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Cover photo: *Langur monkeys are among the most common wild mammals in Indian forests*
I. de Borhegyi

Contents

EDITORIAL

Forest biological diversity

Is a forest with 1 000 species better, and managed better, than a forest with 500 species? This issue of *Unasylva* looks at issues related to forest biological diversity and its conservation and sustainable use. One of the key messages is that numbers are not the only issue.

In the first article, J. Burley clarifies some of the central concepts and issues related to forest biological diversity. He introduces the three levels of biological diversity – genetic, species and ecosystem – and discusses key issues such as value and use, assessment, and public and political attention to the subject.

J. McNeely focuses on forest biodiversity and the role of people at the ecosystem level. Human impacts can be negative (e.g. deforestation, overhunting), but McNeely emphasizes that people are part of many forest ecosystems, and that forests must be managed to balance diverse objectives – to meet needs for timber, fuelwood and non-wood products, to safeguard aesthetic and recreational values and to provide global environmental benefits, including biodiversity conservation.

With intensive forest management practices focused mainly on wood production, forest biodiversity in Poland, as in other countries of Central and Eastern Europe, has decreased in recent centuries even while forest cover has been increasing. In the past decade, however, the conservation of biodiversity has been emphasized in Polish forest policy and practice as one of the central concerns of sustainable forest management. K. Rykowski presents the main principles of Poland's approach to conservation, focusing primarily on production forests. He emphasizes that protected areas are inadequate, on their own, to ensure the conservation of trees and other forest-related species.

To conserve forest biodiversity, new policy and practices are also needed in managed forests in the Brazilian Amazon. M. Kanashiro and co-authors describe the work of the Dendrogene Project, which focuses on providing skills and tools to forest users so that knowledge-based management systems and policies can be applied in practice.

R. Nasi and co-authors examine implications of forest fire for biodiversity. Fire can destroy plant and animal communities, influence species functioning and deprive forest fauna of habitat and food. Yet it is a natural force necessary to maintain the health of certain fire-adapted ecosystems.

Co-management protocols developed in East Africa primarily apply to forests and woodlands managed for local goods and services. Can they also be applied to forests that have global and national value for conserving biodiversity? Using examples from a project on reducing biodiversity loss in Kenya, Uganda and the United Republic of Tanzania, W.A. Rodgers, R. Nabanyumya, E. Mupada and L. Persha stress that communities need to derive tangible benefits as an incentive to conserve.

From a local perspective, there is generally little difficulty in identifying the main threats to forest biodiversity in tropical countries (predominantly habitat loss, encroachment, unregulated exploitation and environmental degradation); thus D. Sheil argues that biodiversity conservation needs to be concerned less with research and monitoring than with good on-the-ground practice. Resources must be allocated effectively if conservation is to be successful, focusing on fundamental priorities such as preventing conversion of protected areas to other land uses and protecting high-profile taxa.

In the next article, C. Palmberg-Lerche shares some thoughts on forest biological diversity conservation, including the need for close links among conservation activities at various levels. She notes the need for dynamic programmes that harmonize conservation and sustainable use of forests and forest genetic resources within a mosaic of land use options, and that include a strong element of active gene management. She stresses that human intervention in nature is not necessarily negative.

Forest plantations are often considered to be limited in biological diversity – perhaps because they are compared with natural forests rather than with the degraded ecosystems that they often replace. In our last article, M.L. Wilkie describes how plantations established centuries ago to stabilize sand dunes in Denmark have become, with time and careful management, species-rich ecosystems.

An important topic not covered here is the equitable sharing of the benefits of biodiversity, which is one of the three main goals of the Convention on Biological Diversity (CBD). This subject was addressed in *Unasylva* 206 (2001), as was the CBD's work programme on forests. The activities of the CBD and FAO in this field are complementary. A box at the end of the current issue refers readers to Web sites for information on FAO's programmes related to forest biological diversity.

