Genetic biodiversity in agricultural and natural systems: Measurement, understanding and management

Report of an Electronic Conference, 6th-31st October 2003

BIOplatform

EPBRS EUROPEAN PLATFORM FOR BIODIVERSITY RESEARCH STRATEGY

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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This report should be cited as follows:
Young, J., Buiatti, M., Pannacciulli, F., Sbordoni, V., Vazzana, C., Negri, V., Broggio, M., Bocci, R. and Watt, A. (editors) 2003. Genetic biodiversity in natural and agricultural systems: Measurement, understanding and management- Report of an e-conference.

Contents

Preface

Research on biodiversity is essential to help the European Union and EU Member States to implement the Convention on Biological Diversity as well as other biodiversity related directives. There is a need for co-ordination between researchers working in this field, the policy-makers that need the research results and the organisations that fund research in this field.

BioPlatform is a network of scientists and policy makers that work in different fields of biodiversity and aims at improving the effectiveness and relevance of European biodiversity research, fulfilling functions that provide significant components of a European Research Area. BioPlatform supports the existing "European Platform for Biodiversity Research Strategy" (EPBRS), a forum of scientists and policy makers representing the EU countries, whose aims are to promote discussion of EU biodiversity research strategies and priorities, exchange of information on national biodiversity activities and the dissemination of current best practices and information regarding the scientific understanding of biodiversity conservation.

This is a report of the BioPlatform E-conference entitled "Genetic biodiversity in agricultural and natural systems: Measurement, understanding and management" preceding the EPBRS meeting to be held under the Italian Presidency of the European Union in Florence, Italy from the 20th to the 24th November 2003. This meeting will discuss the current understanding of genetic diversity in Europe, the current threats and ways in which to conserve it.

Introduction

Adaptation processes, at all levels of the hierarchical organisation of life, are mainly based on the so-called "explorative strategies", involving the generation of quasi-random variability and its selective usage in the plastic response to the ever-changing signals coming from internal or external (environmental) contexts. In particular, genetic variability is exploited for the adaptation of populations and species, developmental plasticity being used for a number of phenotypic adaptive processes such as, for instance, modulation of physiological functions, synapses organisation in the brain throughout life or explorative behaviours like those used by ants and many other animals in the search for food. Within this frame, genetic diversity has many functions. In natural systems it allows species survival in the presence of changing environments and maintains the necessary plasticity of interactions in ecosystems. In agro-ecosystems it can be the basis for diversification of agriculture in response to human needs and environmental changes. For this reason, and for a long time, human cultural differentiation in local communities and therefore in different environmental and social contexts, has led to the fixation of genetic variability of domesticated organisms correlated with human cultural variation, through the wise use of selective techniques. Such a process, led by humans, has occurred in a few thousand years, due to the extraordinary efficiency and power of human minds. A correlation between the genetic variability of leaf-cutter ants and coleopters devoted to farming and that of their domesticated fungal "crops" has taken many million years to be determined by selection.

Until a few centuries ago human driven selection had been aiming at the adaptation both to the environment and to human cultures and needs. Lately, and particularly in the last two centuries, humans have been changing their strategy from adaptation to the environmental conditions, to adaptation of the ecosystems to human projects. This strategy, without a sufficient conscience of the limits of nature exploitation, has led to the fast reduction in genetic variability of most species through climate changes and habitats destruction, but also through the specific drastic homogenisation of the genotypes of domesticated organisms. In this case, reduction of cultural diversity has been paralleled with the elimination, through selection, of plant and animal genotypes not considered to be useful for the proposed and leading mono-tonic model of agriculture and food. Due to the intimate connection between human local cultures and organisms living in cultivated areas, agro-ecosystems are a privileged object for research on the social and economic effects of genetic diversity loss and, conversely, on the impact of the accelerated dynamics of local and global societies on genetic variation in domesticated organisms and their habitats.

The aim of this E-conference is therefore to open an interface discussion on genetic diversity not limited to non-humans but extended to the research field of human ecology, where the dynamics of cultural variation in our species is correlated with that of the inherited variability of the other inhabitants of our planet.

The conference will be subdivided in three sessions, each led by a chairman who will write a keynote introduction to the subject, and stimulated on more specific areas by other keynote writers. Session 1 will explore genetic variability in natural populations and species in natural systems. Session 2 will focus on genetic variability in agro-ecosystems, with specific attention devoted to the practice and ethics of variability conservation by agriculture, the role of international organisations and NGOs on the in situ and ex situ maintenance of genotypes along with a comparison of the two methods, the specific techniques used for monitoring and measuring biodiversity of agricultural interest. Finally, session 3 will address the evaluation of the impact of economic and social factors on genetic diversity, targeting the impact of trading rules and intellectual property rights on biodiversity, the question of the interpretation of rules defined within the frame of the Convention on Biodiversity such as those related to the "equitable sharing" principles, the social and cultural value of biodiversity.

Session 1

Measuring, managing and conserving the genetic diversity of populations and species in natural systems

Measuring, managing and conserving the genetic diversity of populations and species in natural systems: opening comments

Valerio Sbordoni, Session chair, Dipartimento di Biologia, Università di Roma "Tor Vergata", Italy.

Genetic diversity is one of the three basic levels into which biodiversity can be structured. It is concerned with the spatial and temporal variation of gene pools within and among populations and species. Understanding patterns of genetic diversity in natural populations and their underlying causes has represented so far the backbone of the population genetics, a science that provided major insights into the evolutionary process.

The challenge now is: are we able to use genetic information to manage and conserve biodiversity? In the last few years, the outstanding progress in molecular biology, theoretical population genetics, and bio-informatics produced a blooming of new molecular techniques and analytical algorithms to measure virtually any sort of genetic variation of any living organism. Which of these tools are capable of providing practical guidelines to face the ongoing process of genetic erosion and species extinction? In other words, how can operators such as politicians, bureaucrats and managers who are involved in making conservation-oriented decisions use the great deal of genetic information produced?

Conservation genetics attempts to fulfil the recommendations of the Rio Conference, which urged the preservation of natural population gene pools from erosion and extinction. This discipline deals with a variety of issues, all of which can be addressed, and in many cases guided, by the use of molecular genetics, i.e.: delimitation of species and conservation units, phylogeny reconstructions, population structure, introgression, hybridization, colonization dynamics, etc. Additionally, conservation genetics may have a role in the optimal design of captive breeding programs and germplasm management and conservation.

However, some limitations of molecular approaches are apparent. For example, several scientists question the dogmas of conservation, which are the expected effects of effective population size on inbreeding depression. Moreover, molecularly based phylogeny may only provide a skeleton to which other taxa, whose genes will not be sequenced for eons to come, must be linked by using phenotypically based systematic relationships. It is a pity, however, that the morphology-based systematic expertise has not been promoted in the last twenty years, an attitude resulting in increasingly high rate of extinction of taxonomists.

Another important aspect worth discussing in this conference is related to conservation of communities and habitats rather than target species. Ultimately, this means proper choice and management of areas and landscapes. Mapping biodiversity to provide GIS relevant information to environmental planners is certainly wise. However, which indicators are relevant to biodiversity conservation is a controversial issue.

Data integration appears to be the key to success in conservation. In this context comparative phylogeography, combining data from different organisms, and the emerging discipline of landscape genetics are promising fields, capable of providing information on genetic diversity manageable through GIS technology. This could fill, at least in part, the gap between evolutionary biologists, environmental planners and decision makers. I hope that this conference will promote discussions about these and other topics relevant to management and conservation of genetic diversity in nature.

The potential of molecular tools in detecting and recording information on the genetic diversity within and between gene bank accessions

Theo J.L. van Hintum, Centre for Genetic Resources, The Netherlands.

KEYWORDS: Genebanks, neutral markers, functional markers, funds, cost effective molecular techniques.
SUMMARY: Molecular tools, based on neutral or functional markers, have a great potential for genebanks. The costs are however still a major limiting factor.

Genebanks need new tools to further improve their operations. This relates to all aspects of genebank management: acquisition, maintenance, characterization / evaluation and utilization. At the moment information and communication technology and molecular genetics are likely sources of these tools. Molecular biology since it allows a direct look at the DNA, the stuff genetic diversity is all about.

Molecular tools for genebank management at the moment can be divided in the application of neutral molecular markers and functional molecular markers. The neutral markers based on random regions of the genome include the widely applied AFLP and microsatellites. They are used to quantify diversity within and between accessions, or to predict occurrence of traits based on tight linkage, as in marker assisted selection. Quantifying diversity can be suitable to validate expected duplication of genebank accessions, or to monitor changes during regeneration of a genebank accession. They are, however, less suitable to be used to optimise the composition of a collection or a selection thereof since the diversity quantified by neutral markers may be different from the diversity desired by the user of the germplasm. The users will generally be interested in functional diversity: new traits, new alleles for known traits. A large experience has been build up as to the pros and cons of neutral markers for the quantification of diversity. The possibility to use for genebank purposes neutral markers qualitatively, as linked to traits, has been explored less extensively. It should, however, be possible to use known linked marker to predict if a trait occurring in an accession is based on a new allele or on a known one, already in use in crop breeding.

The functional markers are generally used as a qualitative tool. These markers are based on a PCR primer targeted to a conserved part of a gene combined with one matching a less conserved part. As a result the marker can indicate if an allele is present or not. Such functional markers could also be used to quantify functional diversity if the appropriate generic functional markers were available. Experience with this tool, both qualitative and quantitative, is still very limited. Much research is going on in this field, mainly concentrating on the qualitative approach under the heading of 'allele mining'.

Thus, molecular tools clearly have a great potential for quantifying diversity and identifying new alleles. However, there is a major pitfall: the costs. Quite standard and efficient systems for the detection of neutral markers are already available to the genebank community. However, the costs of using these systems may be substantial. As a result the application of molecular tools in genebanks are largely restricted to research oriented model studies. Application in standard genebank protocols is still very limited since the funds have to compete with alternative classical activities of proven value. The development of more cost effective molecular techniques and strategies for applying these in genebank protocols is therefore a prerequisite to a successful application.

Genetic diversity in forest trees

Ricardo Alía, Maria Teresa Cervera and Dolores Agúndez, Forest Research Centre, Madrid, Spain.

KEYWORDS: Forests, quantitative genetics, genomics.
SUMMARY: Forest diversity has to be assessed combining different fields of expertise to identify meaningful evolutionary significant units and to preserve adaptability of forest species to changing environments and to fragmentation.

Forest ecosystems play a major role in the preservation of biological diversity: they cover 30% of the surface at the world scale and 46% at the European scale, forest trees are among the most genetically diverse organisms (Hamrick et al, 1992), and they harbour communities of other organisms.

Genetic variability (term preferred to genetic diversity when adaptive traits are concerned) has been studied in forest species for more than 200 years (Langlet, 1971). Provenance research, i.e. the analysis of geographical variation in common environment experiments, have been broadly used in order to define patterns of genetic variation, to study adaptation to different environments, and to determine the relationship between environmental conditions of seed lot origin and the site where they were tested.

Quantitative genetics has demonstrated that adaptive traits in general are characterized by high heritabilities and large population differentiation. Molecular markers have been extensively used to determine levels of genetic variation in many forest species, and to unravel genetic structure (distribution of diversity at different levels: regions, populations, etc.) of the species. At present, genetic diversity has been analysed for many forest species all over the world. Range-wide studies have demonstrated the pattern of genetic diversity of many forest species and the influence of post-glacial migration, human intervention, and other factors in shaping the genetic architecture of the species (examples of range-wide studies are those of Kremer et al. 2002, Vendramin et al. 2002, Bariteau et al. 2002, among others). Species from the same genera and similar distribution can differ greatly in their levels of diversity among and within populations. Comparisons of levels of differentiation among quantitative and molecular traits have shown the important role of selection in the genetic structure of species (Merilä & Crnokrak, 2001; Reed & Frankham, 2001; McKay and Latta, 2002).

Studies on gene flow at the local scale are being undertaken to analyse the mating systems of the species, the processes of natural regeneration, and how they affect the genetic diversity within populations. These analyses are essential to undertake conservation programs of genetic diversity, identify Evolutionary Significant Units (Fraser & Bernatchez 2001) and establish sustainable forest management systems. These goals have been addressed recently, by implementing the resolutions from the Ministerial Conferences on the Protection of Forests in Europe (MCPFE) that have recommended the preservation of genetic diversity and the sustainable use of forest resources. As a result, the program for the Conservation of Forest Genetic Resources (EUFORGEN) has been implemented in Europe.

As diversity has mainly been assessed for anonymous and neutral markers (due to the long life cycle of most forest species), there is an important need for developing methods to analyse in situ diversity for traits of adaptive significance. In this context, genomics is an essential tool to assess diversity at its fundamental scale (genes and nucleotide), and to extend the results to the population level. To assess adaptive diversity is an important challenge for research, which requires the creation of new methodologies, data resources, and can effectively be addressed through common garden experiments, genomic studies and gene flow analysis.

The conservation of common and endangered conifers in the Maritime Alps

Giorgio Binelli, Department of Structural and Functional Biology, University of Insubria, Varese, Italy

KEYWORDS: Plant genetics, Maritime Alps, environmental change, adaptive genetic variability.
SUMMARY: Maritime Alps represent a hotspot for plant biodiversity. The assessment of genetic diversity in this area can therefore provide guidelines for the in situ and ex situ conservation of plant genetic resources.

The interlinked themes of assessing genetic diversity and of conservation have become a major focus for Plant Genetics and are likely to play this role again in the near future. In fact, increasingly rapid environmental changes, caused by human activities at the local and global scale, are expected to impact wild populations of plants by altering their fitness to the environment they presently occupy. The possible impacts on natural resources under this scenario are those of the loss of genetic diversity (genetic erosion) and therefore of fitness. This, combined with the loss of wilderness area due to human activities, will have a deleterious effect on the ability of many species to survive (or to maintain levels of genetic diversity suitable for survival). Although in the management of natural resources genetic criteria must be integrated with balanced human activities, the assessment of the amount and distribution of genetic diversity is an essential prerequisite for any protection action. In cases where the type of stress, or environmental change, can be clearly identified (e.g. climate warming, desertification, reduction of the natural range, overexploitation), and the genes or genetic processes involved in response are known, the observation of populations can gauge the pressure they are subject to, and predict the ability of populations and species to respond to stress.

The reconstruction of the possible recolonisation routes by important tree species (beech, oak, spruce) after the last Ice Age points to the Alps as one of the suture zones between different migratory flows (Taberlet et al., 1998; Hewitt, 2000). Maritime Alps can be considered as the most important centre of endemism of the whole Alpine chain, being characterised by 32 exclusive endemic species (Pawlowski, 1970). Besides, Maritime Alps represent, together with South-Eastern Alps, one of the two main refugia of Southern Alps where alpine taxa concentrated during quaternary glaciations (Favarger, 1972). In the case of Norway spruce it was proposed, based on the analysis of the patterns of genetic variation by means of molecular markers, that possible refuges have occurred in the Argentera region (Scotti et al., 2000). The Maritime Alps also represent the major gate for Mediterranean species migration along Alpine chain: isolated relict colonies of Mediterranean species can be found (Juniperus phoeniceae).

This kind of environment will presumably get involved in the future in processes such as the reduction of rainfall, related to global warming and to the tendency to desertification that Mediterranean areas have already started to experience. It is therefore of paramount importance to obtain data on the genetic variability of the selected species both at neutral loci by the use of molecular genetic markers and at loci involved in the response to environmental stresses related to water metabolism ("adaptive genetic variability"). Finally, based upon geographical, climatological and paleoclimatological data, as well as on the description at the genetic level of the populations analysed, the use of Geographical Information Systems (GIS) could provide an integrated model to understand the possible singularities in the distribution of genetic variability in the Western Alps.

E-Conference comments

Allan Watt, Centre for Ecology and Hydrology, Banchory, UK

I have greatly enjoyed reading the contributions to the e-conference this week, although being very unfamiliar with the topics discussed, I had to read each of them several times!

The main purpose of these e-conferences is to identify research priorities, not only for the European Commission's Framework Programmes, but for the whole research community engaged in research on biodiversity in Europe. Therefore, although I enjoyed reading the contributions to the e-conference, I am left wondering what the many participants in this e-conference (over 400 of you!) think about research priorities in this area. It is not the task of the keynote contributors to list the research priorities; it is up to us, the participants, to discuss them. Given the current lack of discussion, I am left wondering whether the participants feel that this area has low priority in general. I do not agree and having worked on the conservation of genetic diversity in endangered tropical trees, I feel that research in this area should have a high priority. However, I would like to know what the participants consider to be the priorities for research within Europe.

As you know, The European Platform for Biodiversity Research Strategy is a forum for scientists and policy makers to ensure that research contributes to halting the loss of Biodiversity by 2010, to quote its mission statement. The purpose of this e-conference may be stated as answering the following question:

To gain the knowledge necessary to halt biodiversity loss by 2010, which research action points have the highest priority?

I look forward to hearing your views, however short, blunt or speculative.

RE: E-Conference comments

Jim Mallet, Galton Laboratory, Department of Biology, University College London, UK

KEYWORDS: Blue skies science, funding, research programmes, training.
SUMMARY: The author acknowledges the importance of species concepts, introgression and gene flow (both within and between species) in biodiversity and conservation, but points out a few worrying trends in funding. He argues for the promotion of overall excellence in science, a move away from narrow programmes dictated by special interests or current fads and the broad training, prestige, and advances provided by a well-funded, high-quality science base.

I have decided to reply to Allan Watt's note in what I hope is the spirit intended. Maybe this will get a response!

My laboratory is engaged in studies of the genetics of biological diversity just above and below the species level. We have been particularly concerned with speciation in South and Central America, and work with Lepidoptera, which are in general well-collected and have a well-known enough ecology to be useful in investigations of speciation.

I am sure I don't have to argue with this audience about the importance of species concepts, introgression and gene flow (both within and between species) in biodiversity and conservation. However, several trends in funding are troubling.

In Europe and also in Britain (including at NERC) funding organizations tend to focus on immediate local, applied research, rather than to take a global and broad-ranging "blue skies" approach to funding the best science whatever the field. This has resulted in Britain and Europe of increasing numbers of directed "programmes" as opposed to responsive mode science judged entirely on scientific quality.

Of course government-funded research is funded by the taxpayers, who undoubtedly want to see applications result from their funding, but I believe that if the funding promotes parochial science, the taxpayer is very poorly served. My colleagues and I are aghast when we read what European Commission research is supposed to achieve in the field of biodiversity. It seems most likely from the way these Frameworks are written that huge amounts of money will go to fund boondoggles, at least in the funding areas about which I know anything.

Of course, perhaps the people who write these programmes will argue that they can't possibly fund research as airy-fairy as studies on speciation in butterflies and moths in the Amazon, and that they must restrain scientists from being funded in such useless areas of research. To this criticism I would reply robustly:

1) We obtain international-quality scientific results published in major high-profile journals.

2) The results on studies of speciation, the debates about species concepts, hybrids in conservation, and whether speciation takes place in allopatric Pleistocene refuges or via natural selection while in gene flow contact with sister populations, are all extremely important issues in the understanding of global biodiversity, and inform conservation policies directly.

