Preface

Conservation of Threatened Plants of India

Development of appropriate scientific principles and their application of these principles to develop technologies for the maintenance of biological diversity are two main goals of conservation biology[1]. Although the origin of plant conservation is traced back to the beginning of agriculture when farmers started saving selected seeds for future use, conservation biology as a scientific discipline evolved only in the late 1970s. The realization that there is a need to save all the species to halt biodiversity loss has made conservation biology a frontline scientific discipline in the recent years. The herculean task of developing technologies and strategies for halting the process and decelerating the pace of species loss is the prime concern of conservation biologists today. In this respect, conservation of species that face imminent threat of extinction, and ending the ever-increasing list of threatened species due to various anthropogenic as well as biological causes are the two most important challenges. The nature of biological information required for conserving the threatened species has been intensely debated during the past two decades. The ecological or genetic approach has long been argued for species conservation. The advocates of genetic approach argue that understanding the organization of genetic diversity is the key to long-term survival of species, as genetic variation is a pre-requisite for evolutionary adaptation, and also has short-term fitness consequences[2]. On the other hand, the supporters of ecological approach argue that biotic interactions and habitat requirements of a species should be central to any sound conservation programme[3].

In 1985, Michael Soulé in a landmark paper proposed that conservation biology needs to be an interdisciplinary science, and it should be based both on natural sciences and social sciences[4]. Conservation biology embraces a wide range of disciplines and draws theories from the diverse subjects such as island biogeography, genetics, ecology, population biology, patch dynamics, pedology, nutrient recycling and hazard evaluation. Diversity of organisms is good, ecological complexity is good, evolution is good, and biotic diversity has intrinsic value – these are the four normative postulations of Soulé that represent core values and moral component of conservation biology. Besides being a holistic science, conservation biology is also a crisis discipline, i.e. action in conservation must be taken before all the facts and related data are gathered. Because it concerns with imminent threat and extinction, activities under conservation science are always constrained by time.

The importance of conservation biology in sustaining human life and welfare through maintaining the processes fundamental to the health of ecosystems and biosphere is well recognized. Models that link species extinction to habitat loss conclude that the accelerated rate of extinction may be difficult to avoid unless current rates of deforestation and other habitat loss are sharply reduced[5]. The contribution of natural products, an important element of biodiversity, to industries such as pharmaceuticals and to human healthcare is immense. Plants used in traditional, folk and herbal medicine meet about 75% of the medical needs of the developing countries. Unfortunately, these important plant resources are becoming threatened due to over-exploitation, and conservation biology needs to restore back their populations to ensure the continued health-care benefits of biodiversity. In addition, the contribution of conservation biology to the enhanced ecosystem services is now well recognized with empirical evidences on the strong linkage of biodiversity conservation and availability of ecosystem services[6].

The use of data-based decision in identifying site-specific conservation actions is increasing day by day, which in turn is yielding significant impacts with limited resources[7]. Systematic conservation planning and priority setting have now become pre-requisites for any conservation action. Biodiversity conservation based on sustainable utilization by humans, which was not emphasized in Soulé's framework of conservation, has now become an integral part of conservation planning.

An analysis of the success and failure of conservation actions during the past three decades revealed that the role of people is a key determinant of conservation, and the expression of human values in conservation action is clearly evident[8]. Conservation actions targeting only biodiversity often affect lives and livelihoods of people. As a direct result of conservation, economic well-being of the human population in several instances has been harmed, e.g. displacement from protected areas. In other cases, conservation has benefited people, e.g. biodiversity-based livelihood. This highlights the need for paying more attention to the trade-off between conservation and human needs during conservation planning.

While the importance of threatened species conservation is well recognized, the functional roles of species diversity, particularly those which are crucial for maintaining ecosystem health and services need to be re-emphasized in biodiversity conservation[9]. However, functional diversity alone is not adequate to reach global conservation targets as a degraded ecosystem with alien invasive species can still have high functional value[10]. Therefore, conservation value of the species is equally important as functional, phylogenetic and species diversity while prioritizing the conservation action(s)[11].