As this issue shows, there is no optimal level of biodiversity. There are many reasons why one ecosystem may have more diversity than another – not all of them related to human intervention. Moreover, conservation should not aim at preserving a chimaeric status quo. Changes in biodiversity occur through time in all communities and ecosystems. Conservation management can only be successful in the long term if it uses the intrinsic dynamics of ecosystems and species to conserve their diversity and evolutionary capacity. Productive and protective purposes can be rendered compatible with conservation through sound planning and intersectoral coordination of activities at the local and national levels. ◆

Forest biological diversity: an overview

J. Burley

Some key concepts and issues related to forest biological diversity – the number, variety and arrangement of living organisms within forests – a fundamental resource for human and environmental welfare.

Jeffery Burley is Professor of Forestry at Oxford University and Director of the Oxford Forestry Institute, Oxford, United Kingdom. He is the Immediate Past President of the International Union of Forest Research Organizations.

What's in a word? The term "biodiversity" – a jargon contraction of "biological diversity" – has been particularly contentious or misunderstood, giving rise to conflict and confusion at high levels of policy and science and among the public. Often the aesthetic or ethical attractiveness of individual species or ecosystems has led to calls for their conservation to the exclusion of their wise use to meet human needs in subsistence and economic development. Biological diversity means different things to different people. It receives great but often confused public attention through newspapers, magazines, television and films. There is a pressing need for scientists, natural resource managers and conservationists to clarify their terminology, descriptions, objectives and evaluation methods in order to achieve greater public understanding and political action for the wise management (including conservation and use) of biological diversity.

Forest biological diversity represents a fundamental resource since it includes the world's species and their constituent genes upon which humanity depends for health, prosperity and environmental welfare. The loss of ecosystems, species and genes poses a major threat to the survival of humans and other organisms. This article is intended to clarify some of the central concepts and issues of forest biological diversity.

THREE LEVELS OF BIOLOGICAL DIVERSITY

Biological diversity covers the number, variety and arrangement of living organisms (i.e. all life on earth) (see FAO and IUFRO, 2002, for an overview of definitions). It is typically described, quantified, managed and used at three levels. First, it includes heritable *genetic variation* within and between populations of a given species; this is of particular interest to geneticists and breeders and includes the extent and pattern of population variation, the variation of genotypes and the frequencies, effects and flows of alleles (the different mutational forms of a given gene, and the units upon which selection works to result in genetic diversity). Second, it refers to *variation among species*, which is of special concern to taxonomists, ecologists and conservationists and includes the number, abundance or rarity, and endemicity of species; it has commonly been treated as synonymous with the original term "diversity" used by theoretical ecologists when discussing competition and coexistence of species (Pielou, 1994). Third, it concerns the *variation among ecosystems* and the way in which species interact among themselves and with their environment; this is clearly a major subject of ecologists but it is especially important to ecosystem/landscape managers as it includes the global and local importance of the composition, structure and function of ecosystems, and the existence of so-called "hot spots" of biological variability.

FOREST BIOLOGICAL DIVERSITY

Forest biological diversity refers to the diversity within forests at these three levels. It includes all species of plants, animals and microbes occurring in the forest, not just the tree species. Tropical forests alone contain some 50 percent of all known vertebrates, 60 percent of plant species and possibly 90 percent of the world's total species. Forests, as ecosystems, vary widely throughout the world and include the following broad categories:

- boreal forests in which one woody species is dominant;
- temperate mixed forests with several mixed broadleaved species;
- temperate evergreen forests with a range of coniferous species;
- tropical rain forests with high diversity;
- tropical deciduous forests with relatively low diversity;

FAO FORESTRY DEPARTMENT/FO-0007/J. WOODS

Forest biological diversity at the genetic level (which is of particular interest to geneticists and breeders) involves genetic variation within and between populations of a given species, as illustrated by variation in growth of Douglas fir (*Pseudotsuga menziesii*)

- tropical dry forests with few species growing in open stands.

Each of these ecosystems has a range of types which in turn have their own characteristic faunal and floral components that require different assessment, valuation and management.

For each forest type, the tree species diversity is usually relatively well known and quantified, and the plant species are reasonably well characterized; however, much still remains to be discovered about the animal and microbial species, their identities, genetic variation, interactions and human uses. Furthermore, even among the plants and animals, most attention and resources are devoted to the visually attractive, charismatic species rather than less visible, less attractive species that may be equally important in ecosystem integrity. Some of these less "popular" species may have hitherto unknown uses. Conservation and ecotourism are often promoted through attractive images of large mammals, birds and macrolepidoptera, but microlepidoptera and ants are valid indicators of environmental change, while unseen fungi are essential for ecosystem functioning.