3) Perhaps the best-supported claim that I can make about the sorts of research we do being valuable for the community is about training. One of my ex-student students, who has just graduated with a PhD, is now working in the Forensic Science Laboratory, London, which analyses many of the UK DNA and chemical samples from crime scenes in the UK. The care and attention to detail she needed in the laboratory, as well as the molecular and population biology skills she acquired while here is now contributing to our quality of life by making Britain a safer place. She is only the most recent graduate from my laboratory. Other students and postdocs are equally successful, in business and journalism, as well as science.

The idea of training lots of people to be butterfly speciation experts may not at first sight seem very sensible, but successfully carrying out a difficult molecular/field project, giving talks and writing up the results is a far more general training than this immediate goal. At the same time, this training contributes directly to the understanding of the natural world and the scientific prestige of our national and European institutions.

In the USA, blue skies science funding has always taken a top priority (though they have their share of boondoggles too), and it seems likely that their continued competitiveness in high-tech is due to this science policy - a policy that has been consistently followed and strengthened by successive Republican and Democratic governments. The USA also wins an increasing fraction of Nobel prizes, and the large amount of money in science attracts increasing numbers of major European and other world scientists to leave their homes for American academic or industrial science posts.

In Europe, I believe we need to take a leaf out of the Americans' book and promote overall excellence in science, and reduce our emphasis on narrow programmes dictated by special interests or current fads. We Europeans need the broad training, prestige, and advances provided by a well-funded, high-quality science base.

RE: Genetics of biological diversity and blue-skies research

Giorgio Bertorelle, Department of Genetics, University of Ferrara, Italy.

KEYWORDS: Blue-skies research, conservation genetics, science, practical implications.
SUMMARY: The author agrees with the need for blue-skies research funding and supports the importance of genetic studies for the development of territorial and environmental politics in Europe but stresses the fact that the final goal in sciences related to the protection and management of threatened species and natural habitats is to find out what should be done on a practical level.

I would like to add just few comments to this e-conference, considering some points raised by Jim Mallet and at same time vigorously supporting the importance of genetic studies for the development of territorial and environmental politics in Europe.

I totally agree with Jim Mallet when he says that funding blue skies science is fundamental, given that most of the advances are reached when good science is produced, almost independently on the short-term implications. Some fields more than others, however, are "applied" almost by definition, having a clearly applied final goal. Conservation biology and conservation genetics, I think, are among them, and also the title of this conference: Measuring, managing and conserving the genetic diversity of populations and species in natural systems, includes at least two words, managing and conserving, which have an obvious practical implication.

As a logical consequence, I do not expect that somebody will fund a population genetics, or evolutionary genetics, or molecular taxonomy study within a framework of "conserving biodiversity" if the proposal will not clearly identify the practical implications of the study. All scientists believe that these kinds of studies are very important for defining strategies to conserve biodiversity, but are the policy makers who should be convinced about that. And I do not think that saying only that the most important thing is doing good science, or that doing that the training of young people will be very good, will convince the people in Brussels who are deciding how to allocate money to stop biodiversity loss, or how to restore it, to allocate this money (or part of it) for genetic diversity studies.

We should on the other hand stress always the fact that not only the study of genetic diversity is very important to reconstruct evolutionary processes of divergence, introgression, migration, hybridization, population decline, etc., but it is always very useful to solve practical problems of management and protection such as restocking, reintroductions, selected hunting, captive breeding, selection of habitat and species to protect with larger efforts. We should always try to do good science, in conservation genetics as well as in any other field, but we should not forget that the final goal in sciences related to the protection and management of threatened species and natural habitats is typically a practical one: what should we practically do? I think that if we want that the study of genetic diversity will have high funding priority within "conserving biodiversity" calls (and not just "studying biodiversity" calls) the practical implications of these studies should always emerge very clearly.

Effects of human activities

Marek Sammul, Institute of Zoology and Bortany, Estonian Agricultural University, Tartu, Estonia.

KEYWORDS: Management, comfort, ecosystem dynamics, long-term impacts.
SUMMARY: The author argues for the need to carry out research on the estimation of the effects of managing natural resources- especially long-term effects of human activities- not only on natural communities, but also long-term effects on economy, social interactions and human populations.

My contribution originates perhaps from the main keywords of this e-conference: measurement, understanding and management. Inevitably, all human activities can be seen as a kind of management. We manage our environment in all possible ways to make it more comfortable for us. Sometimes, but not often, the presence of populations of other species- I don't mean agricultural species such as crop or domesticated animal species here- is considered when trying to improve this comfort. The condition of other species, their needs and status are also examined and some measures are taken to improve them. In general however, we don't understand what the role of the other populations is (or biodiversity in general) in the maintenance or improvement of our own comfort. We don't understand how our own management methods influence our own comfort. There is still not enough information on how human activities, whatever reasons they have (including measures directed at the protection of habitats or species), really influence the functioning of ecosystems or dynamics of populations or evolutionary processes (see e.g. contributions by Kadri Tali and Robin Moritz).

The larger the scale we look at, the more obvious the lack of information and the bigger the need for more research. We can often estimate status and predict needs of certain populations or communities with fair probability. But to generalise from that to species level or ecosystem level or even further up to the dynamics of the whole biosphere we cannot. However, the larger the scale the more important it becomes for humans. The largest effect of global change is going to be on human comfort. Which in turn is also going to directly influence the status of other species and all ecosystems.

Basic research in population and community ecology and evolution could provide the answers to these developments, as pointed out by James Mallet. Additionally, direct applied science can improve our understanding of how human activities are changing ecosystems. I argue here that one of the largest research needs is the estimation of the effects of managing natural resources- especially long-term effects of human activities- and not only the effects on natural communities, but also long-term effects on economy, social interactions and human populations.

Possible evolutionary consequences of different management regimes

Kadri Tali, Institute of Zoology and Botany, Estonian Agricultural University, Tartu, Estonia.

KEYWORDS: Grassland diversity, traditional grassland management, heterochronic mechanisms, phonological differentiation.
SUMMARY: Semi-natural communities are one of the most species-rich biotopes in the temperate zone. Besides enabling species with different habitat requirements to grow together, traditional management may have had more direct impact on taxon formation in some grassland species.

It is proposed that the early and late flowering forms of *Gentianella amarella*, *Neotinea ustulata*, *Rhinanthus glacialis* and other such taxa have been created and maintained as a consequence of former grassland management practices (Tali and Kull, 2002; Winfield et al. 2003; Zopfi, 1998). Molecular analyses have proved, at least in cases of *N. ustulata* and *G. amarella*, that there is very little genetic difference between these phenologically well separated taxa and thus these are probably very young taxa. It may be that there has been selection for alleles at a small number of loci (or even a single locus), as a result of the traditional management of grasslands - mowing or grazing in July would have removed forms with intermediate flowering times and driven selection for the two extremes, early and late taxa of the species. AFLP data of *N. ustulata* indicates that phenological differentiation has taken place independently in England and in Estonia, the geographical differences being greater than the differences between late- and early-flowering populations (Tali et al. in press).

Such taxa have not evolved any form of isolation barrier in the brief time that they have been separated by the influence of man. Changes in land management (abandonment of pastures and meadows) have removed the barrier to hybridization, the removal of the selective force has allowed flowering times to overlap and no profound changes in the gene pools can take place. Now hybridization between such relatively newly formed taxa is threatening the integrity of them. Nevertheless, the removal of former management practices has not taken place sufficiently long ago to allow complete elimination of genetic differences between the extreme types. The reintroduction of former management regimes would probably ensure the maintenance of heterochronic forms, varieties or subspecies as distinct entities.

In the literature there are few examples of infraspecific differences in the onset of flowering of more than five weeks (Rhinanthus species, *Madia elegans*). Heritable infraspecific differences in flowering times usually do not exceed two to four weeks (*Prunella vulgaris*, *Scabiosa columbaria*, *Verbascum thapsus* etc.) (Zopfi, 1995). If heterochronic mechanisms adjusting species' fitness in differentiated conditions work so quickly, why isn't it more universal in semi-natural communities where hay-making and grazing have influenced grassland species for centuries. Or is it more universal and we just haven't realised it???

RE: Possible evolutionary consequences of different management regimes

Paolo Degli Antoni, Italian Academy of Forest Sciences, Italy.

Kadri Tali, your article makes me consider how rich environmental diversity is in Europe. We are lucky!

You studied how traditional grassland management could positively affect genetic diversity inducing different blooming times in populations of wild species, thus separating each other. In a flat land mowing can be the main cause of reproductive separation.

In the hilly landscape of Tuscany however, different exposures to sunlight induce important reproductive separation, because blooming time can vary up to a whole month in the same altitude range; this occurs, for instance, for wild orchids blooming in early spring (March), when sun radiation is dramatically different compared to opposite slopes. Species blooming later (June) have nearly the same radiation in each slope; so, reproductive separation is less common. The Maremma Park, with its varied landscape and environment, is considered as one of the origin-sites of some wild Mediterranean orchids.

The same species also live at different altitudes and on different soils; this induces a natural selection in the wide genetic range of each species. For instance, this occurs for *Quercus peduncolata*, whose different populations are found on hilly clays or in riparian forest, each one tolerating its own environmental limitations, but not those of other populations; this adaptation is then genetically fixed. In our territory I suppose that different management regimes may have evolutionary consequence as well, but they are just one among many factors of differentiation.

Measuring, managing and conserving the genetic diversity of honeybees (*Apis mellifera*) in natural systems

Robin Moritz, Institut für Zoologie, Martin-Luther-Universität Halle-Wittenberg, Germany.

KEYWORDS: Honeybee, beekeeping, introgression, wild populations.

SUMMARY: The biology of endemic European honeybees and beekeeping traditions in Europe are both diverse, however, the introgression of imported honeybees can have serious consequences on wild honeybee populations. Possible endemic wild population conservation strategies include the use of reserves, using only endemic honeybees for beekeeping and regulations to control honeybee transport.

Genetic diversity in European honeybees (*Apis mellifera*) falls into two postglacial lineages. One lineage includes two subspecies (*A. m. iberica, A. m. mellifera*) ranging from Gibraltar to Scandinavia and from Ireland to Poland. The other includes subspecies from central Europe and the northern Mediterranean (*A. m. carnica, A. m. ligustica*, several others). As diverse as the biology of the endemic subspecies are the beekeeping traditions in Europe. They have deep cultural roots because beekeeping dates back to prehistoric ages. In spite of numerous honeybee-breeding attempts to improve colony performance, honeybees essentially remained "wild" animals with the potential to survive in the wild. Bee-breeding schemes often rely on imported stock and can endanger endemic honeybee populations. Wild and managed populations co-exist sympatrically, and managed populations typically outnumber local wild populations by far. Because queens find and mate with drones from distant locations (>10 km), wild and managed populations are genetically mixing. As a consequence wild populations can be extinct by massive gene flow from imported stock.

Two examples drastically illustrate how introgression of imported honeybees had disastrous consequences.

1) Honeybee queens were imported from Africa to Brazil in the 1950s and spread as "Africanized" honeybee swarms within few decades to the southern states of the US (Visscher and Baptista, 1996). The media termed these honeybees as "killer bees" because of their enhanced defence behaviour.

2) Capehoneybees (*A. m. capensis*) from the Western Cape in South Africa were transported by migratory beekeepers in large numbers to the north, causing the so called "capensis calamity" in beekeeping in *A. m. scutellata*. Thousands of scutellata colonies were destroyed due to the invasion of parasitic *A. m. capensis* workers, which can kill the queen, establish themselves as pseudoqueens and eventually destroy the colony (Neumann and Moritz, 2002).

In Europe the effects of anthropogenic honeybee transport may currently appear less spectacular. The impact of bee breeding practice on population structure is however clearly detectable. For example the differences in population structure on the Iberian peninsula (little or no breeding) and Italy (strong breeding and migration) are remarkable. No population substructuring was detectable between north and south Italy (Marino et al. 2003) whereas in Spain various discrete subpopulations can be found (De la Rua, 2003).

Honeybee breeding must take into account the need for conserving endemic wild populations (Kraus and Moritz, 2003). In the past honeybee breeders were concerned that wild populations interfered with the bred stock. From a biodiversity perspective it is essential to protect wild populations from the managed colonies. This can be achieved by establishing honeybee reserves and using only endemic honeybees for beekeeping. Some European nations already have regulations in place to control honeybee transport. The island of Læsø for example is a reserve to conserve Danish honeybees. On the mainland the size of these areas must exceed the mating rage of queens and drones (10 km²) and the number of participating beekeepers need to be sufficient to sustain viable population sizes. This is not only a question of ecological constraints but also of beekeeper motivation. Extension work must therefore include economic aspects. Extension officers must explain why local bees are better than imported stock in spite of potential short-term benefits (e.g. marketing regional honey of regional bees, reduce spread of diseases, improved mating control).

Conclusion: The problem of managed populations introgressing into wild populations is not unique to the honeybee. Similar examples are know from fisheries were streams and lakes are restocked by bred fish after fishing (Gross et al. 2001; Koskinen et al. 2002). Consequently few breeding lines dominate entire aquatic systems at the expense of endemic species and subspecies diversity. The honeybee may be a good model system to illustrate such introgression processes; yet the conservation management concepts require individual solutions for each species affected.

Session 2

Measuring, managing and conserving local genetic diversity in agro-ecosystems

Measuring, managing and conserving local genetic diversity in agro-ecosystems: Opening comments

Concetta Vazzana (University of Florence, Italy) and Valeria Negri (University of Perugia, Italy), Session Chairs.

The expression "conservation of local genetic diversity in agro-ecosystems" contains an inherent contradiction in terms: a) agriculture has adversely affected local genetic diversity at the species and ecosystem levels through restructuring of landscapes, the use of chemicals, the introduction of high productive varieties, hybrids and genetically modified organisms; b) for most farmers, genetic diversity means weeds, insects, disease and competition for land.

There are powerful cultural, aesthetic and ethical arguments for the conservation of agro-ecosystem diversity, and some of these are directly relevant to agricultural production: Agriculture can benefit from greater biodiversity and loss of biodiversity threatens essential agro-ecosystem processes; In crops, biodiversity maintains production in difficult environments; In the soil, microfauna break down organic matter, maintain the quality of soils and recycle nutrients; Insects pollinate crop plants and fruit trees and prey on agricultural pests; Hedgerows and woodlots attract beneficial insects and predators that feed on agricultural pests. The different components of biodiversity are responsible for general ecosystem resilience and there is no questioning the fundamental role biodiversity has had in shaping and maintaining the landscape in which we practice agriculture.

In the agricultural context, genetic material of commercial value remains undiscovered and those unexploited plant and animal species may be important for the development of sustainable farming systems in the future. There is a growing recognition of the importance of landraces, both as components of sustainable production systems and as sources of variation for modern plant breeding. However, knowledge about the various effects of farmers' practices and government policies on the sustained conservation of landraces is limited.

Local diversity conservation in agro-ecosystems could be defined as the conservation of entire ecosystems, including immediately useful species (such as cultivated crops, forage and agroforestry species) as well as their wild and weedy relatives that may be growing in nearby areas (in situ conservation on farm).

There are many questions arising from the previous considerations:

- Should the emphasis lie on genetic variety within species, species diversity, or ecosystem diversity?
- What level of biodiversity is required to maintain agricultural landscapes in a condition "fit for the purpose" of agricultural production?
- Is it possible to develop local farming systems that conserve sufficient biodiversity to restore ecosystem health without significant social and economic changes?
- What is the amount and distribution of genetic diversity maintained by farmers over time and space?
- What processes are used to maintain this genetic diversity on-farm?
- What factors influence farmer decision-making to maintain diversity on-farm?
- What biodiversity measurements are needed to monitor different agro-ecosystems?
- Is the actual knowledge sufficient to optimise agro-biodiversity for productive agriculture?

Measuring, managing and conserving local genetic diversity of Europe's traditional rural landscapes

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KEYWORDS: Agro-ecosystems, gene flow, wild and domesticated species, management practices.
SUMMARY: The genetic heritage of Europe's agro-ecosystems, a product of the co-evolution between man and nature, is undergoing far-reaching transformation through land abandonment, neotechnological slash-and-burn, and transgenic crops. Landscapes planning needs knowledge not only about these effects of novel technologies, but also on the genetic diversity of traditional crop species and wild species in different landscapes, and on the genetic interactions in Europe's traditional agro-ecosystems. The authors argue that research should therefore focus on three gene flow processes: those between domesticated morphs, from wild types into domesticated forms and from agriculture into the wild.

The genetic heritage of Europe's agro-ecosystems is the product of co-evolution between man and nature, domesticated and "wild", though this distinction sometimes becomes blurred. It is characterized by regional blends of natural, domesticated and imported species that are organized spatially in culturally differentiated arrangements that contribute to the identity of specific landscapes. These arrangements result from management practices inherited since the Neolithic agricultural revolution and in the Mediterranean even earlier, from hunter-gatherer practices. Our traditional landscapes became suitable habitats for man by a millennia-long cultivation of the "wild", and thus by manipulating its genetic heritage. This occurred for instance by selective breeding, hunting and fishing, controlled burning, grazing, changing the land coverage, and through infrastructure projects that isolate plant and animal subpopulations.

Many European agro-ecosystems - and their landscapes - are undergoing a far-reaching transformation by land abandonment with subsequent secondary succession, or through neotechnological slash-and-burn of traditional agro-ecosystems (Vos and Stortelder, 1992; Vos, 1993), eventually accompanied by re-naturalization projects for compensation. These processes cause a decline of the identities of traditional agro-ecosystems and unforeseen changes in genetic diversity. The formerly culturally diversified European space is reorganized into on the one hand a new wilderness and on the other a neotechnological space. Both of these are characterized by the attempted control of biodiversity, with the former aimed at maximization of "natural" biodiversity, and the latter at limitation to economically useful- sometimes transgenic - species.

Traditionally, this distinction has not been as rigid, and recent movements favouring local engagement with cultural and natural identities show that many people are uncomfortable with the environmental impacts and the declined spatial differentiation caused by current practice. The past decade has seen an upsurge in attempts at biological conservation aiming to minimize the negative impacts of this reorganization by applying knowledge on agro-ecosystems (Paoletti et al., 1989), metapopulations of wild species and habitat networks (Gutzwiller, 2002; Pedroli, 2003) in rural planning. It is doubtful, however, that the lofty goal of "maximized biodiversity" - whatever that is - is best served by imposing corridors between "wild" patches, and barriers between them and "civilization", when the traditional interactions between the two, and their effect on genetic diversity, are so poorly understood.

The discomfort with the landscape changes is exacerbated by the fact that the impacts, socio-economic and otherwise, of transgenic crops on man, nature and rural societies are unclear. A sound planning of our landscapes needs knowledge not only about these effects of novel technologies, but also on the genetic diversity of traditional crop species and wild species in different landscapes as an attribute of these landscapes, and on the genetic interactions in Europe's traditional agro-ecosystems. Here, we argue that research should therefore focus on three gene flow processes: those between domesticated morphs, from wild types into domesticated forms and from agriculture into the wild.

