India)** Conservation and Management of Endangered Plant Species: A Case Study from Northeast India (pp 47-53)

#### ABSTRACT

**Original Research Paper:** Extinction and species introduction are two major biodiversity crises of the current millennium. A species may become endangered and eventually extinct when death rate exceeds birth for a prolonged duration. The reasons may be natural or anthropogenic. Anthropogenic activities are now-a-days prominent and causing extinction of many plant species of ecological and economic significance. Many species are facing tremendous pressure and are on the verge of extinction in Northeast India, one of the global biodiversity hotspots in the world. In the present communication, we present the population status and conservation requirement of three rare/endangered and endemic plant species of the region viz. *Aquilaria malaccensis*, *Gleditsia assamica* and *Gymnocladus assamicus*. Natural populations of *A. malaccensis* have been depleted due to over-harvesting of mature trees for its precious 'agarwood'. However, plantations have been established in home-gardens of upper Assam and serving as a means of *ex-situ* conservation of the species. The *G. assamica* and *G. assamicus* populations are also very poor in nature which culminates with poor natural regeneration. Therefore, a similar way of *ex-situ* conservation in plantations as practiced in *A. malaccensis* is suggested for effective conservation of the species.

**M. D. S. Chandran, G. R. Rao, K. V. Gururaja, T. V. Ramachandra (India)** Ecology of the Swampy Relic Forests of Kathalekan from Central Western Ghats, India (pp 54-68)

#### ABSTRACT

**Original Research Paper:** Introduction of agriculture three millennia ago in Peninsular India's Western Ghats altered substantially ancient tropical forests. Early agricultural communities, nevertheless, strived to attain symbiotic harmony with nature as evident from prevalence of numerous sacred groves, patches of primeval forests sheltering biodiversity and hydrology. Groves enhanced heterogeneity of landscapes involving elements of successional forests and savannas favouring rich wildlife. A 2.25 km<sup>2</sup> area of relic forest was studied at Kathalekan in Central Western Ghats. Interspersed with streams studded with *Myristica* swamps and blended sparingly with shifting cultivation fallows, Kathalekan is a prominent northernmost relic of southern Western Ghat vegetation. Trees like *Syzygium travancoricum* (Critically Endangered), *Myristica magnifica* (Endangered) and *Gymnacranthera canarica* (Vulnerable) and recently reported *Semecarpus kathalekanensis*, are exclusive to stream/swamp forest (SSF). SSF and non-stream/swamp forest (NSSF) were studied using 18 transects covering 3.6 ha. Dipterocarpaceae, its members seldom transgressing tropical rain forests, dominate SSF (21% of trees) and NSSF (27%). The ancient Myristicaceae ranks high in tree population (19% in SSF and 8% in NSSF). Shannon-Weiner diversity for trees is higher (>3) in six NSSF transects compared to SSF (<3). Higher tree endemism (45%), total endemic tree population (71%) and significantly higher above ground biomass (349 t/ha) cum carbon sequestration potential (131 t/ha) characterizes SSF. Faunal richness is evident from amphibians (35 species - 26 endemics, 11 in IUCN Red List). This study emphasizes the need for bringing to light more of relic forests for their biodiversity, carbon sequestration and hydrology. The lives of marginal farmers and forest tribes can be uplifted through partnership in carbon credits, by involving them in mitigating global climatic change through conservation and restoration of high biomass watershed forests.

**Madhugiri Nageswara-Rao (USA/India), Gudasalamani Ravikanth, Kotiganahalli N. Ganeshiah, Ramanan Uma Shaanker (India)** Role of Protected Area in Conserving the Population and Genetic Structure of Economically Important Bamboo Species (pp 69-76)

#### ABSTRACT

**Original Research Paper:** Due to widely expanding threats to the forests, protected areas may offer the best approach and prospect to conserve the biological diversity. However, there have been few studies that have emphatically demonstrated the role of protected areas in conserving the genetic diversity of plant species. We examined the population structure and genetic diversity of two economically important bamboo species, *Bambusa arundinacea* and *Dendrocalamus strictus*, in the core, buffer and the peripheral regions of the Biligiri Ranganathaswamy Temple Wildlife Sanctuary (BRTWS) at central Western Ghats, India. Our results indicate that the proportion of human disturbance on both the bamboo species were significantly less in the core and buffer regions of the BRTWS as compared to periphery. In both the bamboo species, the core and buffer regions maintained a better population stand. The frequency distribution of the genetic similarity indices of the core populations were found to be more widely distributed as compared to the peripheral populations. Our results strongly indicate the relevance of

protected areas in maintaining the population structure and the genetic diversity of economically important plants such as bamboos that are otherwise prone to heavy extraction pressures.