ASSESSMENT

The assessment of biological diversity is complex and varies according to the objectives of the assessor. Typically there are four main reasons for assessing biological diversity (Burley and Gauld, 1994; Bachmann, Köhl and Päivinen, 1998):

- for scientific understanding of ecosystem structure, function and evolution, which is necessary as a basis for managing resources for their life support functions and productivity;
- for conserving and developing germplasm for breeding and genetic improvement of individual species for planted forests and agroforestry;
- to monitor the impact of land management interventions and both natural and anthropogenic environmental changes on biological diversity;
- to decide areas of priority for conservation of biological diversity in its own right for reasons of ethics, aesthetics, religion, culture, scientific enquiry or future production including "biodiversity prospecting" (Reid *et al.*, 1993).

Estimates of biological diversity at the ecosystem and species level need to take into account several sources of variation (Burley and Gauld, 1994). These include: long-term temporal changes and short-term seasonal changes in the diversity of species present in an ecosystem; variation in the numbers, abundance and rarity of individual species through their life stages; mobility of animals causing migration to and from ecosystems; stage of community development; physical position within the ecosystem from the soil to the crown of individual trees; and geographic scale (global, regional, national, ecosystem, habitat or patch).

Whatever the index or indicator required, and whatever scale or sampling intensity is used, the assessment of biological diversity employs a number of methods. These include expansion of traditional forest inventory of trees and timber into multi-taxon surveys based on temporary and permanent sample plots or the long-term ecological research plots used by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Smithsonian Institution, FAO and other international and national agencies. Such inventories are facilitated and enhanced by remote sensing, databases and geographic information systems. Modern biochemical methods are becoming widely applicable for quick and precise evaluation of genetic diversity, systematics and population genetics at the DNA and protein levels (Glaubitz and Moran, 2000).

POLITICAL AND PUBLIC ATTENTION

Much of the recent global attention on biological diversity emanated from the United Nations Conference on Environment and Development (UNCED), held in 1992, and the resultant Convention on Biological Diversity (CBD), which entered into force in 1993. The goals of the CBD are the conservation of biological diversity, the sustainable use of the components of biological diversity, and the fair and equitable sharing of benefits arising from the use of genetic resources. It is noteworthy too that the World Conservation Strategy (IUCN, UNEP and WWF, 1980) defined conservation as “the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations”; this was the first modern attempt to recognize that conservation of renewable resources, including biological diversity, involves wise dynamic use and not just static preservation or protection.

Despite the impression given by recent international policy processes, however, biological diversity and its conservation are not new subjects. Herodotus in 450 BC was aware of the importance of intraspecific variation in tree species although he did not know the word “genetic”. Charles Darwin in the middle of the nineteenth century was well aware of biological diversity and its importance for evolution and ecosystem stability. Foresters at the same time were preparing forest working plans in Europe and India that fully recognized the multiple values of forests, including species diversity, for sustainable use and ecosystem stability for the maintenance of human environments and life processes.

Progress made in the negotiations of the CBD has been greeted with wide acceptance. At the fourth Conference of the Parties in 1998 a work programme for forest biological diversity was adopted which included the following elements in addition to specific research and technological priorities: an ecosystem approach to integrate conservation and sustainable use of biological diversity; an analysis of the impacts of human activities, especially forest management, on biological diversity and ways of mitigating negative effects; and development of criteria and indicators of biological diversity in forests (see Le Danff and Sigaud, 2001).