Interbreeding between domesticated morphs can have socio-economic and ecological impacts, such as the loss of local adaptation in vanishing varieties - and thus an increased vulnerability for weather extremes and/or pests and plagues, through the homogenisation of agricultural metapopulations. Genetic diversity within crop stands has been shown to be effective in disease control (Zhu et al. 2000), and so the dynamics of this diversity within domesticated subpopulations as well as gene flow between them, both accidentally and as deliberate farmer practice, should be better understood. This is imperative since instances of farmer crossbreeding of "illicit" transgenic crops have already occurred in India (Jayaraman, 2001), and it seems only a matter of time until this happens in Europe.

Crop plants often are not reproductively isolated from wild ancestors. Gene flow from wild relatives into the crop gene pool is possible, and farmer selection that takes advantage of this to increase variation and quality has been shown in traditional agro-ecosystems (Elias and McKey, 2000). Methods of preserving and increasing diversity through the addition of wild types into the crop gene pool should therefore be investigated (Jarvis and Hodgkin, 1999).

Gene flow from domesticated forms into their wild relatives affects the whole ecosystem (e.g. aggressive weeds, extinction of wild species through hybrid infertility). More data is needed on the frequency and effect of hybridisation and introgression (Ellstrand et al. 1999). This is especially so since findings here give insight into the dynamics of the spread of transgenic DNA into wild relatives, a phenomenon that is starting to be reported (Quist and Chapela, 2001) - though evidence is still controversial.

This fundamental knowledge should have higher priority than applications of genetic theories of higher order dynamics that focus on the distribution of wild species in planning. The technical question of how to bring more high-ranked species in rural and urban landscapes is clearly respectable. However, the focus should also be on both the genetic make-up of the combined wild and traditionally domesticated species and the interactions between them as fundamental characteristics of a landscape.

Managing and conserving genetic diversity in the Romanian agro-ecosystems

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KEYWORDS: agricultural crops, livestock, anthropogenic activities.
SUMMARY: For a sustainable conservation of biodiversity, a coherent application of the sustainable agricultural requirements is necessary where the promotion of agriculture with various species and the protection of wild flora and fauna are major components.

During the last 200 years, especially after amelioration works were developed for plants, starting with the 1960s, the genetic diversity of agricultural crops in the developing countries has fundamentally changed (Pingali et al. 2001). The main traditional local crops were cultivated by humans for thousands of years under the pressure of national selection and farmers' selection, while varieties and hybrids, the so called "modern varieties" were obtained through amelioration programs about 100 years ago. The first highly productive corn varieties were obtained 50 years ago, rice varieties of high productivity and semi-high wheat varieties were created less than 50 years ago and were successfully used in intensive agriculture systems especially under irrigation conditions, achieving "The Green Revolution".

The increased need for agro-food products determined by the demographic explosion during the last decades caused a rapid change of agricultural system in the world simultaneously with the appearance of services for agricultural global development (research, mechanization, fertilization, irrigation, storing, preserving, processing, etc). The replacement of local traditional varieties with modern varieties produced essential modifications in crop technologies determined by the requirements of the new genotypes for soil fertility, water supply and agro-phytosanitary conditions. Considering that plants melioration and modern varieties belong to the agricultural productive systems, their impact on biodiversity is significant and direct.

Statistic data regarding the spread of modern varieties in comparison with local varieties attest that in most countries over 80% of the surface is cultivated with ameliorated varieties of the main crops of wheat, corn and rice (IRRI, 1999 and CIMMYT, 1997). Consequently, the last decades of the 20th century represent for the developed countries the transition from the extensive agricultural system to the intensive one, but in a smaller extent for the developing countries.

In order to implement international conventions, to develop and apply a national strategy for biodiversity conservation, coordination and close cooperation are necessary between the policies of various fields concerning sustainable development. The understanding of the biodiversity importance of cultivated species and their preservation can be shown through the agrarian policy, programs and strategies developed by the state bodies acting in this field, by finding the economic means and instruments necessary for this purpose.

An important part in preservation of agricultural crop biodiversity is played by scientific research. The efforts of the agrarian policy that show the willingness and the means of implementation, sustained by research activities, can lead to the amelioration of this situation. For this purpose, scientific research can offer diverse biologic materials with attractive production levels with genetic resistance to diseases and unfavourable environmental conditions. Scientific research can also offer farmers the proper technologies for various environmental conditions.

In order to diversify the local vegetal genetic resources, during the last 25 years the research institutes working under the coordination of the Romanian Academy of Agricultural and Forestry Sciences (A.A.F.S.) created 458 new varieties and hybrids of field crops, 107 new varieties of fruit trees, 28 types of grapes, 221 types of vegetable and flower crops and 26 new varieties of aromatic and medicinal plants.

In order to conserve vegetal biodiversity, two complementary strategies are combined: "in situ" and "ex situ". The agricultural research institutes and stations from the A.A.F.S. network, botanical gardens, natural reservations, Agronomical and Biological Sciences Universities as well as the Bank of Vegetal Genetic Resources of Suceava are involved in both strategies.

To avoid any future threats to the vegetal genetic diversity in Romanian agro-ecosystems, the researchers from the Academy of Agricultural and Forestry Sciences recommend the following measures: (i) the adequate organization of the territory; (ii) the adequate technologies for the cultivated areas in friendly environment conditions; (iii) rotation and a corresponding structure for agricultural crops; (iv) diversification for each cultivated plant variety and hybrid; (v) genotype conservation in gene-banks and periodically recultivation "in situ" and "ex situ".

Romania has also an old tradition in animal breeding, which represents 45% of the agricultural production, meaning over 6% of the Gross National Product. The situation of the present genetic resources as well as the biologic creations obtained by the Romanian zootechnical research institutes working under A.A.F.S. coordination, included in the annual report for the FAO Program/2002 on "Conservation of animal genetic resources", emphasize a total number of 37 new local breeds of bovines, sheep, swine, horses, poultry, foxes, bees and silkworms.

From the scientific point of view, the problem of animal genetic resources includes the following peculiarities: (vi) taxonomy aspects still unresolved in our country and abroad leading to numerous confusions regarding the belonging of an animal to a certain breed; in this context we have to mention the involvement of molecular genetics in taxonomic delimitations; (vii) biodiversity conservation "in situ" through a modern methodology and in close collaboration with the international bodies involved in this activity; re-establishing the National Bank of Animal Genes; (viii) drawing up of the new amelioration national plans.

Further research will also be necessary for the developing and applying a system of indicators to assess the state of biodiversity, for monitoring the evolution of the indicators especially regarding the emission of pollutants and the release or spreading into the agro-environment of alien species and genetically modified organisms.

Hybridisation within wheat (*Triticum aestivum*), *Agropyron intermedium* and *Agropyron repens* complex: the case of crop - wild relative gene flow

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KEYWORDS: Wheat, Agropyron, gene flow, hybridisation
SUMARY: Hybridisation within wheat, *Agropyron intermedium* and *Agropyron repens* complex is the case of crop - wild relative gene flow with consequences in natural ecosystems.

Hybridisation between crops and their wild relatives is a hot topic of contemporary research in agro- and natural ecosystems. Namely in the light of the release of genetically modified crops, hybridisation between crops and wild relatives has appeared as a potential problem for the biodiversity in mentioned ecosystems. Agriculture itself has a great impact on the biodiversity: many hectares of uniform crop composition reduce the biodiversity to the minimum. But it is necessary if we want to ensure enough food for so many people. With genetically modified crops another problem can arise: the threat to biodiversity of alien genes incorporated in GM crops. Because we know that the gene flow occurs but we don't know how the genes will influence natural ecosystems, it is a question worth considering if we have to grow genetically modified crops in regions where it is not necessary for human survival.

If plants do hybridise in nature, these examples are of crucial interest. The case of *Triticum aestivum* - *Agropyron intermedium* - *A. repens* is an example of gene flow with consequences in relatively natural habitats. It is because *A. intermedium* species plays, via its ability of crossing with both *Triticum aestivum* and *Agropyron repens* species, the role of a bridge between agro-ecosystem and both semi-natural and natural habitats. *Agropyron intermedium* cross with wheat, although the frequency in the field is unknown, as well as with A. repens; hybridisation between these two species seems to be very common and hybrids are repeatedly found in the field and they are fertile. *A. intermedium* (syn. *Thinopyrum intermedium, Elytrigia intermedia, Elymus hispidus*) is a species with a limited distribution strongly dependent on the presence of steppe-like habitats. Other conditions for successful gene flow are assured: synchronization of flowering, sexual compatibility, mode of pollination. Another important aspect increasing the chance of crossing is that there are common localities, where all three species grow in direct contact, where extreme morphological (and we could say genetic) variability of both Agropyron species was found.

Natural hybridisation between wheat and *A. intermedium* is not proved yet, but it is normal routine work to cross them in the lab in order to transfer some traits from *Agropyron intermedium* into wheat. So it is clear that the possibility of such gene flow exists in the field as well, namely under conditions mentioned above. If we take into account the release of genetically modified, herbicide resistant or virus resistant wheat, it is a question how the gene(s) could be expressed in Agropyron sp. in natural habitats after hybridisation or introgression. In general, it is assumed that hybrid plants have lower fitness and that they are not able to survive and establish. This is not the case of example discussed. The wheat x Agropyron intermedium hybrid does not need to be fully fertile, because it is perennial and its spread could be allowed by clonal growth (vegetative propagation). This fact increases probability of further hybridisation by multiplication of hybrid individuals and multiplication of years available. So, the introgression is more probable than for annual plants such as oil rape. Such genes incorporated into wild populations of Agropyron would increase their fitness: herbicide-resistant plants would have advantage in all systems under herbicide treatment (not only arable fields, but also railways, margins of highways, orchards, vineyards etc.). The advantage of virus-resistant plants is self-evident in all habitats. In this case, impact on adjacent flora is possible, because both Agropyron species grow in natural, often protected habitats.

During a literature search we found another possibility of similar hybridisation: Plant breeders often use *Thinopyrum elongatum* to improve wheat. In Germany, *Elymus obtusiflorus* has recently spread as an adventitious species throughout different man-made habitats. The search through synonyms showed that both names belong to one species. This example shows the need for simplification of names to allow readers with little experience in plant names to evaluate literature data.

Studies concerning gene flow from genetically modified crops to wild relatives are therefore very specific problems, because it is necessary to resolve them case-by-case. Such research includes many relations that should be taken into account. Will the hybrid (introgressant) have higher or lower fitness? Will the hybrid persist under field conditions? And for how long? Will the new genes have impact on non-targeting organisms? Will the hybrid invade adjacent ecosystems?

Conserving and protecting genetic biodiversity - research activities at the AgroBioInstitute in Sofia, Bulgaria

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KEYWORDS: Plant gene banks, biodiversity, biosafety,
SUMMARY: The AgroBioInstitute in Sofia, Bulgaria conducts activities and research related to the conservation, maintenance and creation of genetic biodiversity for agriculturally important species in two main ways: development of plant gene banks including molecular and phenotypic characterization and database documentation, and implementation of the National Biosafety Framework for Bulgaria under the obligations foreseen by the Cartagena protocol.

The AgroBioInstitute (ABI) in Sofia, Bulgaria conducts activities and research related to the conservation, maintenance and creation of genetic biodiversity for agriculturally important species. In 2000 the ABI was appointed Center of Excellence (CE) of the EU (2000- 2003) with the highest score, for its program and activities. Two of the work packages (WP) of the CE are directly related to the subject of conserving and protecting genetic biodiversity.

The 1st WP is dedicated to the Development of Modern Gene Banks of Small Fruits, Grape and Rose that are traditionally important for Bulgarian agriculture. Modern disease-free germplasm collections of existing Bulgarian breeding lines are established and their molecular characterization and database documentation are in progress (http://bulgenom.abi.bg). The aim is to solve the pressing problem for management and conservation of native, local varieties and species and establish sources for certified planting material. The gene banks will be linked to related European networks. The experience, expertise and know-how obtained will serve as a base for further establishment of modern gene banks for other economically important species and to build the strategically important National Plant Genome Center in ABI. Providing an opportunity to preserve and study the reservoir of valuable genetic variation present in the gene pool of wild species, the Center will be an important contemporary tool for ex situ conservation and rehabilitation of biodiversity including endangered species.

The 2nd WP has addressed initiatives connected with Biosafety issues. In the framework of the CE, a Regional Conference on various aspects of practical utilization of LMP and implementation and publicity of biosafety legislation was organized in 2003 to discuss social and economical aspects, environmental and health issues of LMP utilization and the integrated approaches for risk assessment and management. Currently ABI promotes biosafety and genetic preservation efforts in Bulgaria under the obligations foreseen by the Cartagena protocol. ABI coordinates a national GEF-UNEP project supporting the implementation of the National Biosafety Framework for Bulgaria. The institute has actively participated in the development of LMOs Act of Bulgaria. The GEF-UNEP project objective is to build capacity on risk assessment and management, transboundary control of LMOs to prevent possible adverse effect on conservation and sustainability of biodiversity in Bulgaria and neighbouring countries. A Biosafety Clearing House is created as a tool to control the transboundary movement of LMOs. The ABI operates up-to-date laboratories for risk assessment and the control of LMOs and LMO products. Botanical files for economically important plant species for Bulgaria are undertaken to assess possible LMPs' impact and to ensure adequate conservation and sustainability of biodiversity. To raise public awareness on "Plant Biotechnology, Biosafety and Biodiversity", several training courses and workshops are organized targeted to governmental officials, policy makers, media, broad pubic, scientists, etc). The project also intends to compile the existing approaches for monitoring LMOs and to conduct strategically important monitoring studies for risk assessment purposes that will guarantee the environmental and human health safety.

Landraces are commons

Massimo Angelini, Rural History, University of Genova, Italy

KEYWORDS: Landraces, common heritage, historical and community context, tradition, local varieties.
SUMMARY: Local varieties are not only a genetic resource, but, much more than that, they are a common heritage and endowment of rural communities where over generations they have been selected, maintained and handed down, and, sometimes, can also be a good economic opportunity.

Varieties, populations and clones of crops may be defined as local - and, more, traditional - when they have cultivated in a place with continuity, in the time of generations, and within that area are known with at least one proper name. They are characterised by their having been handed down from one generation to the other, from mother to daughter, from hand to hand, following a family or community custom: and it is this very act of "handing down" that makes the word "tradition" meaningful. Regardless of how wide the traditional area of cultivation may be (as large as a parish, a valley or region), of the duration of the continuity (two or more generations), and of the kind name the varieties are known (of learned or dialect origin, coined or modified by the imagination), because the name of the notoriety always is that "true": its presence in the community lexicon is in itself evidence of a relation to the place and sign of an embedded relationship of memory and identity.

The variability of local varieties is not only the result of an adaptive answer to environmental pressure, but also a cultural product: the issue of a process of selection and domestication carried out by farmers, in time, to privilege some characteristics - shape, resistance, palatability, productivity - over others, by practices usually socialized and shared on a local scale. All this makes local varieties a repository of customs and knowledge, and betrays their partial nature of "handcraft", when not even - for those who are able to read in them the alphabet of time - of "documents". Their existence is tightly interwoven with local agronomical knowledge, cooking recipes and the shaping of landscape - over time they have been accompanying dowries, the spread of mother tongue, the mobility and the nostalgia of emigrants, in order to become, for the communities of places in which they have co-evolved, a "mirror" in which one may reflect and recognize oneself. Their value cannot be understood unless we keep into account the context of time, place and community which has made and still makes them what they are; just as a word is not fully understandable out of sentence. In other words, we may preserve and develop our agricultural heritage only if we preserve and develop the rural context in which it has been produced and evolved. Outside this context, and away from the primary role and interests of farmers, and from on-farm dynamic conservation, they remain but amateur collectors' items, kitchen-garden knick-knacks or museum heirloom, exercise in good-will or mere support for genetic information; but such an approach to local varieties is reductive and, to a certain extent, may even be deceptive.

Nevertheless, those who institutionally deal with biodiversity mostly overlook concerns over the history and culture of a community or reduce it to folklore. For those who ignore or overlook the historical and community context of local varieties, only the preservation of their genes appears to matter - what begins and ends in gene-banks and in research institutes.

If local varieties are a common heritage, then the rights and consequential benefits deriving from their use concern only the local communities who, by selecting their shape and behaviour, have preserved and handed down them. On this principle, often but also eluded, a collective work of protection and economic development has been carried out in the Genoese province since 1996, initially focalised on the recovery of a few traditional potato clones and now extended to other garden crops, progressively involving farmers and restaurants, generating, over the years, a commercial net - still closed but constantly growing, and a channel for information on biodiversity (see: www.quarantina.it) .

Community rights over heritage varieties cannot easily be inscribed into categories of public or private law, they exist on the same level as the material, juridical or symbolic expressions of that community - as are customs and commons, the places for feast and prayer, the mother tongue and the nets of gossip. And the commons, the cultural expressions of the community, its resources and heritage, for their intimate nature, cannot be abolished or sold, appropriated or expropriated. So are the landraces. And the power of maintaining and reproducing them and changing their seeds. Freely and reciprocally.

RE: Landraces are commons

Erling Berge, Department of sociology and political science, Norwegian University of Science and Technology, Trondheim, Norway.

In a well-written and pertinent intervention Angelini concludes, "Community rights over heritage varieties cannot easily be inscribed into categories of public or private law…"

That is a bit too pessimistic. There is a long tradition both in customary law and in statutory of "Rights of Common". And the many ways of instituting common ownership of a resource is also the topic of research for a broad cross-disciplinary group affiliated with The International Association for the Study of Common Property (see http://www.iascp.org/). So if people want common ownership, the legal technology is there.

Four items en passant

Massimo Angelini, Rural History, University of Genova, Italy

KEYWORDS: Compresence, free exchange of seeds, primal law, putative tutelage
SUMMARY: Proclaiming the rights of rural communities is not enough, unless we previously agree upon the meaning of 'local community', define the boundaries of their ownership rights, and discuss the issue of the relationship between ownership and tutelage.

This brief article follows a previous one ("Landraces are commons") in which I attempted to outline the heritage value of landraces and the rights of local communities over them.
The heritage and rights of communities are sensitive issues, of topical interest these days, when we witness the attempts of wiping out the last remains of community prerogatives, as a result of a centuries-old process of denial and erosion, gradually erasing them from law and, then, from memory. Landraces are themselves subject to a peculiar form of erosion, worsened by the introduction of laws that legitimate either the appropriation by privates or the expropriation at the hands of public institutions. An example is EU directive 98/95, which, by dictating the guidelines for national seed laws, declares the free exchange of seeds and reproductive material illegal; but without that exchange there exists no possibility to hand down landraces according to community custom, and the possibility of a dynamic preservation in the rural context that makes them specifically meaningful and valuable is thereby denied.

Rethinking local varieties as a function of the environmental and communitarian context by which they have been created and to whose creation, in turn, they contribute, we could observe that whenever a rural community ceases to exist - at the disappearance of even its last witness - then the meaning of their conservation is lost as well, and varieties may only be preserved as relics fit for a museum, or as a mere material support for breeding or gene technology. Really just a little thing. As a function of that context, for the ultimate goal of conserving landraces as heritage, rural communities can do without gene-banks, but the latter without the former are still as morgues.

On the other hand, proclaiming the rights of rural communities is not enough, unless we previously agree upon the meaning of 'local community', define the boundaries of their ownership rights, and finally discuss the issue of the relationship between ownership and tutelage. On this subject, I would like to propose a few suggestions without argumentation (provocatively, but also due to the limited space available).

