Himalayan bamboo diversity and its conservation: a case study

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Bamboos are multipurpose plants, widely harvested from natural forest and also cultivated. Their uses are dependent upon the characteristics of individual species such as culm strength, flexibility and size. Their contribution to the ecology of an area derives from their ability to recycle nutrients efficiently (Rao & Ramakrishnan, 1990), their ability to protect against soil erosion, and the high nutritive value of their leaves and shoots. As economically and ecologically important plants, they merit serious attempts to conserve their diversity.

Unfortunately the natural reproductive behaviour of bamboos can be a major problem. The occurrence of a long cycle of purely vegetative growth followed by synchronised flowering of large areas of a single species is well documented. When it occurs it can lead to elimination of large components of the population if the habitat has become degraded and the seedlings fail to survive. Recovery is not then possible until the cycle has been repeated and the next phase of seed production occurs. Meanwhile intervention through propagation or storage of genetic material is not easy. Bamboo seed has a short life. Vegetative propagation is complicated, and can result in an undesirable narrowing of the genetic base. Tissue culture is not yet possible without seed to provide initial embryogenic callus. Thus ex-situ conservation is not yet a viable option (Stapleton & Rao, 1995), and for practical purposes successful conservation of bamboo diversity probably depends upon the protection of natural habitats along with deliberate management or cultivation. This requires a good understanding of their ecology and the effects that different land management practices may have upon different species.

Bamboos are distributed throughout the Himalayas, with a variety of different genera adapted to different ecological zones, and an as yet unknown number of species, subspecies and varieties. These are often limited in distribution to a narrow geographic or topographic area. Because of their infrequent flowering their taxonomy has been rather neglected. It is difficult to relate flowering specimens in herbaria to vegetative plants in the field, so that identification of species can be very difficult. In addition, different taxonomists have used different classification systems, recognising different genera according to which parts of the plants they consider to be the most important.

In the hottest and driest outer limits of the Himalayas such as the Siwalik Hills, a limited range of species occurs, including such relatively drought-tolerant species as *Dendrocalamus strictus* and *Bambusa bambos*. Inner valleys of such areas can be classified as semi-arid, and water stress severely limits the distribution of bamboos. The subtropical middle hills of the Western Himalayas are also relatively dry and contain only a few species of bamboo from the genera *Bambusa*, *Dendrocalamus*, and *Drepanostachyum*. The temperate forests are home to a few more, from the genera *Himalayacalamus*, *Thamnocalamus*, and *Yushania*. They are naturally restricted to cooler, damper sites but are also sporadically cultivated. As they are at the end of their natural range, they are particularly sensitive to environmental degradation. Deforestation, fire or overgrazing can eliminate all bamboos rapidly under such conditions. Reduction in canopy cover can lead to death of even well-established bamboos through increased insolation, wind and water stress. Conscious management of forests to protect the understorey, and deliberate cultivation of bamboo crops are necessary if bamboo diversity is to be maintained under such conditions.

At the eastern end of the Himalayas heavy monsoon rain and frequent topographically-induced cloud cover for much of the rest of the year lead to minimal water stress and conditions that are well suited to bamboo growth. Here a very different and much wider range of bamboos can be found. Although Beniwal & Haridasan (1988) estimated that Arunachal Pradesh had around 12 genera and over 30 species, I suspect that when thorough inventories have been undertaken, there will probably be around