The fifth Conference of the Parties in May 2000 emphasized the need to progress from research to practical action; this was expanded through the joint meeting of the CBD and the United Nations Forum on Forests (UNFF) in Ghana during January 2002. The joint meeting identified specific areas for collaboration including: forest protected areas; ecosystem management; integration of conservation and sustainable use at the national level (especially between national forest programmes and national biodiversity strategies); cross-sectoral impacts of for-

FAO FORESTRY DEPARTMENT/FO-0334/T. HOFER

Biological diversity at the species level includes the number, abundance or rarity, and endemicity of species; shown, a flower of **Metrosideros polymorpha**, *a tree species endemic to Hawaii, United States*

FAO FORESTRY DEPARTMENT/FO-1065/C. PALMBERG-LERCHE

Biological diversity at the landscape level refers to variation in the composition, structure and function of ecosystems; shown, a well-managed boreal forest in Finland with a mosaic of species including **Pinus sylvestris, Picea abies** *and* **Betula** *spp.*

est biodiversity (including agriculture, water, transport, mining, industrial development and infrastructure); monitoring; and valuation of forests and the goods and services they provide.

Considerable efforts to refine indicators for biological diversity had already been under way within the work on criteria and indicators for sustainable forest management carried out by the Intergovernmental Panel on Forests (IPF) and the Intergovernmental Forum on Forests (IFF), their successor the UNFF, and the various regional criteria and indicators processes (see e.g. Castañeda, 2000; Raison, Brown and Flinn, 2001). In preparation for the sixth meeting of the Conference of the Parties in April 2002, a number of experts contacted informally by the CBD Secretariat propose a breakdown of activities into national and international levels before prioritization; the experts propose that the following priorities should be incorporated into national biodiversity strategies and action plans and national forest programmes: land use changes; reducing forest fragmentation; impact of fires; impact of invasive alien species; restoration of forest ecosystems; management of protected areas; sustainable use; underlying causes of forest biodiversity loss; and capacity building.

VALUE AND USE OF FOREST BIOLOGICAL DIVERSITY

The widespread public and political attention to biological diversity is often emotional, and the reasons for conserving and using such diversity are frequently forgotten. While the levels of diversity may be appreciated and quantified, human needs for them are often overlooked. It is exceptionally difficult to place economic values on biological diversity and there are strong arguments to suggest that morally it is beyond value; however, politically it is essential to obtain estimates of relative values in order to establish conservation areas and programmes, breeding

Forest animal biodiversity

The reproduction of many plant species depends on the presence of a species-specific pollinator, such as pygmy possum pollinating Eucalyptus *sp. in Australia*

CSIRO AUSTRALIA/E. SLATER

The rich animal life of forests has been relatively overlooked by mainstream forestry. Yet animal species are vital to forest ecosystems in a number of ways:

- ***herbivory*** **– grazing and browsing animals influence the structure of the vegetation and can influence its composition as well;**
- ***predation on potential animal pest species*** **– predators large and small keep in check outbreaks of pest species;**
- ***pollination*** **– bats, birds, butterflies, moths, bees and other insects pollinate forest plant species, including trees;**
- ***seed dispersal*** **– dispersal of seeds by bats, birds and a range of animals is often crucial to the survival of plant species;**
- ***seed germination*** **– the seeds of certain plant species need to pass through the digestive tract of a ruminant or bird before they can germinate;**
- ***seed predation*** **– seed predators, which include antelopes, birds, elephants and primates, as well as insects, help maintain the balance of plant species composition of ecosystems.**

These ecosystem functions can also have economic importance. For example, where economically significant plant species are pollinated by animals (such as the durian fruit of Southeast Asia, which is pollinated by cave-dwelling bats), a reduction in the efficiency with which they are pollinated could have economic implications. Similarly, the loss of predators due to indiscriminate use of pesticides can result in crop pest outbreaks leading to economic losses.

Forest animal diversity also has economic significance through the income generated by ecotourism; trade in commercially attractive birds, insects, mammals and reptiles; and income earned from trade in bushmeat (wild animals hunted or collected for food). Meat from forest animals is also important to the nutrition of many people who live in or near forests.

Conservationists have coined the phrase “the empty forest syndrome” to refer to forests in which the fauna has been depleted by hunting to the point where its ecological and actual or potential economic role has been severely curtailed. The long-term implications for forest ecosystems of the loss of animal species are not clear because the issue has not been well studied and the effects are likely to be subtle and slow to emerge.

Measuring radiata pine in a research trial in New Zealand to quantify genetic differences in selected families; such assessment of biological diversity is important for breeding and genetic improvement of individual species for planted forests and agroforestry

FAO FORESTRY DEPARTMENT/FO-0012/A. YANCHUK

programmes and research to ensure future survival and sustainable use. Flint (1991) developed a typology of values for biological diversity that included use values and non-use values.