1. The 'local community' is not a demographic or administrative unit, but the compresence of those who dwell and are hosted in a place and those who once dwelt there (I would be tempted to add: "and of those who shall dwell there"); from the logical impossibility to represent the compresence of generations derives the inalienability of community heritage and rights - including landraces, which may be collectively managed and handed over, but not appropriated, renounced, eroded or ceded.

2. The handing down of landraces is among the rights of the communities owning them, and implies the possibility of reproducing their seeds freely: it is therefore necessary to urge the adoption of national and regional laws, at least acknowledging the right to exchange, directly and in a local context, seeds produced autonomously by family farms in a quantity limited to their needs.

3. Such a right of exchanging may only be acknowledged by law, but cannot be the object of derogation or authorization, nor can it be limited or forbidden, since the exchange of seeds is a subsistence practice and, as such, pertains to the primal law that precedes (and constitutionally founds) the formation of any codified law.

4. Wherever a local community has no acknowledged corporate existence, the tutelage of landraces should be exercised - provisionally and in a putative form (on behalf of the community) - by local institutions, having the jurisdiction over the territory where landraces have traditionally been grown.

Land use patterns affect biodiversity in (semi) natural-and agro-ecosystems

Paolo Degli Antoni, Italian Academy of Forest Sciences, Italy.

KEYWORDS: plant species diversity, land use patterns, landscape, Tuscany
SUMMARY: Two case studies in Tuscany show how the subject of the committed research may affect the evaluation of biodiversity.

The aim of AEMBAC international project (http://www.AEMBAC.org) is to develop a methodology to internalise positive and/or negative environmental externalities, from different agricultural practises, into the economic performances of the primary sector; an attempt to introduce in the formulation and implementation of local agricultural programmes the "total economic value" of agriculture.

The Italian partner has chosen two pilot areas in Tuscany: the upper basin of the Greve River and the Maremma Park, studying the present conditions of biodiversity, landscape and conservation of water and soil, trying to recognise the pressures on these parameters due to the farm system.

Such research could easily be based on the wide international literature dealing with the precious role of traditional agriculture in enhancing and promoting plant species diversity, in comparison with the poor species diversity shown by modern agriculture. Also partners from different countries involved in the AEMBAC project stress this aspect and show, for instance, how traditional farm systems provide species rich meadows and pastures.

In the two pilot areas, although a radical change in agriculture is recorded in recent decades, the main causes of plant species diversity loss are different. In the upper basin of the Greve River, the main biodiversity loss seems to be due to the extremely intensive land use pattern developed from the 1830s to 1950s, when the original forest was frequently cut as a coppice the most fertile land converted from (semi)natural ecosystems to fields, using the typical mixed dry agriculture pattern, requiring tillage every year in order to avoid competition of wild grass for water; no perennial specialised flora succeeds to settle in these conditions. In the forest, the most precious and needy tree species, naturally confined to specialised micro-environment, did not survive frequent cut or were voluntarily changed with chestnut, in order to provide food from the forest. Riparian forest was converted to ploughland. Species like *Quercus robur*, *Quercus petraea*, *Fraxinus excelsior*, *Fraxinus angustifolia* and *Carpinus betulus* are reduced to a few individuals, with almost no hope of genetic survival without human intervention. The process is not reversible, due to extreme genetic erosion, and made even worse by the low number of sexually mature arboreal specimens that each surface unit can support. Something similar, but extenuated by a higher number of sexually mature individuals per surface unit, occurred to the precious underwood of nemoral grass. There is international evidence that some precious species survive only in undisturbed forest; choosing flagship species such as orchids, for instance, we can record how the genera Epipactis, Cephalanthera, Neottia, Goodyera, Cypripedium and Platanthera appreciate forest more than open spaces and also how some species of the genera Orchis and Dactylorhiza live in woodland. Forest internal environment also allow tertiary species (e.g. *Ilex aquifolium*) to survive.

After a few decades (1960s-1980s) of forest abandonment, coppice cutting is a common practice again; half of the century old specimens of *Quercus petraea* still surviving in the Greve basin pilot area were cut a few years ago!

In Maremma precious plant species are confined to peculiar natural ecosystems, almost undisturbed. Among the flagship species, some orchids are endangered and one species has already become extinct, all of them overgrazed by an abnormal population of wild boar.

Measuring, managing and conserving local genetic diversity in agro-ecosystems: Closing comments

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Concetta Vazzana (University of Florence, Italy) and Valeria Negri (University of Perugia, Italy), Session Chairs.

Agriculture feeds the world mostly through intensive agricultural systems (those based on modern varieties), even though to date poverty, war, lack of education and lack of infrastructure have prevented the eradication of hunger. In such systems concern has been raised regarding the depletion and corruption of resources that are important in the long term, i.e. increased erosion, lower soil fertility, reduced biodiversity, water pollution and eutrophication, change in the atmospheric composition, etc.

As the world enters an era in which global food production is likely to double in order to continue to feed a growing population, mankind needs models of agriculture that can sustain growth without depleting resources (i.e. sustainable agriculture). Sustainable development should also involve the reassessment of human wants, i.e. the shifting of human demands from an environmentally destructive, manufacturing/consuming economy to an environmentally benign amenity/service economy. As human economies are inescapably embedded in ecosystems, which is much more true for agriculture, a definition of sustainability that is in better accord with the more recently evolved concept of biological conservation can be suggested: ecological sustainability. The ecological sustainability approach is informed principally by population biology and evolutionary and community ecology and aims to preserve ecological integrity and biodiversity at every level of organisation. Consequently, meeting human needs should be accomplished without compromising the health of ecosystems, i.e. their normal ecological processes and functions.

The contributions of this 2nd session of the e-conference underline at first that the sustainable conservation of biodiversity is a common feature of traditional agro-ecosystems. Many of these traditional agro-ecosystems constitute major in-situ repositories of both crop and wild plant germplasm. Farmers directly manage these plant resources that have evolved in part under the influence of farming practices coming from particular cultures and knowledge.

In modern agriculture a shift toward more complex (in term of biodiversity and productive strategies) agricultural systems is needed. For a sustainable conservation of biodiversity, the application of the sustainable agricultural requirements is necessary where we want to maintain rural landscape and promote agricultural production with different species and the protection of wild flora and fauna. In most cases it would be important to maximize biodiversity but it is not easy to obtain this result when the traditional interactions between the natural and cultivated biodiversity and their effect on genetic diversity are still not well known.

Measuring, managing and conserving local genetic diversity in agro-ecosystems have to be the future objective of policy and research. For a sustainable conservation of biodiversity we must introduce adequate biodiversity indicators for monitoring rural ecosystems. The development and application of a system of indicators will allow the assessment of the state of biodiversity and the monitoring of the effect of pollutant emissions, the release or spread of alien species into the agro-environment and the effect of genetically modified organisms on local biodiversity.

Deeper knowledge on the genetic diversity of traditional crop species, wild species and on their interaction in different agro-ecosystems and landscapes is fundamental. Research is needed in relation to gene flow processes thatare active in agricultural environments: between domesticated plants, from wild types into domesticated forms and from agriculture into the wild. Studies concerning gene flow from crops to wild relatives include many relations that should be taken into account and are therefore very specific This flow affects the whole community and research is needed on the frequency and effect of hybridisation and introgression. There are many questions arising about hybrid (introgressant) fitness, persistence under field conditions, duration, and ability to colonize other ecosystems.

From some the contributions we understand that landraces (folk varieties, traditional varieties, hereafter called LRs) are farmer-developed populations of cultivated species that show among and within population diversity and are closely linked to traditional cultures. The agro-ecosystem based on LRs (and local breeds) was prevalently aimed at being self-supporting, which means that different animals and crops, as well as the means of production, were produced on the farm. Consequently, the environments were quite diverse due to the number of different species and the within-species diversity. LRs were passed down from one generation to the next as a family heritage along with the traditions and uses that were related to them. LRs that differed with respect to adaptation to environmental constraints, agricultural techniques adopted and destination uses, emerged and became a constituent part of rural landscapes and cultures. A mosaic made up of minute elements of diversity was made up throughout the area of distribution of a certain crop over the centuries since domestication. Landrace tolerance to biological and environmental stresses and epidemics has relied on their innate diversity, as well as on the diversity of the number of different species present in an agro-ecosystem which hosts natural enemies of pests or acts as physical barriers to their diffusion. The complexity of the system buffered environmental constraints and favoured the co-evolution of the players, both crops and their enemies.

Farmers and people in general should be made aware of the fact that agriculture is more than a source of actual or potential income, since it can play a role in sustainability and in the protection of environmental biodiversity. Policy makers should support activities aimed at helping people reflect on what will bring about the greatest balance of happiness over unhappiness in the agro-ecosystem for the future.

Referring in particular to farmers, activities should be undertaken aimed at promoting the awareness that they are the prime stewards and managers of the environment. This awareness can then be handed down from one generation to the next. When farmers or farmer communities finally recognize the important role that agriculture plays in ecological sustainability, it will then be easier to maintain biodiversity on-farm.

Session 3

Understanding and measuring the impact of economic and social factors on genetic diversity

Understanding and measuring the impacts of economic and social factors on genetic biodiversity: Opening Comments

Marcello Broggio and Riccardo Bocci, Session Chairs, Istituto Agronomico per l'Oltremare, Italy.

It is an extraordinarily difficult task to sketch a conceptual picture on the influence of economic and social factors on genetic diversity in general, as well as on the continental scale. Measuring their impact on it may be even more puzzling.

Economic factors include a whole range of human activities: agriculture (cropping and animal husbandry), extraction of forestry products, manufacturing, landscaping, leisure... Of particular interest in this respect is the variety, structure and relative dominance of production units and their actual or potential dependence on genetic diversity in the generation of income, e.g. whether these are highly dependent on biological resources (the case of traditional small farmers on one side, and that of life science and biotech industry as opposed to investment and technology), or do not require diversity (e.g. large scale agricultural production of commodities).

Here one can identify a first contradiction of an economic activity (namely R&D on biological goods) which requires high diversity (diversity of genes and associated traditional knowledge) but whose output is responsible for unprecedented simplification of biological systems in the environment (monocultures of agricultural, conventional and genetically modified crops, forestry plantations, bio-factories etc). Since conserving biodiversity is not a profitable business in general, and particularly as far as Genetic Resources for Food and Agriculture (GRFA) are concerned, governments committed to the goals of framework multilateral agreements (e.g., the Convention on Biological Diversity) should design and put in place suitable incentives in order to counterbalance economic and social forces acting as a constraint. The key note contribution by Annette Von Lossau will deal with this specific matter. Still on the topic of incentives, the legal grant of monopolies on the products of human ingenuity in the form of intellectual property rights have profound economic, social and ethical implications on the conservation and enhancement of genetic diversity as well as on the ownership of traditional knowledge associated to it. Anna Fonte's contribution is precisely focussed on the impact of exclusive utility patent rights on the conservation and utilisation of Plant GRFA in particular, but the arguments might be applicable to native biodiversity as well.

From another perspective, Niels Louwaars will address the conflicts between intellectual property, indigenous knowledge and the conservation of genetic diversity. Another keynote, written by Danilo Igliori, will focus on the significance of collective property rights with respect to biodiversity conservation and sustainable utilisation, analysing specific cases of traditional and indigenous peoples collecting non-wood biodiversity products from the Amazon basin. In our view, some considerations on such case studies may be applicable to communal rights in some European countries as well.

These effects are also amplified by a general trend of consolidation and conglomeration of economic and financial enterprises into a bunch of huge global complexes, concentrating most key patents on enabling technologies and intermediate inputs. Geoff Tansey's keynote is expected to offer some insight on some implication of such economic trends for the conservation and utilisation of genetic diversity. Positive incentives, as well as the removal of perverse incentives, for the conservation and utilisation of elements of biodiversity, are key in reversing the trend of genetic erosion pushed by economic forces. Incentives may include, inter alia, development and strengthening of local markets and brands, labelling, protection of geographic origin, certification, enforcement of sui generis legal systems of protection of communal intellectual property, etc. Laure Emperaire will present some evidence of the importance of local markets and suitable commercial brands in encouraging the farmers to cultivate their own landraces.

Policy-making and legislation of genetic diversity as a public good, and as a contract among present and future generation, is therefore key for the implementation of the objectives of the Convention on Biological Diversity. Measuring the impact of genetic erosion under the effect of mainstream economic and social forces from one side, or as a result of policy, economic change and social pressure on the other side, is a major goal of inter-disciplinary research efforts facing us. It is however very important to realise that a European dimension and perspective in this study is strongly dependent on the evolution of the global economic system and the outcome of the current dialogue/confrontation among North and South on one hand, and on the transatlantic discussion on the other one.

Threats to genetic diversity in managed forests

Antoine Kremer, INRA UMR Biodiversity Genes and Ecosystems, France

KEYWORDS: Silviculture, managed forests, species introduction, climate change, silvicultural regimes, genetically improved varieties.
SUMMARY: As almost all European forests have been to some extent managed by man, with few pristine forests left, the question of how much genetic diversity has been affected by natural and human interferences is raised. There are several current and future threads to which genetic diversity in European forest will be exposed such as the modification of gene pools, range shifts resulting from future climatic changes, alterations of genetic processes due to silvicultural regimes and the use of genetically improved varieties.

European forests underwent important evolutionary changes due to their recurrent expansion-retraction as a response to climatic changes during the quaternary era. Silviculture was introduced at the beginning of the second millennium; almost all growing forests in Europe have been to some extent managed by man and there are only a few pristine forests left in the eastern part of the continent. Hence the question raised on how much genetic diversity has been affected by natural and human interferences.

There are several current and future threats to which genetic diversity in European forest will be exposed:

- Modification of gene pools. During the past century, a large number of species were introduced in Europe mainly from North America. In addition, native European species were transferred to new environments with the rapid development of reforestation. In France for example, the forest area has increased from 10 to 15 millions ha between 1900 and 2000, 70% of which is due to artificial plantations. These practices resulted in important changes in the genetic composition of autochthonous European forests. The genetic structures that were progressively established by natural processes during previous historical times have been in most cases modified by the extension of plantations and the introduction of new gene pools. How much the disruption of geographic structure inherited from evolutionary history will affect the forests is unknown. However there are records where population (or species) transfers has lead to hazards: concurrent introduction of diseases, dieback of stands resulting from long distance transfers, introgression of genes in autochthonous stands.

- Range shifts resulting from future climatic changes. There will also be modification of gene pools due to environmental changes. There is evidence that the extant distribution of most tree species will be shifted as a result of climatic changes. Mediterranean species will migrate northwards and there is the risk of decline for some temperate species at the southern edges. As the European tree flora is composed of genera where interspecific hybridisation is frequent, hybridisation between Mediterranean and temperate species will increase (in the oaks, the pines...).

- Alterations of genetic processes due to silvicultural regimes. Exposures to genetic risks due to silvicultural regimes and treatments have only recently been investigated. There is some evidence that even aged stands are able to maintain larger levels of genetic diversity than uneven aged, because larger populations are maintained and there is no generation overlap that would enhance inbreeding. However the same conclusion may not hold for biodiversity at the ecosystem level. Response of levels of diversity is usually delayed following human interference and there is a need for monitoring diversity and genetic processes in the future. How much, for example, gene flow will be modified due to the changes in landscapes composition (widely used plantations) is unknown.

- Use of genetically improved varieties. Genetic improvement programs are run worldwide on fast growing short rotation species. These programmes started in the early sixties and have entered in several cases into the third or fourth generations. A number of concerns have recurrently been raised about the risks that breeding activities would introduce to plantations of fast growing species. The central question is whether risks are increased due to the wide use of material originating from artificial selection. In most cases the level of diversity in improved seed lots is maintained to high levels due to the large breeding population used. However, the extensive use of clonal varieties as in poplars, has definitively introduced several risks towards the remaining natural resources of poplars in Europe and to the poplar culture itself. In the long run, the extensive use of the same improved varieties in other species (pines, spruces...) will require that policies for maintaining genetic resources be reinforced.

RE: Threats to genetic diversity in managed forests

Allan Watt, Centre for Ecology and Hydrology, Banchory, UK.

I have enjoyed reading the invited contributions to this e-conference, but I have been very surprised at how few people have engaged in discussion. I have been particularly surprised at the reluctance of participants to specify research priorities (Vaclav Mahelka and Christian Kleps are among the few contributors who have outlined future research needs). Should we conclude that research on genetic diversity has a low priority, at least in the context of halting biodiversity loss?

Several contributors have discussed genetic diversity in forest trees. Ricardo Alia and colleagues, Giorgio Binelli and Antoine Kremer have all mentioned past changes in the range of trees. Our understanding of these historical patterns has been made possible by research on the genetic structure of species populations. But surely this research has also shown that species can survive enormous reductions in their range and, presumably, their genetic diversity. If we are concerned to halt biodiversity loss in Europe, should we not concentrate on species rather than on genetic diversity? If research funding is scarce, we need clear, persuasive arguments for the importance of genetic diversity and convincing research priorities.

To my mind, research priorities lie in the genetics of the kinds of managed systems discussed by Antoine Kremer, who cites several examples of practices leading to reductions in genetic diversity, thereby putting Europe's forests at risk from a number of potential threats.

I remain to be convinced, however, that research on genetic diversity can help to halt the loss of biodiversity, particularly where it is most threatened in Europe.

Incentives for the sustainable use and conservation of agrobiodiversity

Kirsten Probst and Annette von Lossau, Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany.

KEYWORDS: Incentives, agrobiodiversity
SUMMARY: The Convention on Biological Diversity (CBD) encourages all Contracting Parties to 'adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity' (Article 11, CBD 1992). Incentive measures are defined as specific measures designed and implemented to influence government bodies, business, non-governmental organisations, or local people to conserve biological diversity or to use its components in a sustainable manner. They should have the defined purpose of changing the behaviour of individuals and institutions to achieve the conservation and/or sustainable use of biodiversity. The need for incentive measures arises out of the public-good character of biodiversity and the difficulty of determining the value of its present functions and (possible) future functions.

Agricultural biodiversity has characteristics of a public interest as well, and the value expressed by its price in the market is usually too low for optimal use and supply. Therefore the aim of incentives and incentive measures is to turn a part of the non-paid public value into private benefits for farmers in order to encourage them to contribute to the use and conservation of agrobiodiversity. At the same time, incentive measures may charge costs to activities that lead to loss of agrobiodiversity in order to reduce unsustainable behaviour. CBD also mentions perverse incentives. Many of these lead to the loss of agrobiodiversity through replacement of local varieties and animal breeds.

Participants in a workshop on incentive measures on sustainable use and conservation of agrobiodiversity in Lusaka, 2001, defined a framework for analysis of incentives and incentive measures which differentiates between positive and negative incentives, direct and indirect incentives, economic and non-economic incentives. Moreover, it was stated that three main stakeholder groups could be distinguished: farmers, consumers, and support system actors (policy makers, extension, research, NGOs, seed producers and other service providers). Each of them can both receive incentives and design and implement incentive measures to motivate and stimulate others. Table 1 presents examples of the different types of incentives for stimulating farmers' use and conservation of agrobiodiversity.