Considering the financial and human resource constraints and the crisis factor involved in conservation, saving the threatened species from extinction clearly becomes the top priority of conservation science. Threatened species are defined using the International Union for Conservation of Nature's (IUCN's) classification: (i) a critically endangered (CR) species is one which is facing a very high risk of extinction in the wild, (ii) an endangered (EN) species is in danger of extinction and unlikely to survive if causal factors continue to operate, and (iii) a vulnerable (V) species is likely to move into the endangered category in the near future if causal factors continue operating. The IUCN Red List of Threatened Species is widely recognized as the most comprehensive approach for evaluating the conservation status of plant and animal species. However, very few plant and animal species of the world have so far been assessed. In addition to the large number of unassessed species, the species those that went extinct before AD 1500 as well as the Least Concern (LC) species, i.e. plants that have been evaluated to have a low risk of extinction are not included in IUCN Red List of species. The number of threatened species is an important measure or indicator of the immediate need for conservation in an area. At least 153 plant species are now extinct, and of the 268000 flowering plants[12], only 22566 species have been evaluated by IUCN that constitutes only 8% of the total. This calls for a concerted effort by the biologists to complete the threat evaluation of all the plant species following the IUCN protocol.

There has been a huge gap between intention and practice in effective implementation of the principles of conservation biology. It should be addressed by better planning and targeted research. Effective conservation depends on pragmatic, innovative and realistic research aiming at providing solutions at the ground level. In this special section, we present an integrative framework to threatened species conservation that has been designed keeping the Indian scenario in mind, but equally applicable to any situation with minor modifications. The framework was piloted for 100 prioritized threatened species of India, of which the populations of at least 75 species are now stable and are on the path of recovery for self-perpetuation. This effort is being supported by the Department of Biotechnology, Ministry of Science and Technology, Government of India through a project entitled, 'Preventing extinction and improving conservation status of threatened plants using biotechnological tools' (Project No. BT/Env/BC/01/2010) during the period 2012–2018. More than 150 scientists from 37 institutions spread all over the country contributed to the conservation of 100 selected species following a ten-step protocol designed for the purpose.

One of the significant outputs of the programme following the above protocol is improved threat status assessment for all the species due to use of advanced techniques for new population survey, and collection of data on population size, population trends and habitat vulnerability. We have also illustrated how application of modern techniques such as ecological niche modeling (Adhikari *et al*., **page 519**), Meta-population modeling (Lyngdoh *et al*., **page 532**) and more accurate determination of area of occupancy and extent of occurrence can improve the accuracy of threat assessment within the IUCN framework (Barik *et al.*, **page 588**). The role of reproductive biology (Marbaniang *et al*., **page 576**), and plant taxonomy including herbarium and field germplasm bank (Haridasan *et al*., **page 512**) in species conservation has been demonstrated with evidences from the selected threatened plant species. Ravikanth *et al.* (**page 504**) have highlighted the importance of developing a species-specific conservation strategy after analysing the cause(s) of rarity, and need of genetic enrichment of the genetically impoverished populations following a source-sink approach. Molecular profiling was undertaken for several threatened species for assessing genetic diversity within the species as well as among its different populations for genetic enrichment, and establishing correct taxonomic identity. Chrungoo *et al*. (**page 539**) have successfully demonstrated the importance of molecular studies in threatened species conservation. The importance of developing micro- (Deb *et al.*, **page 567**) and macro-propagation (Panda *et al*., **page 562**) techniques for large-scale multiplication and thus, saving the threatened species from extinction, has been demonstrated taking the examples of several threatened species. The conservation of threatened plant species through their utilization has been demonstrated by Venkatasubramanian *et al.* (**page 554**). They have illustrated how identification of elite germplasm through chemoprofiling of the active compounds helps large-scale cultivation by the farmers for industrial raw material production and saves the species from extinction. A review on threatened plants of India by Barik *et al.* (**page 470**) analyses the geographical distribution pattern and total number of threatened species in the country as described by earlier workers and different agencies.

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S. K. Barik
N. K. Chrungoo
D. Adhikari
– *Guest Editors*