18 genera and up to 60 or more species. In such areas an almost continuous succession of different bamboos may be found from the plains to the treeline, and many of these are presently utilized by local communities or extracted for use elsewhere. However, temperature and rainfall are still constraints to bamboo growth, and the genera and species are still sensitive to changes in these and other environmental factors. Many species are also dependant upon good soil structure and fertility as well as plentiful supplies of water. Deforestation, detrimental forest management practices or overgrazing will progressively eliminate more sensitive bamboos, such as species of *Neomicrocalamus*, *Ampelocalamus*, *Borinda*, *Cephalostachyum*, *Teinostachyum*, and *Pseudostachyum*. Where there was originally a broad base of species, loss of the more sensitive species may not be apparent, especially if the diversity of species has never been documented accurately. The initial effect of tree felling is often to encourage the growth of certain bamboos, so that the need for protection of other species may be far from obvious. However, to complete the cycle of regeneration even rampant bamboos usually require the protection of a tree canopy, which is why they are not found in natural grassland. When flowering occurs in severely degraded subtropical forest areas, the combination of drought, grazing pressure, and soil impoverishment can destroy most bamboo seedlings. In addition, several bamboos in the Eastern Himalayas are scrambling or climbing in habit. Like the rattans, they are not self-supporting and require substantial woody vegetation to develop properly. Scrambling species such as *Neomicrocalamus andropogonifolius* provide strong, flexible weaving material of the highest quality, widely used in cottage handicraft industries. Deforestation poses an extra threat to the survival of such species. The more rampant climbing species such as *Melocalamus compactiflorus* or invasive spreading species from the genera *Chimonobambusa* and *Yushania* can quickly dominate secondary vegetation to the exclusion of both forest tree regeneration and more useful bamboos.

At higher altitudes bamboos in the genera *Arundinaria*, *Thamnocalamus*, *Himalayacalamus*, *Yushania*, and *Borinda* are common in natural temperate forest across much of the Himalayan Range. The spreading bamboos in the genera *Arundinaria* and *Yushania* are often found on flatter areas. They require wet ground for most of the year for good rhizome development, and some species are adapted to waterlogged sites. After forest clearance they may persist to form bamboo pastureland, but it is unlikely that they will regenerate after flowering under such conditions. They are often eliminated by heavy grazing pressure alone, or by sporadic cultivation of such areas for temperate crops such as potatoes. Intensive forest management can also deplete bamboo diversity in such areas. Bamboos are often perceived to be a threat to regeneration of timber trees. Dense plantations of exotic tree species and weeding operations are intended to lead to monocultures, but the demand for timber and fuelwood cannot be denied. A balance between such operations and more sensitive management of natural forest is required, with areas set aside for cultivation of minor forest products, and conservation of biodiversity an important component of management plans.

The upper altitudinal limit of alpine bamboos is around 3,500–4,000m in the Eastern Himalayas, but considerably lower in the west where winters are colder. The absolute limit is usually about 100 metres below the natural treeline, as trees provide shelter from cold and wind. All such areas are ecologically highly sensitive, and after damage the vegetation can take centuries to recover. Nevertheless, steady deforestation, mining, and increasing grazing pressure are common, despite the fact that many parts of the higher altitude belt of the Himalayas are designated as conservation areas.

Thus the factors that are likely to lead to erosion of bamboo diversity are varied. In the driest parts of the Western Himalayas fire is a major threats to bamboo regeneration. At medium altitudes throughout the range bamboos are steadily being eliminated by forest degradation and agricultural encroachment. In more fertile districts cultivation of bamboos is practised on private farmland, but vegetative propagation is always used, which narrows the genetic base. While selection of desirable traits by cultivators may result in a process of improvement, particularly through selection of non-flowering clones (Stapleton, 1990), from a biodiversity point of view present bamboo cultivation practices are inadequate for maintaining genetic diversity. At higher altitudes alpine bamboos are an important evergreen source of high quality food for wildlife, and they protect against erosion in a fragile environment, yet heavy grazing pressures following deforestation are a constant threat.