The distinction made between economic and non-economic incentives deserves attention because it goes to the heart of the meaning of the word incentive. The significant positive influence of non-economic incentives should not be underestimated. They involve access to information, capacity building and recognition and are relevant to all stakeholders, i.e. farmers, the service delivery system, politicians and consumers. Seed and animal fairs with diversity competitions are an illustration of an incentive measure that yields a range of different incentives. The prizes for those farmers that display most diversity are a crucial incentive. Increased awareness of the existence, beauty and importance of genetic diversity and the recognition for the custodians of that diversity probably contributes to the success of such events.

While the framework developed during the workshop in Lusaka constitutes an important tool for differentiating and distinguishing different types of incentive measures, the systematisation of experiences with different incentives and the analysis of their impact remain an important challenge for research. Assessing impact on the ground asks for the development proper assessment criteria, tools and the resources to apply them.

Table1. Different types of incentives for stimulating farmers' use and conservation of agro-biodiversity (adapted from Workshop on Incentives Measures on Sustainable Use and

Conservation of Agro-Biodiversity, Lusaka, 11-14 September 2001). The same framework can be adapted for other stakeholders in the service system and consumers.

Types of Incentives	**Positive Incentives** Encourages beneficial activities' (economic, legal or institutional)	**Negative Incentives** Induces unsustainable behaviour that reduces agro-biodiversity'
Direct Incentives 'directly encourages a stakeholder to use and conserve agro-biodiversity'	Economic - Direct payments for sowing local varieties - Subsidised market price Non-economic - Rewards for maintaining biodiversity - Improved access to good quality seed of local varieties - Access to credit for growing local varieties - Training (e.g. IPM) and education	Economic - Lower market price for smaller volumes, for lower level of uniformity or distinct quality - Market for food product of (semi-) wild species (indigenous vegetable species). - Subsidies for modern varieties Non-economic - Restricted access to genebank conserved materials - Illegal status of marketing seeds of local/non registered varieties - Non acceptance of local varieties • By buyers • By processors because of heterogeneity and small volumes/ quantities
Indirect Incentives 'induces changes in the agro-ecological, socio-economical environment of a stakeholder which affects use and conservation of agro-biodiversity'	- Legislation that allows farmers to commercialise seeds of local varieties - Development of food chains for diversity product • Processing • Labelling • Collective marketing	- Extension messages promoting mono-culture and high-input agriculture - Promotion of export/cash crops at the expense of food crops - Access to credit linked to use of modern varieties

Patents and genetic erosion of agro-biodiversity

Maria Fonte, Dipartimento di Teoria e Storia della Economia Pubblica, Università di Napoli "Federico II", Italy

KEYWORDS: Patents, biopiracy, agro-biodiversity, germplasm, CGIAR, Treaty on Plant Genetic Resources.

SUMMARY: The obligation that WTO members countries contracted with the Trips agreement to extend monopoly privileges to living material and the strengthening of intellectual property regime that biotechnology development brings with itself have severe negative consequences on both agrobiodiversity and developing countries.

Patents on life are a threat to food security and ecosystem resilience; they cancel the farmers' rights to save, plant, exchange and sell seeds from their cultivated crops, rights that has been the basis of peasants' and farmers' reproduction, but also of biodiversity conservation. Furthermore, patents have often been used to misappropriate traditional knowledge and genetic resources belonging to traditional farmers and indigenous communities, introducing a further element of injustice and inequality in the international system. Biopiracy may be carried out in a formally legal way, since for many IPR national legislation absolute novelty it is not required for entitlement to protection (it is possible to protect a variety that it is not commercialised in the country, but known and cultivated in any other country; or it may be the case that foreign oral traditional knowledge it is not recognised as "prior art").

As a monopoly privilege and barrier to the entry of new firms, patents are an incentive to the consolidation of industry. About five multinationals constitute the agrochemical- seed complex today, which control a big share of the commercial market for seeds, along with an unprecedented concentration of patents. For the sake of biodiversity conservation and utilisation, it is not the same thing if plants are reproduced in laboratory conditions by few multinationals or by millions of peasants and farmers in the most diverse agro-ecological areas of the planet.

Patents are also a threat to public research, encouraging the privatisation of the "public domain" resources, be they research results, traditional knowledge, landraces or wild materials. Agrobiodiversity erosion is worsened by the difficulty of defending ex situ germplasm collection from private appropriation.

As it is known, CGIAR germplasm collection is the most important collection of vegetable genetic resources for food and agriculture, containing about half a million different plants varieties, that came from farmers and indigenous peoples across the developing world. Since 1994 the germplasm collection is managed under the auspices of the FAO, through a "trusteeship" agreement with the IARCs and the CGIAR, meant to protect this germplasm from misappropriation. The trusteeship agreement is about to undergo a major revision, to bring the system in line with the new FAO Treaty on Plant Genetic Resources (IT-PGR), once it is ratified. While the Treaty recognises Farmers' Rights (art. 9), germplasm in the CGIAR banks is considered "public domain". In practical terms, this means that germplasm from collection will be freely distributed to anyone in the world, who will sign a MTA (material transfer agreement), implying an obligation not to claim IPRs on the material "in the form received" (the recipient part contracts also an obligation to share benefits, through information exchange, technology access and transfer, capacity building and sharing of monetary and other benefits of commercialisation).

This Treaty is an advance in the strategy for access and benefits sharing, in the spirit of CBD. But some questions may be raised: is it appropriate to consider landraces accessions "public domain", when all around there is a rush to the privatisation of public domain? Will the obligation not to patent the material "in the form received" stop biopiracy? What other mechanisms may be envisaged to protect ex situ and on farm agrobiodiversity?

Conflicts between intellectual property, indigenous knowledge and the conservation of genetic diversity

Niels Louwaars, Centre for Genetic Resources (CGN), Wageningen, The Netherlands.

KEYWORDS: IPR, local knowledge, humanitarian licenses, farmer's privilege, breeder's exemption.
SUMMARY: Although negative socio-economic impacts of Intellectual Property rights have been widely discussed, the author argues that instead of fighting against IPRs, one should look at opportunities to combine IPRs for the commercial sector with a freedom to operate for farmers who do not wish or who cannot use the formal seed system and find openings within the patent systems that will allow countries to balance the interests of their commercial farmers (and seed suppliers) and local food security based on local seed systems and participatory breeding.

The socio-economic impact of intellectual property rights has been widely discussed in several forums. Maria Fonte summarises a number of the key discussions very well: patents distort traditional seed systems that form the basis of crop-genetic diversity on-farm and an effective sharing of plant materials ("lateral spread"). Intellectual property over genetic resources is alien to the traditional views in all local communities that I have come across. Patents furthermore are part of the shift from research directed at the production of public goods towards private ownership over results (both by private and public breeders) thus redirecting research efforts from smallholder farmers to commercial ones and supporting the concentration of breeding internationally in few conglomerates. Finally, patents are also used to misappropriate local knowledge (biopiracy).

Quite often however, the opponents of intellectual property on biological materials (and processes) are proponents of a very strict 'ownership' over genetic resources by local communities. The CBD offers such possibilities: the national sovereignty of states over genetic resources may be translated in a strong voice by local communities with regard to Prior Informed Consent and benefit sharing. There is a serious risk that this introduces administrative requirements that may have exactly the same effects as patents on the use of genetic diversity in local seed systems and in research for development. Stimulating local seed systems and on-farm conservation leads to the need to optimise the role of the 'genetic commons'. The International Treaty on PGRFA has contributed enormously through its multilateral system by cutting the transaction costs associated with implementing the national sovereignty over genetic resources. The IPR-side seems to have done very little in this respect.

We may assume that property rights provide a useful stimulus for the private sector to breed for commercial farmers. Fighting IPRs per se therefore seems unproductive. We should rather look at opportunities to combine IPRs for the commercial sector with a freedom to operate for farmers who do not wish (organic farmers in Europe) or who cannot (smallholder farmers in the South) use the formal seed system. The openings that the current international obligations and national laws on intellectual property provide have not been sufficiently researched. The TRIPs Agreement provides the option of a "sui generis" system for the protection of plant varieties. Most countries choose for an early version of the UPOV Convention providing for a wide farmers' privilege (or farmers' right as some say) to save, exchange and sell in a non-commercial way, seeds of protected varieties, and to provide for different levels of protection for commercial and subsistence crops. Few countries even combine breeders' rights and farmers' rights in one system. Patents may still threaten the farmers' freedom to operate by accepting very wide claims (notably in the USA) and providing a very strong protection compared with the current sui generis options used (with respect to local knowledge, this can only be balanced by similarly widely defined claims in the registers that are currently being developed in several countries. Such generic descriptions of local knowledge should make it difficult to 'engineer around' the rights in order to appropriate it).

Insufficient thought has gone into possibilities to find openings within the patent systems that will allow countries to balance the interests of their commercial farmers (and seed suppliers) and local food security based on local seed systems and participatory breeding.

The first point of study may concentrate on humanitarian licenses that are used in the pharmaceutical sector to provide access for the poor to protected drugs. Similar licenses are now negotiated for smallholder farmers on a case-by-case basis (e.g. "Golden Rice"). The next step might be to define 'resource-poor farmers' in such an unambiguous way that such humanitarian licenses can be turned into 'humanitarian rights', providing a blanket exemption within the patent system. Furthermore, in line with computer-programmes, we should like to look into providing 'open-source' genetic resources for farmers in developing countries. Furthermore, there are examples of particular rules for 'softening the system for biological inventions' introducing a farmer's privilege and breeder's exemption in patents in line with the breeder's rights. The USA provide for an unlimited farmers' privilege within their UPOV membership without taking the interest of the right holders into account, and Europe has defined small farmers with regard to unlimited on-farm seed multiplication and use. Developing countries should be able to design their IP-systems in such a way that the local seed systems are effectively supported to continue to develop and maintain genetic diversity on-farm using any genetic resource that the farmers can lay their hands on. Current bilateral agreements, however, seem to limit such opportunities of countries to make their own choices within the international (WTO) framework. Both Europe and the USA should take this very seriously.

RE: Conflicts between intellectual property, indigenous knowledge and the conservation of genetic diversity

Maria Fonte, Dipartimento di Teoria e Storia della Economia Pubblica, Università di Napoli "Federico II", Italy

I very much appreciated Niels Louwaars' note, especially its pro-positive attitude. My question however is: how realistic are these suggestions? What would be the "political way" to make them realistic?

At the end of the note, Niels Louwaars notices how current bilateral agreements "seem to limit such opportunities of countries to make their own choices within the international (WTO) framework". Bilateral agreements are very indicative of where the real position of EU and USA government stand in relation to the "patent on life" problem. So the push to implement new systems in the protection of PBR, more compatible with the aim of a sustainable utilization of biodiversity must come from other directions. It is a pity that UPOV instead of presenting itself as an alternative system of protection, with respect to industrial patents, seems to compete in the restrictions it poses to farmers. Furthermore the possibility of double protection (through UPOV and industrial patents) may make any reform of UPOV useless (unless the first reform is to make the two systems as alternatives, rather than complementary). The International Treaty on PGRFA and its multilateral approach seems to be the most promising way to secure access and benefit-sharing but the restricted obligations it imposes, not to claim IPRs on the material "in the form received", may favour a rush to privatisation of public resources. It may be reformed on this respect?

I like the idea of an "open-source system" for genetic resources- and I think it is worth exploring its feasibility- but I would like to point out that at the moment, rather than us "providing 'open-source' genetic resources for farmers in developing countries", farmers from developing countries should be the ones providing open-source -even better free - genetic resources to rich countries industries and farmers! Is it not ironic that we should destroy their systems, privatise seeds and then go back to propose something similar to what they have now on the basis of a "humanitarian right"?

Property Rights and Development Paths for biodiversity conservation

Timo Goeschl and Danilo Igliori, Department of Land Economy, University of Cambridge, UK.

KEYWORDS: Property rights, optimal resource management, development issues, extractive reserves.

SUMMARY: The choice of optimally designing the internal property right systems might fail to take into account the broader economic context where traditional communities often generate a viable revenue stream. There is a clear need for further research exploring in greater detail the link between internal property right systems and broader development strategies.

Since the seminal work by Hardin (1968), the role of property rights for balancing the conservation-development trade-off has been discussed in the economic literature. The research on property rights has been mainly concerned with the assessment of different community based arrangements in promoting efficient management of natural resources. In several studies a particular emphasis has been placed on property rights internal to the study area or the theoretically conceived community area (Baland and Platteau 1996, Bardhan 1993 Seabright 1993, Ostrom 1990).

The accumulated economic theory and empirical evidence provide very mixed insights regarding the adequacy of choosing between private property, public ownership or communal property as optimal resource management systems (Baland and Plateau 1996, Seabright 1993). A natural response for the difficulty of choosing a single property right regime can be found in the combination of the "pure" categories, building co-managed systems. The combination of state-based with community-based modes of regulation might be effective in reducing informational asymmetries and monitoring costs.

While the property rights literature has been mainly focused on optimal resource management of specific areas, other strands of development economics and policy-oriented research have been concerned with broader development issues (see Sadoulet and de Janvry 1995, and Bardhan and Udry 1999). For the latter, questions regarding poverty alleviation, technological progress and the capability to compete in market economies pose challenges that go beyond the local areas where traditional communities live and include the wider economy (Angelsen 1999, Lipton and Ravallion 1995, Aghion and Bolton 1997, Foster and Ronsenzweig 1995, Keller 1996, Rodriguez 1996). The interface of these two bodies of research becomes important when traditional communities interact with the outside world by trading products.

Building on previous research on the spatial economics of extractive reserves (See Goeschl and Igliori (2003a)), Goeschl and Igliori (2003b) illustrate the connections between the above-mentioned literatures by investigating the property right regimes impacting the development perspectives of extractive reserves. The main result is a negative one: The current property rights properly supports only one of three principal development pathways, namely the extraction of established NWFP. We argue that this development pathway has very limited capacity to serve as a growth engine for the communities living in extractive reserves. On the other hand, the current property rights structure generates no or very limited rents for the inputs required to access the other two pathways, diversification into newly discovered NWFP and supply of biological inputs into the intensive production of NWFP.

The current design of internal property right systems fails to take into account the broader economic context where the reserves must generate a viable revenue stream. We conclude therefore that under the current set of institutions, the development objectives inherent in the extractive reserves model are likely to face considerable challenges to be accomplished in the future. This problematic conclusion also suggests that there is a clear need for further research exploring in greater detail the link between internal property right systems and broader development strategies rather than merely the optimal management of a given resource.

Local varieties, local and global markets and geographical indications

Laure Emperaire, Institut de Recherche pour le Development (France)/ Centre for Sustainable Development (University of Brasilia, Brazil)

KEYWORDS: Traditional agriculture, local knowledge, cultural identity, geographical indications.

SUMMARY: The rich agro-biodiversity that is created, maintained and used by local populations cannot be dissociated from the knowledge and know-how linked to cultural identity. The current tendency seems to be a loss of both genetic diversity and cultural wealth. A number of factors are responsible for this trend: intensification of agriculture based on only a few species, a change in attitudes towards food production, the cultural model increasingly influenced by the urban environment, the growing involvement of local people on the market... An important task is to identify ways in which one could insure that local populations not only have enough food, but are also economically and culturally stronger. The conservation of both phytogenetic resources and the future of diverse forms of traditional agriculture need to be considered.

The discussion here is the result of a comparative approach on the traditional management of manioc in the Amazon where very different cultural groups, ranging from the pioneers to Amerindian populations, grow the plant. With over 40 different varieties grown on a same field, the manioc grown by indigenous populations has a very high diversity, which is the product of a highly elaborate knowledge. This diversity allows them to cover wide ecological conditions and develop numerous products such as many types of manioc flour (Cruzeiro do sul, Uarini). These products are widely acknowledged at the regional scale and their production depends on the use of certain varieties and a regionally defined know-how. In this context, what is the use of geographical indications?

This legal instrument is used mostly in Europe and its purpose is being largely discussed in Southern countries. The resulting added value is based on the existence of a differential that is biological (local varieties or races), ecological (particular climatic or edaphic characteristics) and cultural (local knowledge and know-how) of a product or foodstuff exclusive to a locality and a cultural group. In this sense, it can be used as an instrument that aims to maintain a certain biological and cultural diversity in the light of globalisation, and secure the protection and development of traditional knowledge. These instruments are founded on a collective tradition and are put in place through a collective decision taken by a group of producers.

However, the GIs can also have a negative effect on local knowledge and local varieties. Its set up depends on the creation of rules responsible for the entire procedures, from the varieties used to the final product. This standardisation implies choices, even though a certain degree of liberty can be allowed, that will restrict individual practices and choices. One also has to question the impact of this standardisation on the development of traditional knowledge and the way in which it is handed down, both important in the high diversity of different varieties. The development of GIs is costly at the local and national level, and, unless there is serious investment in developing new niches in the market, they will only apply to nationally (manioc flour?) or internationally (guarana?) renowned products. There is little doubt that these instruments can be favourable for the conservation of traditional agro-biodiversity, but they must take in a wide range of quality labels such as organic agricultural products, such as those developed in Amerindian agriculture, and regional labels.

This brief discussion shows that our knowledge of genetic and cultural erosion is still scant. It is a priority to create instruments capable of determining the state of agro-biodiversity and the associated knowledge. Observational instruments integrated at different levels would allow both a long-term approach and the development of state indicators.

Understanding and measuring the impacts of economic and social factors on genetic biodiversity: Closing Comments

Marcello Broggio and Riccardo Bocci, Session Chairs, Istituto Agronomico per l'Oltremare, Italy.

First of all, I would like to take the opportunity to express, also on behalf of the e-Conference Chair, my sincere thanks to the contributors of this session with very valuable keynotes.

These contributions, while in no way exhaustive of the whole range of issues associated with genetic diversity and hence exploring only some of the questions related to research needs and priorities in this respect, deserve further consideration by EPBRS and by major stakeholders at the local, national, European and international levels.

While most research people participating in the e-conference are engaged, inter alia through the Biodiversity Science Smartgroup, in sound scientific discussion around biological aspects of biodiversity to be approached with the highest priority within the ERA, I would advocate for a higher attention and awareness on the economic, social and legal aspects that might turn in a short run our favourite research subject in a very rare commodity.

Session 4

Identifying research priorities

Research priorities: Summary and more…

Juliette Young, Centre for Ecology and Hydrology, Banchory, UK.

As you know, the main purpose of this e-conference is to identify research priorities for the forthcoming meeting in Florence, as well as for the European Commission's framework programmes and the research community involved in biodiversity research in Europe. A number of participants have already highlighted their research priorities during the course of the e-conference, and these are now summarised below.