Use values refer to the current or future utilitarian value of biological diversity to humans and can be subdivided into direct, indirect and option values. Among the direct use values are:

- consumption of forest and tree products such as bushmeat, fruits, fodder, medicines, fuelwood or timber;
- improved production through the use of genes in tree breeding;
- non-consumption uses of ecosystems for amenity, tourism, cultural and religious purposes.

Indirect use values refer to services related to ecological processes and human environments including the moderation of climate; hydrological, carbon and nutrient cycles; water flows and soil conservation, wherever these are dependent on species diversity. Option values reflect public willingness to pay to retain access to habitats, species or genes. Most governments now identify national conservation areas and parks, but there is considerable debate about other option values (such as medicinal uses) because past values of known resources may not provide a good guide to the future value of hitherto unknown resources. It is always possible that a spe-

FAO FORESTRY DEPARTMENT/FO-0259/T. HOFER

A forest ecosystem in the eastern Himalayas, West Bengal, India, very rich in biological diversity – foresters in India have long recognized the value of species diversity for sustainable use and ecosystem stability

FAO FORESTRY DEPARTMENT/FO-0430/C. PALMBERG-LERCHE

The utilitarian value of biological diversity includes consumption of forest and tree products such as bushmeat, fruits, fodder, medicines, fuelwood or timber – shown here, non-wood forest products at a market in Hanoi, Viet Nam

cies will never be of material value but will still have an ethical or existence value.

It is clear that all of these concepts are relevant to forests and the values are therefore subject to reduction if forests are converted to other land uses, silviculturally disturbed or fragmented (Young and Boyle, 2000; Young, Boshier and Boyle, 2000). Tropical forests in particular are fragile ecosystems and their species are vulnerable to human-caused or natural habitat change. The potential impacts of climate change and pollution on forests and their biological diversity worldwide have not yet been determined or fully modelled but it is clear that, in many countries, forest sites that have been set aside as conservation areas will cease to be suitable habitats for many of the species they were intended to conserve (Geburek, 2000; Innes and Haron, 2000).

POLITICAL WILL FOR BIOLOGICAL DIVERSITY CONSERVATION

On a global level, the political will to seek the sustainable management of forests and the conservation of their biological diversity has been widely demonstrated. The work programme of the Convention on Biological Diversity is explicit in broad terms; many signatory countries have elaborated national strategies for sustainable development and the conservation of biological diversity. The immense efforts of the IPF and IFF, the UNFF and the several regional initiatives on criteria and indicators for sustainable forest management demonstrate great political, public and professional concern. However, despite national strategies, implementation at the national level has frequently been disappointing because of lack of financial resources, professional skills and public participation. Historically, policies and management plans have been implemented widely for forest reserves, with particular emphasis on production and environmental benefits; however, deliberate planning and management for the conservation and wise use of the biological diversity of the plants and animals within forest reserves have received less attention, while other reserved areas have come under increasing political pressure for removal of reserved status and public use.

The Global Environment Facility (GEF) during the past decade provided over

Forest plantations and biological diversity considerations

Forest plantations have been referred to by some advocacy groups as "biological deserts". It is true that forest plantations usually have less total biological diversity than do indigenous forests, and their associated biota are also different in composition from those of indigenous forests in the same area. However, forest plantations do not generally replace natural forests – they complement them. Most forest plantations are established on degraded or barren land. The plantations host much greater biological diversity than the degraded land, as well as more than most agronomic crops. The different suites of biota sustained in forest plantations thus add to regional biological diversity. This is a clear positive benefit of forest plantations.