**Vladislav N. Kalaev, Svetlana S. Karpova, Valery G. Artyukhov (Russia)** Cytogenetic Characteristics of Weeping Birch (*Betula pendula* Roth) Seed Progeny in Different Ecological Conditions (pp 77-83)

#### ABSTRACT

**Original Research Paper:** The present study of cytogenetic characteristics in seed progeny of woody plants in stress and no-stress conditions is important for better arrangement of green spaces in cities and reforestation on anthropogenically polluted territories because it allows to select maternal trees producing seeds resistant to stress factors. The following cytogenetic characteristics of the root meristematic cells of weeping birch (*Betula pendula* Roth) seedlings were studied: mitotic and nucleolar activities, frequency and spectrum of pathological mitosis, frequency of persistent nucleolus in mitosis. Seeds for this study were collected from maternal trees growing in anthropogenically polluted and ecologically safe areas of the Central Black Earth Region of Russia. Cluster analysis revealed four clusters of seedlings on each territory: "mutable", "low-mutable" and two clusters with intermediate characteristics. The characteristics and differences of these clusters are described in the article.

**Maria Emila Malvolti, Paola Pollegioni, Alcide Bertani, Sergio Mapelli, Francesco Cannata (Italy)** *Juglans regia* Provenance Research by Molecular, Morphological and Biochemical Markers: A Case Study in Italy (pp 84-92)

#### ABSTRACT

**Original Research Paper:** In the current climate change scenarios, the choice of seed sources is one of the main factors affecting the establishment and productivity of plantations of forest trees. *Juglans regia* L. (walnut) is one of the more valuable hardwood species since it could provide high quality timber and fruits. The aim of this study was to search peculiar Italian walnut provenances as putative biodiversity sources for seed orchards and to establish new hardwood plantations. A multidisciplinary approach, integrating molecular markers (ISSR), seed morphological traits (equatorial and polar diameter, shape, dry weight) and fruit composition (total oil, fatty acids, tocopherol) was applied to analyze samples collected in ten sites (three in Campania and seven in Abruzzo regions) and samples of four varieties (two from Southern and two from Northern Italy). Eleven selected ISSR primers exhibited a strong ability to discriminate walnut provenances. The Principal Coordinate Analysis performed on the  $\Phi_{PT}$  values divided all germplasm in four distinct groups. The genotyping results were partially confirmed by the morphological and biochemical analysis of fruits. Two walnut provenances, the first from a hilly plateau in Campania region and the second from mountainous zone of Abruzzo, shown to be different both for genetic, morphological and biochemical characters, and can be considered promising source of seed for nurseries and hardwood plantations.

**Saha Roy Olivia, Bantawa Pranay, Ghosh Swapan Kumar, Tripathi Shashi Bhushan, Ghosh Partha Deb, Mondal Tapan Kumar (India)** Assessment of Genetic Diversity in Banana (*Musa* spp.) of North-Eastern India by RAPD (pp 93-98)

#### ABSTRACT

**Original Research Paper:** Genetic diversity was studied among 28 landraces of banana collected from traditional farming areas of North Bengal and North East India using Random Amplified Polymorphic DNA (RAPD) markers. Evaluation of genetic diversity is essential for conservation and management and to trace hybrids as well as duplicate entries. The PCR products produced by 10 polymorphic primers revealed 66 bands, 55 of which were polymorphic (72.7%). A dendrogram was constructed based on Dice's coefficient matrix by unweighted pair-group mean analysis (UPGMA) using NTSYS-PC, which reveal two major groups of banana: plains (North Bengal) and high hills (Arunachal Pradesh and Sikkim). The extent of variability was 86.96% and the average inter- and intra-population variability ranged from 45 to 52%. A resemblance matrix was developed using SMC, which was used with NTSYS to compute cluster analysis. To the best of our knowledge, this is the first attempt to assess genetic diversity of banana from North East India.