- The need to prioritise on "blue-skies research", broad scientific training and scientific excellence, rather than focussing funding on narrow research programmes dictated by the latest trend.
- Conserve genomic variability in managed and natural populations rather than screening population with neutral arbitrary markers. SNP and gene expression micro-array technology is well on its way for some species, but we are not yet prepared for using this at a broad species spectrum which might be required to put it in a sensible biodiversity conservation context. There was a well-meant call for such research in the 6th framework, but groups not working on genetic model system species (eg fruit fly, mouse, Arabidopsis) do not currently have the tools to pursue this goal.
- Effects of gene pool modifications, future climatic changes, genetic process alterations due to management regimes and the use of genetically improved varieties on the forests genetic resources.
- Estimation of the effects of managing natural resources- especially long-term effects of human activities- not only on natural communities, but also long-term effects on economy, social interactions and human populations.
- The effects of loss of traditional agricultural management regimes on genetic diversity in agro-ecosystems
- Causes of genetic diversity loss in different European landscapes.
- Genetic make-up of the combined wild and domesticated species and the interactions between them in order to better understand the socio-economic and ecological effects of transgenic crops on humans and nature.
- Evolution of landrace population structure under on-farm conservation
- Applying and monitoring of specific indicators to assess the state of genetic biodiversity in agricultural and natural system, with an emphasis on damages caused by pollutants emission and the spread of alien species and genetically modified organisms.
- Develop state indicators for agro-biodiversity and the local knowledge associated with agro-biodiversity.
- Research on ways to conserve local varieties and protect the rights of the "local communities" who have preserved and handed down these varieties.
- All aspects of genebank management, including acquisition, maintenance, characterization/evaluation and utilisation need to be improved. Although molecular tools are potentially useful in quantifying diversity and identifying new alleles, the costs associated are still high. There is a need here for the development of more cost-effective ways of applying molecular tools in genebanks.
- The relation between seed market structure and genetic erosion of biodiversity and the ecological effect, in terms of biodiversity conservation, of agro-biotechnology industry concentration.
- Systematisation of experiences with different types of incentives for the conservation and sustainable use of genetic resources and the analysis of their impact with the development of proper assessment criteria, tools and the resources to apply them.
- Explore alternative ways of protecting IPR on life, ways that do not involve industrial patents and UPOV 1991. How does the concept of "public domain" and "collective rights" apply to agricultural genetic resources? Is there any possibility of extending the logic of "open-source" software to genetic resources? Which are the obstacles: characteristics of the goods, economic, political, institutional or relating to juridical systems?

- Explore the link between internal property right systems and the broader development strategies rather than merely the optimal management of a given resource.
- Research on the use of humanitarian licences and farmers' privilege and breeders' exemption on patents as a way to reduce the conflict between IPRs, indigenous knowledge and the conservation of genetic diversity.

All sessions of the e-conference will be open for discussion for the rest of the week, so this is your chance to highlight any research priorities you feel are important for the measurement, management and conservation of genetic resources in Europe.

Looking forward to your comments, however brief, on the above research priorities, or any other research areas that have not yet been mentioned.

RE: Research priorities: Summary and more…

Marina Michaelidou, Intercollege, Cyprus.

Dear colleagues,
I would like to suggest adding the following research priorities, which have also been addressed in some of the papers presented:

- Local knowledge and genetic diversity
- The interdependence between genetic and cultural diversity.
- The effects of loss of genetic diversity on natural ecosystems and local communities.

RE: Research priorities: Summary and more…

Bob Allkin, Centro Nordestino de Informacoes sobre Plantas (CNIP), Brazil.

Dear Colleagues
I support the lines of research proposed by Marina Michaelidou in response to this post. I would stress:

- The importance of developing new approaches for measuring the social and economic impacts of maintaining diversity (and its loss)
- The need for greater effort, collaboration and creativity in documenting and effectively communicating the results of studies of the impacts of genetic loss to the development community and society as a whole.

RE: Research priorities: Summary and more…

Alan Feest, Faculty of Engineering, Bristol University, UK.

I have now read a large number of submissions requesting the instigation of research that ties together sociological, agricultural and industrial issues and studies to biodiversity. I support all of these as worthy and valuable but surely they must be secondary to the need to understand more about biodiversity in the first place; a logical progression. For this reason I would ask that all of these worthy studies be subtended under the need to be able to measure biodiversity and chart its changes in the various habitats and countries of the EU and the NAS. So far we do not have any unified understanding of biodiversity or how to measure it. Surely this is the first priority.

RE: Research priorities: Summary and more…

Bob Allkin, Centro Nordestino de Informacoes sobre Plantas (CNIP), Brazil.

A response to the contribution from Alan Feest

I imagine that everyone registered on this list would agree with you that there is a desperate need for further research tackling the questions "what is biodiversity" and "how to measure it".

Implicitly I was arguing that an important contributing factor to our current ignorance is that the rest of society and even development agencies do not recognize this as a priority. This must reflect at least in part our own failure to measure and communicate the relevance and significance of diversity loss.

Thus while I whole-heartedly agree with you that it is illogical to pursue agricultural and sociological issues without studying the biodiversity involved, I would invert the question and ask if studying the biodiversity in isolation of its economic and social relevance is the best way to achieve our long term goals?

RE: Research priorities: Summary and more…

Marina Michaelidou, Intercollege, Cyprus.

Dear colleagues,
Please allow me to disagree with the suggestion placed by Dr. Alan Feest that sociological and agricultural issues are secondary in importance to the need to understand more about biodiversity.

I definitely do not doubt the need to study biodiversity, but I believe that the objective of BioPlatform and EPBRS is not only to understand biodiversity, but also to conserve biodiversity and prevent its loss. How can we not focus on sociological factors, when most biodiversity is being lost as a result of human activities? Furthermore, several studies suggest that biological and cultural diversity are often interdependent - ignoring one dimension would therefore inadvertently compromise the other.

RE: Research priorities: Summary and more…

Alan Feest, Faculty of Engineering, Bristol University, UK.

I hope I did not give the impression that I thought sociological and agricultural issues were unimportant. What I am suggesting is that all these research themes should go hand-in-hand but that to pursue the agricultural and sociological issues without determining what biodiversity is and how to measure it is illogical (hence the use of the word subtending). Therefore in a strictly logical and scientific sense, agricultural and sociological themes should be tied to the scientific study of biodiversity. Targeting studies at agricultural and sociological themes in the absence of biodiversity studies will be pointless and only undermine the target of the preservation of biodiversity. This latter point (the conservation of biodiversity) can only be done by making just those studies that Marina supports so I hope this shows how the structure of these research issues is important and that getting this structure right will strengthen efforts to conserve biodiversity.

RE: Research priorities: Summary and more…

Kajetan Perzanowski, Carpathian Branch ICE PAS, Poland.

I fully support Alan Feest in giving the highest priority to determine what the biodiversity is, and how to measure it in a standard and a feasible way. Looking at the formulated list of priorities I cannot see any way to make real progress in conservation of biodiversity unless we are able to tell clearly (also to the public) what we are talking about, and how to verify results of conservation efforts. Otherwise we will still have a nice slogan like "ecological" which now means anything from a toilet paper to anarchist movements.

Referring to Bob Allkin's contribution - the success of implementing measures to conserve biodiversity indeed depends on public support, but how can we communicate an importance of biodiversity to the public, not being able to define it precisely for ourselves?

RE: Research priorities: Summary and more…

Marina Michaelidou, Intercollege, Cyprus.

Some people seem to support the notion that we need to study and understand biodiversity fist, so that we can better communicate its value to the rest of society.

I feel that this view, that only we, the scientists, support biodiversity conservation needs further discussion. Many sociological studies conducted in Cyprus and elsewhere have demonstrated that local communities in protected areas have a deep appreciation for nature and a strong conservation ethic.

Unfortunately, many international conservation initiatives have been based on the assumption that local people are the "enemies" of biodiversity and have implemented measures that ignored people's needs and exacerbated their overall well being. And naturally, local people have often opposed these measures.

Indeed, lessons from community-based conservation initiatives suggest that it is the lack of consideration for socio-cultural factors that often brings opposition to conservation measures, and not local people's lack of appreciation for nature and biodiversity.

RE: Research priorities: Summary and more…

Alan Feest, Faculty of Engineering, Bristol University, UK.

I hope that I did not give the impression that I thought that the sociological context of biodiversity was not important and indeed I think a great deal has been achieved in conservation by appealing to the "soft, furry, cuddly" aspect of biodiversity (particularly if they have feathers!). It is just that I think that we should not "put the cart before the horse"! Enough of the metaphors, the real business is to measure and present biodiversity to non-specialists in a standardised and intelligible way. This can be done and I do do it with some very difficult groups of organisms. What we need to do is to get together and lay out a formalised structure for measuring biodiversity in a simple and clear way such that we can rapidly move on to the sociological part. I think a one day conference would allow the structure of an organising group to be set up with a remit to devise a standardised sampling process for measuring biodiversity by as many different qualities as possible. I currently use six measures to quantitatively measure the quality of biodiversity!

RE: Research priorities: Summary and more…

Filippos Aravanopoulos, Laboratory of Forest Genetics and Forest Tree Breeding, Aristotle University of Thessaloniki, Greece.

I have very much enjoyed the discussion and the contributions of several colleagues on the subject. I find it very hard to prioritise on particular ecosystems that need to be studied or protected first or on particular techniques or research approaches that have to be used. Let me take this opportunity to stress the vast importance of Mediterranean ecosystem biodiversity and the paramount need in studying, assessing and conserving it. The present situation is the result of at least some thousands of years of major climatic changes and constant human interaction with natural resources. Today, forest fires, increasing human impact and a compilation of biotic and abiotic stresses (mainly recent climatic extremes), are threatening the genetic heritage of very delicate ecosystems that have been known as biodiversity, cultural or aesthetic points of international interest.

In more general terms, future action in my view should be a synthetic one for the three points I have indicated above: studying, assessing and conserving. Its range should cover both basic and applied genetic concepts (such as those presented very nicely by Giorgio Binelli) and reach the interplay of biodiversity with society as Marina Michaelidou pointed out. My own contribution to this list concerns the need to study more complex structures in a more unifying way. I propose to consider the need, for example, for co-evolutionary studies that are going to look into species interactions or host-pathogen coevolution in a changing environment, at the gene, population and ecosystem level.

RE: Research priorities: Summary and more…

Marek Sammul, Institute of Zoology and Bortany, Estonian Agricultural University, Tartu, Estonia.

I'd like to add a totally different research field: the effect of policies (e.g. CAP) and other legislative acts (e.g. laws on nature protection or forestry regulations) as well as economic and social conditions on genetic diversity.

This kind of analysis should precede all changes in legislations and all reforms at least when they are related to environment. For example CAP reform directly influences the condition of biodiversity in agricultural landscapes. Can we say that the effect of these changes has been thoroughly analysed? Also monitoring of effects of different legislations on biodiversity is important. The need for this kind of research becomes obvious in transitional countries and/or after big changes in social and economical situation.

RE: Research priorities: Summary and more…

Robert Kenward, Fellow, Centre for Ecology and Hydrology, UK

While (belatedly) reading the many excellent contributions to this conference, I've listed some personal thoughts that reflect a number of the contributions:

1. Biodiversity is hard to measure and defining loss of genetic biodiversity is harder.
2. Landraces are developed through a long period of selection, benefit from an environment of local know-how and can be valuable assets.
3. Wild species too have local adaptations developed by prolonged natural selection and can be or become valuable commercial or cultural assets.
4. We CAN identify loss of landraces and species at local level, without necessarily recognising the precise genetic adaptations that may have gone.
5. As a precautionary measure, it would be wise wherever possible to preserve and restore landraces and wild species locally.
6. This requires local involvement and local support, often through volunteers.
7. There is a great need at national and international level to identify and refine appropriate socio-economic and informatic tools to incentivate, guide and monitor that local work.
8. Biological research is important for fine-tuning any guidance, monitoring and management tools.

On a general note, I believe that conferences of this nature are very useful, but would benefit from slightly longer time frames. It can be difficult for those travelling to read and respond in time. Moreover, some responses become concrete only after a period of reflection, because profound ideas in concise keynotes can take time to digest. Perhaps that helps to explain Alan Watt's comment on low participation.

Thank you to all organisers and contributors.

Research priorities

Massimo Angelini, Rural History, University of Genova, Italy.

I would like to indicate the following research priorities

1. Juridical solutions and proposals about farmers and communities' rights on landraces and heritage varieties;
2. Involvement and empowerment of local communities in on-farm conservation activities;
3. Local strategies for the self-management of landraces putting in value and marketing.

More research priorities

Christian Kleps, Romanian Academy of Agricultural and Forestry Sciences, Romania

Let me introduce a new proposal for a research priority, if possible, entitled "Research and information exchanges for conserving and diversifying of vegetal and animal genetic resources in agro-ecosystems".

Indicators, gene flows and biodiversity levels

Concetta Vazzana, University of Florence, Italy

I would like to indicate the following research priorities for the conservation of genetic resources:

- Biodiversity Indicators: The developing and applying of a system of indicators will allow the assessment of the state of biodiversity and the monitoring of the effect of agricultural management, of the emission of pollutants and the release or spreading into the agro-environment of alien species and genetically modified organisms on local biodiversity.
- Gene flows: Research is needed in relation to gene flow processes which are active in agricultural environments: between domesticated plants, from wild types into domesticated forms and from agriculture into the wild.
- Biodiversity levels: research is needed to decide which level of biodiversity is required to maintain agricultural landscapes in an optimal condition for the purpose of agricultural production.

Genetic diversity of threatened tropical timber trees

Allan Watt, Centre for Ecology and Hydrology, Banchory, UK.

KEYWORDS: Tropical timber, logging, sustainability.

SUMMARY: The author suggests focussing on cases where loss of genetic diversity may lead to loss of species when thinking of research priorities and illustrates this by addressing the loss of genetic diversity in tropical timber trees.

I suspect that most people feel that loss of genetic diversity is much less important than loss of species. So, in thinking about research priorities, perhaps we should particularly focus on cases where loss of genetic diversity may lead to loss of species.

One example is the loss of genetic diversity in tropical timber trees such as mahoganies and related species, which are threatened by logging and deforestation. For these species, it may be argued that the loss of genetic diversity, specifically the loss of the genetic diversity responsible for high quality timber and pest resistance, is even more significant than the loss of the tree species themselves. It is likely that selective logging has disproportionately removed those trees with the highest quality timber and those most able to withstand pest attack. However, this probably results in increased logging pressure on natural forests, threatening other species in those areas.

I therefore suggest that there is a high priority to carry out research on the genetic diversity of threatened tropical timber tree species, on the practical conservation of this genetic diversity and on developing silvicultural and agro-forestry systems that allow the sustainable growth of these tree species, thereby alleviating the pressure on natural forests.

I am sure there are other examples of loss of genetic diversity having a much wider impact on biodiversity.

Loss of genetic diversity in forest trees

Bogdan Jaroszewicz, Bialowieza National Park, Bialowieza, Poland

KEYWORDS: Forestry, Europe, selection, resistance.
SUMMARY: The author reviews the effects of forest management in Europe and suggests two areas of research: the genetic diversity of European tree species in places where trees were not only selected for their timber value, and the relation between the genetic diversity of trees and resistance of forest ecosystems against factors destroying them in connection with expected climate changes.

Although I agree with the point of view stated by Allan Watt ("Loss of genetic diversity of tropical timber trees"), I would like to turn your attention to the situation in European forests. On our continent, forestry (cultivation of forest) has a very long tradition. At least 200 years ago, forestry became a very advanced system of forest cultivation, selection of trees and harvest. It had very strong effects on genetic diversity (but also species diversity) present in our forests:

1. Selection of the best timber trees as a source of seeds for further regeneration of forest excluded trees that did not carry attributes valuable from the point of view of timber production. We do not know how much diversity we have lost on genetic level in European forests and how big an effect it has on their resistance against biotic and abiotic factors.

2. We do not know which attributes of the tree (height, straightness, speed of growth and so on) are related to resistance for "pest" attacks, if they are at all. It is possible that trees of the highest quality timber have the lowest resistance for some "pests".

3. As opposed to tropical forests, where loss of diversity is related to selective logging of the best trees, in Europe we have loss caused by selective cultivation of the best trees. I suppose both processes carry the same threat: loss of part of genetic diversity.

4. When referring to forests, we have to keep in mind that forests consist not just of trees but also of many other organisms, for which certain attributes of wood, bark or leaves may be of paramount importance for their survival. Further selection of trees may cause extinction of some specialized species of organisms.

5. In Europe, selective cultivation of forest trees resulted also in impoverishment of species composition of forests. Where are species like small-lived lime (*Tilia cordata*), Norway maple (*Acer platanoides*) and some others, which in the past had a much bigger share in European wood stands? They were excluded from our forests by choosing for regeneration only the species that produce good raw material.

By the way, in my opinion, when discussing matters of biodiversity, we should avoid words carrying negative connotations like "pest". It suggests that some organisms (trees in this case) are more valuable, than the others (insects="pests"). Is it really an objective point of view?

I therefore suggest that there is a high priority to carry out research:

1. On the genetic diversity of European tree species in places, where owing to long-lasting protection various forms of trees are saved, not just the "best timber" part of diversity. From a practical point of view, conservation of this genetic diversity may play an important role in saving our trees (diversity on species level) in the face of climatic change, air pollution and so on.

2. On studying the relation between the genetic diversity of trees and resistance of forest ecosystems against factors destroying them in connection with expected climate changes.

RE: Loss of genetic diversity in forest trees

Giorgio Binelli, Department of Structural and Functional Biology, University of Insubria, Varese, Italy

The assessment of the degree and distribution of the genetic variability in forest species is a well-understood tool for both practical conservation purposes and for theoretical insights on the natural and demographic history of the populations. Were I to recommend a few strategic guidelines for research in the next years, I think that where we are lagging behind is in acquiring a more accurate understanding of the genetic variability associated to genes of interest. Thus, I would recommend:

- An extension of the "basic" research on genetic variability for all those species that have not received full attention yet in this respect;
- A focus on studies devoted to assess the degree of variability associated with genes responsible for traits of interest either for practical uses or for resistance to stress factors in those species already well studied at the "neutral" genetic level, such as conifers. As an example, genes controlling resistance to drought stress in Mediterranean species would be of interest, given the reduction of rainfall, related to global warming and to the tendency to desertification that Mediterranean areas have already started to experience;
- To search for new genes controlling characters of interest by the new methodologies of genome scanning via "association mapping", especially in those species where high levels of linkage disequilibrium are found, or by the use of DNA micro-arrays.

Biodiversity paradigms

John Hutcheson, Biological Systems Ltd, Rotorua, New Zealand.

KEYWORDS: Taxonomy, Evolution, communication, scientists, policy makers.
SUMMARY: There is the appearance of a catch 22 situation in articulating the importance of the diversity part of the term biodiversity. Science is sure that it could convey this importance - if it could just investigate biodiversity sufficiently. Society in turn says it is willing to fund investigation of biodiversity appropriately - when science can tell them how important it is.

Perhaps it would help society to understand the job involved, if we just admitted that we will never be able to describe biodiversity, even in (the relatively simple and well understood) terms of species. And even if we could catalogue every species on earth, this vast taxonomic achievement in itself would not help us to sustain biodiversity, it would just provide a better list of missing components.

The concept of sustainability requires a mind-shift from seeing biodiversity from a taxonomic and evolutionary perspective (and survival of the fittest), to the ecological perspective, which reveals the collaborative nature of all biological communities. The term 'individual' can only be used if we narrow our perception to just one (human-defined) taxonomic strata. When we scale-up from the classificationist viewpoint to the ecological perspective, we find we cannot extricate any taxonomically defined entities from their internal and external community connections - until they are dead.

And because all biological communities modify their physical environment (especially) by buffering physical extremes, the environment is itself a biological creation. So the environment that selects the 'fittest' phenotype, is the local biotic community. We can see this active selection process most easily in man-managed environments, but it is well documented for bacterial communities, and demonstrably true for all systems when researchers see things at the community level. The ecological perspective thus throws up major philosophical questions about our underlying classificationist approaches and assumptions, and should at the very least, make us more open to perspectives different from those we are currently used to.