US$1.1 billion to cover the incremental costs for conservation and sustainable use of biological diversity around the world (Singh and Volonte, 2001). While the next phase of GEF activity includes further work on biological diversity, it is recognized that general objectives such as "strengthen capacity" must be replaced by specific impact-oriented aims such as "raise the population of *x* species", "increase the density of *y* forest" or "regenerate *z* area". Actions are now needed to refine and implement methods for the assessment, conservation, monitoring and wise use of the biological diversity of forests worldwide within ethical, legal and institutional frameworks. An example is the guide to good practice produced by the United Kingdom as a contribution to global biodiversity assessment (Jermy *et al.*, 1995). It is equally clear that these actions will only be effective if all stakeholders participate at all stages of the process (Singh and Volonte, 2001). ◆

Bibliography

Bachmann, P., Köhl, M. & Päivinen, R., eds. 1998. *Assessment of biodiversity for improved forest planning.* London, UK, Kluwer Academic Publishers.

Burley, J. & Gauld, I. 1994. Measuring and monitoring forest biodiversity: a commentary. *In* T.J.B. Boyle & B. Boontawee, eds. *Measuring and monitoring biodiversity in tropical and temperate forests*, p. 19-46. Bogor, Indonesia, CIFOR.

Castañeda, F. 2000. Criteria and indicators for sustainable forest management: international processes, current status and the way ahead. *Unasylva*, 203: 34-40.

FAO & International Union of Forest Research Organizations (IUFRO). 2002. Biological diversity. *Multilingual glossary – forest genetic resources.* Internet resource: iufro.boku.ac.at/silvavoc/fgr-glossary/2en.html

Flint, M. 1991. *Biological diversity and developing countries: issues and options, a synthesis paper.* London, UK, Overseas Development Administration.

Geburek, T. 2000. Effects of environmental pollution on the genetics of forest trees. *In* A. Young, D. Boshier & T. Boyle, eds. *Forest conservation genetics: principles and practice*, p. 135-157. Collingwood, Australia, CSIRO Publishing and CABI Publishing.

Glaubitz, J.C. & Moran, G.F. 2000. Genetic tools: the use of biochemical and molecular markers. *In* A. Young, D. Boshier & T. Boyle, eds. *Forest conservation genetics: principles and practice*, p. 39-59. Collingwood, Australia, CSIRO Publishing and CABI Publishing.

Innes, J.L. & Haron, A.H., eds. 2000. *Air pollution and the forests of developing and rapidly industrializing regions.* IUFRO Research Series No. 4. Wallingford, UK, CABI Publishing.

International Union for the Conservation of Nature – World Conservation Union (IUCN), United Nations Environment Programme (UNEP) & World Wildlife Fund (WWF). 1980.*World conservation strategy: living resource conservation for sustainable development.* Gland, Switzerland, IUCN.

Jermy, A.C., Long, D., Sands, M.J.S., Stork, N.E. & Winser, S., eds. 1995. *Biodiversity assessment: a guide to good practice.* London, UK, Department of the Environment/HMSO.

Le Danff, J.-P. & Sigaud, P. 2001. Latest developments in the implementation of the work programme on forests of the Convention on Biological Diversity. *Unasylva*, 206: 32-33.

Pielou, E.C. 1994. Biodiversity versus old-style diversity: measuring biodiversity for conservation. *In* T.J.B. Boyle & B. Boontawee, eds. *Measuring and monitoring biodiversity in tropical and temperate forests*, p. 5-17. Bogor, Indonesia, CIFOR.

Raison, R.J., Brown, A.G. & Flinn, D.W., eds. 2001. *Criteria and indicators for sustainable forest management.* IUFRO Research Series No. 7. Wallingford, UK, CABI Publishing.

Reid, W.V., Laird, S.A., Meyer, C.A., Gamez, R., Sittenfeld, A., Janzen, D.H., Gollin, M.A. & Juma, C., eds. 1993. *Biodiversity prospecting: using genetic resources for sustainable development.* Washington, DC, USA, World Resources Institute.

Singh, S. & Volonte, C. 2001. *Biodiversity programme study.* Washington, DC, USA, Global Environment Facility.

Young, A., Boshier, D. & Boyle, T., eds. 2000. *Forest conservation genetics: principles and practice.* Collingwood, Australia, CSIRO Publishing and CABI Publishing.

Young, A.G. & Boyle, T. 2000. Forest fragmentation. *In* A. Young, D. Boshier & T. Boyle, eds. *Forest conservation genetics: principles and practice*, p. 123-134. Collingwood, Australia, CSIRO Publishing and CABI Publishing. ◆