Reports on the status of bamboo biodiversity from the Himalayas are limited in depth and few in number. Biswas (1988) reported that bamboo diversity the NE Indian states, which have over 50% of the species found in India, is in a precarious state. The effects of shifting cultivation and destruction of forests and mining encouraged by new roads, are mentioned as the causes of this depletion. He cites the particular danger to areas under shifting cultivation in Meghalaya, where he estimates some 50% of the bamboo species are threatened. Attempts to highlight or quantify species at risk have not been very successful. Bahadur & Jain (1981) listed 26 Indian bamboos that they considered rare and endangered. According to Biswas (1988) 12 of these species are found in the NE region. Unfortunately many of these 'species' are simply ambiguous or puzzling reports of bamboos from old literature, or bamboos represented by unidentifiable, poorly documented fragments of bamboos in herbaria. Rarely do they correspond to a bamboo that can be demonstrated to be under threat in a particular locality. Looking at this list critically it might be more accurate to describe it as a list of persisting taxonomic errors and mis-identifications. That is not to say that there are not many rare and threatened bamboos in the Himalayas. Our knowledge of the taxonomy and distribution of Himalayan bamboos is still just so woefully inadequate that detailed information on which are endangered and where they need protection is largely unavailable.

For an example of how critical it is to improve knowledge of species and names we can look at the most important bamboo in the Eastern Himalayas, a *Bambusa* species usually known locally as *mal bans*. In West Bengal this species is generally referred to as *B. nutans*, on the assumption that it is the same as a common bamboo from Dehra Dun. In Bangladesh the name *B. teres* was given to a bamboo suspiciously similar to it (Munro, 1868), which is now listed as a rare forest bamboo in Bangladesh (Alam, 1982). In Assam a more recent collection, also suspiciously similar, was named *Bambusa cacharensis* (Majumdar, 1985). In SE Tibet adjacent to Arunachal Pradesh a bamboo has been named *Bambusa lixin* (Xue & Yi, 1983), and by the description it is also very likely to be the same species. Also, from E Nepal, what is probably the same bamboo has been considered just a subspecies and named *B. nutans* subsp *cupulata* (Stapleton, 1994). In this fashion we could easily have four different Himalayan countries claiming a rare endemic bamboo, constructing conservation strategies, assessing threats, and evaluating biodiversity status, while all along there may be just be one widely distributed species. As the older bamboo specimens lacked vegetative parts, while newer collections usually lack flowers, and descriptions are not consistent enough to allow good comparison, it is very difficult to decide upon which name to use, or how many species there really are. If this state of ignorance and confusion persists for the most common bamboo in the region, it is easy to see how unreliable information will be for the rarer species. In areas where a more thorough enumeration of bamboos is undertaken, more comprehensive collections and international collaboration allow such problems to be resolved. In addition, many species and even new genera such as *Borinda*, *Ferrocalamus* and *Gaoligongshania* are being discovered. Without collaborative international efforts to compare living material and the type collections of such plants from different countries, any attempt to assess Himalayan bamboo biodiversity may be on very shaky ground indeed.

Biswas (1988) considered that 10% of the bamboos in the NE region of India were rare and endangered, and this would seem as good an intelligent guess as any. There is no means of producing any more accurate assessment of the situation until more thorough enumerations and surveys have been undertaken. Meanwhile, the emphasis in conservation of bamboo diversity should be on protection of habitats, and the encouragement of both sound management of natural forest and cultivation of local bamboo species and varieties. Lahiri (1994) admitted that in the sub-Himalayan and Himalayan regions of India large areas of forest have been clear-felled and replaced with plantations, which are effectively pure firewood and pulp species. Although he reports that local Forest Protection Committees now manage more varied forest plantations, the re-introduction of understorey biodiversity is left to nature, under the assumption that it will spread in naturally from adjoining areas. It would seem that as far as plants such as bamboos are concerned, this optimistic view of nature's ability to recuperate is unfounded, and a more pro-active approach is required. Sharma (1994) also pointed out that although the Indian Wildlife (Protection) Act of 1972 has provisions for conservation of biodiversity, its

applicability is limited, and a more comprehensive legal framework is required to designate and protect areas characterised by genetic diversity in economic plants. It would seem that efforts are required from many different bodies at local, national, and international level, if a serious attempt is to be made to conserve Himalayan bamboo diversity.

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