In our efforts to move beyond the taxonomic to an ecological perspective of biodiversity, we are now amassing vast research efforts to build computer models of the ecological subsystems being studied. However, there are two major problems being ignored here. The first is that current efforts generally ignore the information available from the taxonomic perspective, i.e., that the vast majority of both intra- and inter-specific terrestrial biodiversity is present as insects. So if we want to understand the ecology of biodiversity (which we must do if we wish to retain it), we must know how the insect communities connect with various ecological scenarios. If we were to re-arrange our efforts in accordance with the taxonomic distribution of biodiversity, we would have c. 65% of workers looking at insect assemblages and about 3% looking at all chordates - a reversal of the current situation. So we can tell that we are not really serious about sustaining biodiversity.

The second problem is the logical extension from this taxonomically selective myopia, into our methodologies. The inappropriateness of inferrential statistical design for understanding natural ecology is now widely appreciated. But its been about three decades since Hurlbert's initial paper - so we're not too quick on the uptake either. However, our interpretive methodology also rings alarm bells. As anyone who has ever used a computer knows, if there is any flaw in the instructions going in, the output will be meaningless. So the omission of any species or interaction within the system being modelled will reduce the models at best to schematic sketches and at worst to irrelevance. And because all the systems we study are subsystems, we know that broader system dynamics will inevitably throw up unpredictability. Blindness to this flaw in our logic was discussed with regard to aquatic systems by Rigler and Peters in 1995, so it will probably be another couple of decades before this sinks in, if it follows the normal inertia of science.

This brings us to the rather sobering realization that our current (and forseeable) efforts and abilities, in both taxonomic and ecological endeavors, are going to fall somewhat short of policy makers expectations, and are not of themselves going to help to sustain biodiversity. Please note that I am not for a moment suggesting that these efforts are not needed, our profound ignorance of the biosphere is mind-boggling, given that it is crucial for any sort of continuance of our society. Rather, I'm suggesting that broader society needs to radically reassign its priorities, and that we need to be questioning and broadening our perceptions, assumptions, methodologies and expectations (nothing very major). Even if we had appropriate understanding, there would be another couple of downhill decades of social inertia before processes under the control of vested interests could be changed.

In general, policy makers are submerged within the human endeavor and regard sustaining biodiversity as an 'add- on' to the job of sustaining society, rather than as the dynamic weave of the fabric that cradles society. They ask for an index of biodiversity to plug into some engineering hubris, whereas we all know it is the biological attributes of the species that form the connections within the communities, and which are therefore of importance to the broader system - including us humans. And so there goes the usefulness of diversity indices.

Our attempts at building ecological models, although doomed to be schematic and unreliable, re-emphasize some important points.

1. Life operates in a dynamic context.
2. Although we know some small bits well, we cannot even construct a full taxonomic catalogue for any particular site.
3. All biological entities exist as communities.
4. Even simple ecological systems are far too complex over time and space for us to model.
5. Biodiversity is a manifestation of the processes occurring.
6. Life ameliorates physical extremes.

In the face of these complexities, an approach to gaining the simplicity required to be able to comprehend the relative importance of processes undertaken by biodiversity is to scale up our perspective of communities to enfold the entire global system. When we do this it emphasizes that life buffers the extremes of the constantly changing environment of a globe that is spinning, wobbling and whizzing through space round the sun. This buffering process occurs at all scales, and could be termed the 'non-limited functional fractal' in the jargon, however the simple message is that the context is dynamic, and that life shelters life. For those folk engaged in soul-searching, shelter is the meaning of life.

As each species manifests a different aspect of the countless process pathways generating this sheltering outcome, there is an unassailable argument that it is the diversity of life that provides the response contingencies that enable this incredible buffering capacity to persist and expand sufficiently to shelter human society.

Although there are many naturally low-diversity systems, these tend to be subject to harsh extremes which limit growth of the buffering capacity of the community. It is also possible that the low diversity measured at the species level may mask higher intra-species genetic plasticity. The logic basis for this thought is as follows.

A background in indigenous New Zealand forest system entomology led me to investigate the nature of insect communities in various vegetation systems using Malaise trapped beetles. (Beetles provide 40-50% of insect species, so if there is a ubiquitous terrestrial indicator of biodiversity it is beetles). Along the successional path of (relatively untouched) natural NZ systems from heathland, through diverse shrubland to tall forest, samples showed highest diversity at the shrubland stage. Species life histories showed this to be related to the recycling processes occurring, and this was confirmed in samples from other systems undergoing high turnover. We can extrapolate from this that there is a continuum from high disturbance cycle systems - where recycling is dominated by bacteria (e.g. compost), through insect-dominated intermediate disturbance cycles, to fungi-dominated recycling in the much more buffered (& humid) environment of closed canopy forests.

Bacteria have the facility of passing around genetic material with great gusto in the early stages of establishing their communities, but this facility diminishes as the disturbance cycle lengthens and the various putative species become more ecologically zoned. We can thus postulate that in the apparent low diversity of less-buffered systems, there is a closer association with the bacterial end of the disturbance community continuum, and that this may enable a greater plasticity in intra-specific genetic composition. (This may be able to be elucidated via the comparative attributes of ericoid and endomycorrhizal soil community relationships).

The point of relating all this is not to suggest that GM escapes are probably more likely in highly disturbed systems such as arable systems & compost, although this is likely, but to flag the shape-shifting qualities of our scientific measuring-sticks.

The perception of biodiversity ensuring contingency pathways for the buffering process at the global level was of course given to us several decades ago by Lovelock's daisyworld model. Outside a scientific priesthood who were unable to perceive the biosphere as anything but stochastic bits, the observable fact of a world held in a non-equilibrium state by the presence of life was immediately obvious to most people. Of course, resonance of the global observations with traditional concepts of a sheltering entity that was larger than humankind may have helped many outside science to immediately accept the picture. However, far more fascinating, was the reluctance that many in science had in accepting the actuality - simply because they had not previously accepted the concept of observations at the global scale. Although science is supposedly founded on 'believing what we see', like any other group in society, we are also susceptible to just seeing what we believe.

For some time now the global convection mechanisms have been becoming more energetic due to the greenhouse process, ozone depletion etc. and climatic events are accordingly becoming more extreme. Unfortunately the buffering capacity of biodiversity (and which we should have been using to tell policy makers just how important it is), has been devastated over much of the globe. As a consequence, a whole bunch of positive feedbacks loops are now kicking in to help us understand just how far we are from the concept of sustainability.

Long term climatic trends which have been scientific focus, are largely irrelevant, because our society as it exists today is only about 30 years old - the period of the last doubling of the human population. However, the sun has increased its radiance by c, 30% over the period that life has been on earth. The presence of life here has buffered the inevitable heating marvelously, but the inexorable outcome is self-evident. The outstanding ability of early societies to accelerate this process is evident in the deserts that surround remnants of our old civilizations. But hey we're much better at it since the industrial age kicked in. How ironic that chopping down forests to help build monuments to various human faces of the God concept is still tearing the garden of Eden from around us.

While we may see extinction of species as epitomizing the biodiversity crisis, it is the loss of shelter from the system that is comprised of biodiversity which is currently flicking human civilization over a threshold of no return.

The direct message to policy-makers is: Sorry guys, it's already too late. By the time we convince ourselves of what we should be looking at, what methodology is appropriate, what we are interpreting and we write our reports - and then we convince you, and you get your reports written and convince the legislative processes - and they go through the lawyer fog and attempt to convince, or coerce vested interests to radically change their management of the planet on our behalf - and then an army of highly paid suits argue over seating at some international talk-fest (knowing that the US does not recognize that any such thing as an international community exists), we are all well down the gurgler.

Even just a close look at the stage of the salinisation process associated with irrigation in all the major food production areas of the world is sufficient to show us that we have not got that sort of time left. And that is only one of the major problems. I figure our only consolation in the coming climatic chaos will be that the oil and armament industries are going to learn that there is something out there which is far more powerful than them.

RE: Biodiversity paradigms

Ferdinando Boero, University of Lecce, Italy.

I liked this contribution. I would like to add something. Yes, maybe it is too late already, but we have something to do anyway. I do not think that taxonomy is to be labelled as a myopia. It is only if one thinks that this is sufficient to solve problems of biodiversity, but thinking about biodiversity without knowing its expression is also myopic, to use a fair adjective. Taxonomy and ecology have to interact and collaborate.

There is a short term objective, though. The main threat to biodiversity is habitat destruction. This is also causing genetic erosion, species loss and all the rest of the disasters that we continuously talk about. Habitat mapping and monitoring, to measure the rate of let's call it desertification or denaturalization of ecosystems, is something that is taking place on land (also with remote sensing) and is far from being obtained in the sea (I am a marine taxonomist and ecologist). Once we know that habitats are being lost, we have to go into that and quantify what we are losing. We can lose diversity at a genetic point of view, and we can lose diversity in terms of species pools. Knowing species (sorry, you need myopic taxonomists for this) is a prerequisite to quantify how many species are missing. Knowing the role of species (but first you have to recognize them) can lead us to infer what could be the impact of their loss. Even if we know that species can have different roles in different ecological contexts and that biodiversity is a historical issue, and so unpredictable by definition, if not under very generic terms.

Taxonomy, Ecology and Evolution are to work together, to make biodiversity studies more serious and less myopic, from any point of view. None of these disciplines can do without the others. But people continue to provide their magic recipe, implying that their approach is the only good one, calling the others myopic. Yes, they all are myopic when separate. All are right and all are wrong. We have to stick together and explain to sociologists that we are the product of evolution and that our presence in this world is such because there is biodiversity. We can live in simplified ecosystems (agroecosystems) but while doing so we are cutting the branch we are sitting on. It is as if there were a single approach to how to build societies. Sociology studies the organisation of the groups of a social animal (us) and is a branch of the study of biodiversity. It is not by chance that one of the vates of biodiversity (Wilson) invented sociobiology. So, why not, sociologists are welcome and important, but if they want to speak about biodiversity they have to know what they are talking about. Societies are not extracted from the ecological context. Just as economies are not. All this has been explained so many times to both sociologists and economists. We all agree that integration is important, but then the reductionistic approach (I do what I know and I disregard the rest) always prevails simply because there is not enough space in our neurones to contain all that information. That's why we have to pool our neurones and listen to each other.

By the way, botanists label communities in a way, on land, zoologists-ecologists do it in a different way (and bioregions are different for zoologists and botanists), in the sea the difference is even greater. We do not even agree on what to consider as a community type and the concepts behind this are not so well established. Phytosociologists have their god CLIMAX and consider as immature any state of vegetation that is not what has been established to be the good thing. This finalistic vision, with the equilibrium paradigm, is very followed in the management of terrestrial environments- At least in Italy. Marine guys are horrified by this, and speak about dynamic systems (what is the climax for plankton?). So our paradigms and concepts are not well structured yet, due to fragmentation.

Just to contradict myself, I participated actively to the forum on genetic diversity in marine environments, but disregarded the terrestrial branch... so I did not listen much. And then I arrive at the end saying maybe the most obvious things, without having heard much of what has been said in the rest of this forum. I read just a few messages and.... I liked it. Too bad for me, I missed most of it, sorry if my contribution is out of tune.

RE: Biodiversity paradigms

Alan Feest, Faculty of Engineering, Bristol University, UK.

This is a masterly survey of the current situation and I agree with most of what you say but at heart there is, I sense, a misunderstanding of the nature of biodiversity. Scientists have continued to attempt to measure biodiversity as if it had a quantitative basis. It does not; it is a quality of an ecosystem/habitat. Qualitative measurement is then much more difficult to achieve and explains the unsatisfactory results. My own approach has been to dissect out what this quality consists of and then to measure quantitatively the quality components. This works and allows an appreciation of the quality of biodiversity of a site.

At heart there is still the problem of "what is a species unit"? The pragmatic response is that since the concept of a species is a human construct it is whatever we can perceive to be a species. In a real sense it is what we can measure as a species. Similarly biodiversity is what we can measure so that if most of the beetles in an ecosystem are so little known/described then we are in a poor position to measure biodiversity of beetles and the ecosystem. In the UK this is not the case and my own work on spiders, macrofungi and beetles has shown the above approach to work well.

This then comes to the problem of what taxonomic group(s) should be measured to determine the biodiversity properties of an ecosystem/habitat. This is perhaps where the interface with the sociological context of biodiversity will deform the nature of the assessment but provide the basis of a decision. In my own experience subjective judgements can lead to superficial assessments of the quality of biodiversity. The following real case would suffice to show the problem: two woodlands next to each other; one an ancient oak woodland the other a modern coniferous woodland; subjectively there is no problem in stating the biodiversity value of the ancient woodland would be higher than in the conifer woodland but that would be wrong if you were studying macrofungi where the obverse is dramatically the case (for local climatic/geological reasons). Therefore the biodiversity is based in the values of the observer. How do you then balance these two sites for a policy decision affecting biodiversity?

The sociological context of biodiversity means that we urgently need to devise a way to advise decisions about land use and management and larger scale policies. I already provide this advice using the above qualitative approach (which some might say replaces one problem with another!). At least the decision is made in the context of greater understanding of the context. Therefore my plea (apparently misunderstood!) is that of course the socio/economic context of biodiversity is important but if this context is unable to understand/appreciate the role of biodiversity in the maintenance of the human support mechanisms then we are on the path to destruction.

Therefore we scientists must find a way to present biodiversity in a way that can be readily appreciated by society. Currently it seems the soft/furry/cuddly approach has been used. My plea is for a more rational basis that is still straightforward enough for the non-specialist to appreciate. After all who is going to get excited about the demise of the wart hog or my own specialism: slime moulds, if we only use the current humanistic appeal approach?

The alternative response seems to be that if we get the socio/economics right then the biodiversity will be OK. This is patent rubbish in that there are all sorts of factors such as Islandness/ colonisation/ metapopulation dynamics/ productivity/ eutrophication/ genetic isolation/ population size (could be a very long list) which interfere with this "best hope" approach.

RE: Biodiversity paradigms

James Mallet, University College, London

In reply to the somewhat depressing suggestions by John Hutcheson, I would like to try to be a little more upbeat - to argue that there may be more hope than he suggests.

In general, I completely agree that we humans need to refocus our mind-sets, and integrate economic and social policy with biodiversity conservation from the start. Unfortunately, I do have the impression, as he does, that it won't happen in a hurry, for short-term commercial and political reasons.

But on the specific point that we will never have time to enumerate all the species, let alone time to study all the genes in all the species, I feel that, by painting a depressing picture he may have undercut his own argument for greater spending in alpha-taxonomy and other forms of biodiversity research. (Although a geneticist myself, I strongly agree with the idea that there should be more competitive funding for alpha-taxonomy, and I sent in an opinion to this effect before the recent House of Lords report on taxonomy - the Lords still have a say in UK government, but their new taxonomy report was, in the end, disappointingly meek).

Actually, broad-brush strategies in taxonomy and biodiversity genetics research are useful (even though not as useful as total enumeration would be if it were possible). By allowing the identification of most common or high biomass species (or races, biotypes etc.), it is likely that you will have most of the ecologically important players. Sure, a few rare taxa may be keystone mutualists or otherwise important, but on the whole, rarity or low total biomass implies lack of ecological importance, for obvious reasons – it implies less energy flow (A physics analogy: you can send a man to the moon using Newtonian physics calculations, even though you know that the theory is actually incorrect, because it doesn't take relativity into account).

Similarly, in ecology. The causes of species diversity are still debated, and the question of whether diversity leads to greater ecosystem stability is, bizarrely, still not solved even after 40 years of modelling, surveys and experiments. (A similar example in evolution is the debate about neutrality and selection on molecular variation; in fact the two arguments are related).

Yet, in arriving at our current lack of resolution of the debate, we really do have a lot more understanding, particularly recently via large-scale European experiments, tropical forest surveys, as well as via newer modeling efforts triggered by this new data. As a result, we now know more about how ecosystems function. For instance, we have a better understanding about what "kinds" of ecosystems are more likely to have higher stability if diverse. I am more hopeful than John Hutcheson, therefore!

Finally, there is the "fiddling while Rome burns" problem (i.e. behaving like the Emperor Nero), to which the sociologists maybe are alluding in this debate, when they suggest we need to incorporate sociological factors from the start. Elsewhere in these discussions, I have strongly advocated basic research in biodiversity genetics. Alan Feest, myself and others have pointed out that we need this basic research, or we won't be able to get ourselves out of the hole, because you can't build a management strategy if you don't understand the biological part of the system. But if, as John Hutcheson suggests, it is already too late – "we are all well down the gurgler" to use his words, then why should politicians and the public fund biodiversity research at all?

First: we really don't know it's too late. We do know that there have been changes, and we may suspect that some are irreversible, but we don't honestly know how many changes are irreversible. Looking at the devastations inflicted by natural climate change in the fossil record, it is obvious that many of these were far worse than what we have so far inflicted on ourselves over the last century. Note: I am not a global climate change skeptic: the fossil changes were very nasty, and we really don't want such things to happen to us by our own hand. But we really don't know, yet, whether we can or cannot reverse the major changes in our current crisis. Even if there were a slender chance that reversal could be achieved, there is a good argument to work hard now to find out what we can do. The stakes are very high.

Second: even if it is too late for many species or even ecosystems, we need to study how what is out there now works, before it all disappears, maybe even while it is disappearing.

This applies even better on a region-by region basis. By having 13 bison individuals left in a captive herd, and by luckily having a handful of minuscule sites where the original grasses still grow, our American brethren have reconstructed prairies in various remote areas, and they can, if they want, reconstruct large sections of their midwestern prairie ecosystem; now that would be something! (Even if the passenger pigeon can never come back).

When we have achieved stabilization, after the catastrophe (or whatever!), our survivors and descendents will need to know how to put the remains back together. So by funding biodiversity research we really aren't "fiddling while Rome burns", we are, or should be, racing against time to obtain the body of knowledge to achieve stabilization and/or amelioration.

So let's work on the politics and politicians too. But research on biodiversity and its management has sound arguments for it, whatever happens to our world in the long run through our mismanagement of its resources.

RE: Biodiversity paradigms

Ferdinando Boero, University of Lecce, Italy.

In reference to what James Mallet wrote, I have some agreement and some disagreement. Rare species are potentially important, even though they do not play an important ecological role right now (besides keystones). If you look at the flush and crash theory by Carson, one of the main ways of evolution to occur is the shrinking of populations to a few individuals, with strong bottlenecks and founder effects (the crash) and then reflourishing of the species in another form (the flush). Rare species are a reservoir of diversity and have a potential for future evolution. We have no right to state that they are less important (i.e. expendable) in the ecological play.

I made a survey of Mediterranean biodiversity (marine) and asked the focal points of all countries along the Mediterranean shore if they had an example of final extinction in their country. Besides the monk seal (which is not extinct anyway) they could not provide examples, besides some local extinctions of charismatic animals. Biodiversity is made mostly by rare species. If we disregard them, we lose the meaning of biodiversity. Yes, the Biodiversity and Ecosystem Functioning (BEF) debate arrived to the conclusion that ecosystem functioning (in terms of biogeochemical cycles) is not so influenced by diversity. Great discovery! An ecosystem can work even with one species. If life is monophyletic, there was a single species in the beginning, and the first ecosystem worked at very low diversity. This is very dangerous ground. We need to perceive ecosystem functioning as a historical process, and we cannot stick to the chronicle to understand history. Life is not only biogeochemistry, even though many ecologists think so (while talking about biodiversity)!

RE: Biodiversity paradigms

James Mallet, University College, London

I don't think I disagree with Ferdinando Boero. Let me paraphrase my argument: It would be nice to get a total description, but we can't (cf. John Hutcheson). The point I was making is that we "can" asymptotically approach that total description, which can be very useful, if not perfect.

Research priorities recommendation draft

Dear E-Conference Participants,

Thank you all for your input over the last month, and all your comments regarding research priorities in terms of genetic diversity in Europe.

The WebBoard will be open for comments for an extra few days (until Wednesday 12th November 6pm) to collect your thoughts and views on the following recommendation draft for the meeting of the European Platform for Biodiversity Research Strategy held under the presidency of the EU in Florence, Italy on the 21-24 November 2003.

· Basic research in population and community ecology and evolution
· Extension of the basic research on genetic variability
· Broad scientific training and scientific excellence
· Co-evolutionary studies looking into species interaction in a changing environment at the gene, population and ecosystem level
· New approaches for measuring the social and economic impacts of biodiversity loss and impacts of maintaining biodiversity
· Estimation of long-term effects of managing natural resources on natural communities on economy, social interaction and human population
· Involvement and empowerment of local communities in on farm conservation
· Development of cost-effective molecular tools
· Research on and monitoring of effects of policies (e.g. CAP etc…)

The above research priorities stemmed in particular from the following considerations:

· Genetic biodiversity is equally essential for sustainable agriculture and sustainable natural systems
· Preservation and restoration of landraces requires local involvement and support
· CAP reform influences directly the condition of biodiversity in agricultural landscapes

Looking forward to your comments...

RE: Research priorities recommendation draft

Robert Kenward, Centre for Ecology and Hydrology, UK.

I think a little more could be done to capture the opportunities for conservation from socio-economics, as well as the threats, by revising "new approaches for measuring the social and economic impacts of biodiversity loss and impacts of maintaining biodiversity" to read: "new approaches for measuring the social and economic impacts on biodiversity and exploiting socio-economic incentives to enhance biodiversity".

Also, conservation can benefit from socio-economic measures beyond farmland, so "involvement and empowerment of local communities in on farm conservation" becomes "involvement and empowerment of local communities for conservation".

Then, with slight re-ordering to collate biological and socio-economic elements, you get:

The conference participants tended to focus on the following considerations:

- Genetic biodiversity is equally essential for sustainable agriculture and sustainable natural systems
- Preservation and restoration of landraces requires local involvement and support
- CAP reform influences directly the condition of biodiversity in agricultural landscapes

The resulting recommendations were for:

- Basic research in population and community ecology and evolution
- Extension of the basic research on genetic variability
- Development of cost effective molecular tools
- Broad scientific training and scientific excellence
- Co evolutionary studies looking into species interaction in a changing environment at the gene, population and ecosystem level

- New approaches for measuring the social and economic impacts on biodiversity and exploiting socio-economic incentives to enhance biodiversity
- Estimation of long term effects of managing natural resources on natural communities on economy, social interaction and human population
- Involvement and empowerment of local communities for conservation
- Research on and monitoring of effects of policies (e.g. CAP etc.)

RE: Research priorities recommendation draft

Bob Allkin, Centro Nordestino de Informacoes sobre Plantas (CNIP), Brazil

Dear Robert

I agree that opportunities exist for conservation from socio-economics but disagree that the existing wording describes only threats. Once the value to a community (fruit juice, fence, fodder, cheap medicine, windbreak, charcoal, thatch ......) is explicit and measurable then conservation will become a higher priority.

Your wording ("new approaches for measuring the social and economic impacts on biodiversity and exploiting socio-economic incentives to enhance biodiversity") once more places the emphasis exclusively on the biodiversity for its own sake rather than on its value to communities which may help conserve it and which might indeed have helped conserve it during previous centuries.

I would argue therefore for maintaining the original wording and possibly adding a new phrase to capture your point.

I support your second proposed change.

RE: Research priorities recommendation draft

Robert Kenward, Centre for Ecology and Hydrology, UK.

Dear Bob,

Point taken. How about "new approaches for measuring the social and economic impacts of biodiversity loss and benefits of maintaining and enhancing biodiversity"? Brazilian forests may need maintenance, but European agri-deserts could do with some enhancement of biodiversity.

RE: Research priorities recommendation draft

Alan Feest, Faculty of Engineering, Bristol University, UK.

Robert

It seems as if the whole of this debate has been taken over by sociologists. Can we not agree that we need to identify the parameters of biodiversity and understand what it is before we start bringing in the sociological contexts. This seems a logical progression to me.

RE: Research priorities recommendation draft

Robert Kenward, Centre for Ecology and Hydrology, UK.

Dear Alan,

I certainly agree on the importance of measurement. You could recommend changing a proposal if you feel that the need to identify parameters needs to be more explicit. However, as an ecologist who has watched socio-economic forces change environments hugely during recent decades, I very much favour getting the socio-economic aspects right for conservation too.

RE: Research priorities recommendation draft

Alan Feest, Faculty of Engineering, Bristol University, UK.

Robert,

I work as a consultant from time to time and have found the approach of using a series of measured parameters to describe the biodiversity QUALITY of a taxonomic group for a site works well when communicating with engineers and bureaucrats.

The parameters I measure are:

1. Species Richness (a compiled species list may also be used but this MUST be related to the survey input)
2. Biodiversity Index (S-W, Simpson's etc.). This can be based on relative biomass or individuals.
3. Species Value Index (normally based upon perceived rarity)
4. Density (numbers per unit area)
5. Biomass (can be computed from 1. and 4.)

With carefully constructed and simple sampling methods we have found a uniform approach has worked for macrofungi, spiders and beetles so far. I think a research priority should be to set up a unified methodology for measuring the quality of biodiversity for a range of taxonomic groups such that they may be compared internally and across habitats/ecosystems.

Fortunately using this approach produces a dataset that does not have to be comprehensive since it indicates the quality of biodiversity not the quality. Missed species therefore are less important. With this sort of data engineers and bureaucrats have at hand information to assist them in decision-making. It seems that I should also allow for this to be accessible for sociologists but the output is in the form of numbers which have the benefit of being value free but the disadvantage of not informing about the entities that make up the data. This latter point prevents some of our less numerate colleagues from a appreciating the nature of the data.

RE: Research priorities recommendation draft

Richard Ferris, Biodiversity Research Advisory Group (BRAG), UK.

I am somewhat alarmed that there are still researchers who feel we can and should continue with biodiversity research without taking into account socio-economic factors. With the growing interest in and acceptance of the ecosystem approach for tackling land management issues in an holistic and inclusive manner, it is simply no longer feasible to work in isolation from the real world. Society should have a say in how priorities are agreed and targets set, making decisions on the basis of societal needs and economic factors, as well as purely ecological criteria. If the scientific community is unhappy about the level to which the general public are informed, then perhaps it is incumbent upon us all to communicate the results of our research more readily and in a form that is accessible to all.

The UK Biodiversity Research Advisory Group (UK BRAG) www.ukbap.org.uk/Groups/BRAG.htm is assessing the socio-economic constraints and opportunities for progress in biodiversity research across six cross-cutting research themes, recognising the importance of involving a wider range of stakeholders and examining the issues from all perspectives.

RE: Research priorities recommendation draft

Sandra Bell, Durham University, UK.

I think this position is exactly the one that Robert is trying to alter.

We will do the science and then afterwards we can bring in the social folk. This suggests that societal factors are somehow inscribed onto a blank and prexisting "nature". While I am not a rabid social constructionist, I would nevertheless argue that to try to disentangle the "natural" (biodiversity) from the "social" in this way will not lead any of us to the kind of new insights and ideas that are needed to inform practice. Best wishes,

RE: Research priorities recommendation draft

Robert Kenward, Centre for Ecology and Hydrology, UK.

It is amazing what an excellent debate a little list-changing can trigger. The re-ordering I did was only a tidying exercise, without intending to imply a prioritising in time or effort.

I'm actually a biologist, who has worked on basic and applied research (as have most in the UK Natural Environment Research Council's Centre for Ecology and Hydrology), but also with industry and sustainable-use groups (including IUCN committees). Hence I appreciate the importance of basic research, and of biodiversity definitions, and of getting right the interaction with the human animal in the field and in political terms.

The debate does indicate how important it is that our recommendations are presented carefully, because (sadly) they may be all that some busy people read from our conference. Perhaps we should word as follows?

"The resulting list of recommendations does not imply any priority of urgency in timing or funding. We consider that it is important to address both biological and socio-economic aspects of conserving biodiversity, but note that some individual projects will be most successful if focussed within each area whereas others may benefit from cross-cutting themes. We recommend:

- Basic research in population and community ecology and evolution
- Extension of the basic research on genetic variability
- Development of cost effective molecular tools
- Broad scientific training and scientific excellence
- Co evolutionary studies looking into species interaction in a changing environment at the gene, population and ecosystem level
- New approaches for measuring the social and economic impacts of biodiversity loss and benefits of maintaining and enhancing biodiversity
- Estimation of long term effects of managing natural resources on natural communities on economy, social interaction and human population
- Involvement and empowerment of local communities for conservation
- Research on and monitoring of effects of policies (e.g. CAP etc.)"

RE: Research priorities recommendation draft

Ferdinando Boero, University of Lecce, Italy.

All the points listed by Robert Kenward are alright, and the phrasing is perfect. There is just a little detail, how can we study communities, genes and populations if we do not recognise species? Are we sure that this kind of expertise is genetically inherited by all those who deal with these aspects of biodiversity? Maybe the dirty word taxonomy might be employed with all the other disciplines that are carefully listed in the very nice outline produced by R. Kenward. The National Science Foundation of the US has launched the partnership for Enhancing Expertise in Taxonomy to train new taxonomists. They realised that, in the age of biodiversity, there were no humans left who knew how to recognise species. Are we sure that in Europe this is not a problem? I want to be very clear: I do not say that taxonomy is all we can say about biodiversity, I do not say that species lists are sufficient to tackle this problem, I do not say that this is the most important approach. Far from it. But erasing it as listed item is maybe too much, while listing community ecology, genetics, evolutionary biology, socio-economy, you name it, is maybe not so objective.

To answer another discussant, to me socio-economy, in this context, is the impact of social and economic structures on the well being of biodiversity. The pressures that human activities might exert on biodiversity (and vice versa). Let's be frank. The Rio Convention on biodiversity was not pushed by scientists. It was the environmentalist movement (within the framework of socio-economy) that pushed politicians to take care of all this. The training in biodiversity recognition in university curricula is disappearing, zoology and botany are on the verge of extinction in academia. Grinding things and shaking vials is the most trendy approach to biology. THEN, when money started to become available, all scientists climbed the biodiversity wagon, and the poor taxonomists were left out of the banquet. This is also their fault. We have to improve their quality. No doubt. We need a new, more modern taxonomy that has to cope with the problems of biodiversity. But let's not throw the baby away with the dirty water.

RE: Research priorities recommendation draft

Alan Feest, Faculty of Engineering, Bristol University, UK.

Ferdinando

It is no great consolation that the situation in Italy as regards taxonomic studies is as dire as it is in the UK. In answer to your question about the nature of a species I indicated in an earlier email that as it is a human construct it is whatever we want it to be! I was always taught that, in a strict genetic sense, it is the gene pool that will interbreed and produce viable offspring (so that is the end of landraces and varieties!!!!). This works most of the time except when you get to organisms such as myxomycetes (a special study of mine) where the taxonomy is based entirely on the structure of the fruit body and not a single species description has been confirmed by genetic study despite a huge amount of genetic study. This is compounded by a plasticity of form that has led to a proliferation of species descriptions many of which will fail my test above.

The situation in macrofungi is just as bad since genetic studies have shown that most described species conceal within the description about ten genetic species.

Robert Kenward's list has therefore two omissions:

1. The stimulation of taxonomic studies to consolidate the definition and description of species so that we can understand the true nature of biodiversity.
2. The establishment of a unified protocol for measuring the quality of biodiversity such that a baseline value for a taxonomic group for a site can be established and followed through time (lets see what the socio-economic effects are actually doing to biodiversity!).

I am sure that having started a list there will be no end to the special pleadings for the inclusion of other factors but the above seem to me to represent something fairly fundamental in a wish list.

RE: Research priorities recommendation draft

Ferdinando Boero, University of Lecce, Italy.

Dear Alan

I know very well that defining what is a species is a rather cumbersome question and that there is no univocal definition. But, when we perform ecology, we build up tables with names of species and measurements of their abundance. Sometimes the species are not "real" species in one of the many senses of this term but, anyway, we usually take organisms and give them names. This is VERY clear to the laypeople. if you tell them that a lion is a gene pool they will not listen to you. People are concerned about the extinction of species, and the normal perception of biodiversity is the heritage of species. We might discuss this forever, organize congresses and workshops, write books on what is a species, but the concept will remain well established (with no clear definition, I agree) in the head of the public. Those who decide, through their representatives, who has to receive support. Modern taxonomy is both morphological and DNA based. But I am sure that there is no need of explanation of this issue. So, I concur that the other two points added by Alan should go into Robert's list. Let's make it simple. There are three definitions of what is biodiversity: genes (diversity within species), species (as compact gene pools, or phylogenetic end points), communities. Maybe we can stick to them. Without going into details too much.

Biological vs. socio-economic studies debate

Jim Mallet, Galton Laboratory, Department of Biology, University College London, UK

KEYWORDS: Basic research, socio-economic factors, training.
SUMMARY: I have been following the discussions about biodiversity plus or minus sociology with interest. It occurs to me that some of our apparent conflicts may be due to subtly different usages of the vague term "biodiversity" in different fields.

I strongly agree with Alan Feest and Ferdinando Boero that basic studies in biodiversity are badly needed, and are often ignored in conservation.

This does not mean that I disapprove of understanding sociological factors in the "application" of biodiversity studies to conservation issues, but it inevitably means that I must disagree with those who suggest that socio-economic studies need to be incorporated in genetics of biodiversity research from the start, as though the underlying biological, evolutionary and ecological processes depend in some primary way on the human context. They do not; the two fields are interdependent in only the forward direction.

I made a strong case for the support of basic research in my email comments of 15 October (see Session 1 on the web site). My major argument was that basic research has much higher prestige value, and that the declining competitiveness in European science (including in the UK, where it isn't as bad as in EU funding mechanisms) is due to poor of support for basic research.

Another important argument is that scientists trained in basic biological research are better equipped to go on and apply the latest knowledge, and this will help our competitiveness in the global market.

In biodiversity research, the training spin off will be that the best understanding of biodiversity and ecosystems must lead to better application of that knowledge in conservation, where it is melded with other branches of knowledge for overall economic and social benefits.

The twin prestige and training spin offs of basic science research have been completely misunderstood among policy makers in Europe, but have been strongly supported by successive governments in the USA for many generations. This is precisely why the Americans increasingly get more Nobel prizes than us, but also seem to do better at designing and exploiting financially rewarding inventions and getting patents.

The Americans are also reasonably good at (some aspects of) conservation. Or at least there are people there who know what to do about conservation! Studies of global climate change and its biodiversity effects are an example.

On the other hand, I believe that some of the respondents here, who seemed to be suggesting the incorporation of sociological factors ab initio in biodiversity genetics research, were not really meaning to denigrate basic research. At least I hope not!

I think, therefore, that they used the term "biodiversity" to mean more about the biodiversity research in the sense of understanding human impacts on biodiversity, or politically involved strategies such as conservation or reintroduction, than we biologists do; we tend to mean purely understanding ecosystems, species and so on per se.

In conclusion, I broadly support the recommendations outlined previously, and I would strongly argue for keeping the basic biological research categories at the top of the list, unadulterated by "socio-economic factors". Especially in the genetics of biodiversity, this basic research underlies everything else.

In particular, I argue for a much greater emphasis in Europe for this basic science underlying biodiversity research than is currently in vogue.

RE: Biological vs. socio-economic studies debate

Ferdinando Boero, University of Lecce, Italy.

I have coordinated a HUGE project on the state of coastal environments along the coast of Apulia (the heel of Italy). I used some of the money to have a socio-economic study on the coast we were inspecting from all points of view, including a great emphasis on biodiversity. Knowing the extent of human activities was of great help in understanding the situation we were looking at as well as providing guidelines for future management. Italy launched Marine Protected Areas in places where the socio-economic landscape was not conducive to their presence, and disregarded other areas just because of this bad experience, without knowing that, at those other places, the socio-economic background was very favourable to MPAs. A disregard, and then a mislead approach to socio-economics had great impact on biodiversity protection and management.

In my former message I made a plea for interdisciplinary research. Man is an animal, its behavioural ecology is called socio-economy, OK. If this animal is part of the system we want to know, then we need to include it. Especially if its (not his) impact is huge. The tools to do this are manifold and I am not satisfied with any of them. But it is the same with biodiversity without the human beast. And this forum is more or less quarrelling about the importance of taxonomy, or ecology, or evolution to get some insight on biodiversity. Socio-economics is all right, as long as these guys do not pretend to lead the pack, focusing all efforts in this direction. We need to have public approval, since our research is mostly financed with public money, and there is a public pressure towards investing money in what we are doing. The people in physics sell little green men to get money to go to Mars. We cannot afford being shortsighted; they will steal all the money for irrelevant enterprises (let's go to Mars to see if there is water up there, and let's build big rockets to shoot down the killer asteroid, let's look for cold fusion) and leave nothing to us, the pure (and poor).

RE: Biological vs. socio-economic studies debate

Erling Berge, Department of sociology and political science, Norwegian University of Science and Technology, Trondheim, Norway.

The debate during the last few days is interesting in many ways: in how it reconfirms divisions I have seen in earlier debates, and in how clearly it outlines problems of talking across disciplinary boundaries.

I am a sociologist of human society. I have listened to biologists long enough to know that when they talk of communities or sociology humans are probably not involved. However, here I get the feeling that sociology and socio-economics refer to human society (though I am not quite sure about Ferdinando Boero's statement).

The most serious problem the debate has demonstrated is the misconception that if only scientists are able to document the importance of biodiversity to the political establishment, the politicians will know how to, and have the power to, remedy the situation. And if they do not, then "Sorry guys, it's already too late".

This assumption about the abilities of politics is basically flawed. Demonstrating that biodiversity is declining or disastrously changing does not say anything about necessary long-term political changes. The evidence may underscore the obvious, that which we already know, about how we should not pollute or in other ways mistreat our environment.

It is a flawed assumption in that it assumes long term political change starts from the centre. It very rarely, if ever, does. Human societies, like any living system, change by marginal adaptations at the margin of perceived valuations. This means that change occurs locally along those lines of activity where farmers, or tourists, or industrial entrepreneurs perceive the most valuable activities to be. Biodiversity will affect the decisions of actors directly if they are able to perceive biodiversity and relate it to their values. At the very least this requires measurement of biodiversity, and at a scale making the observations relevant to decision makers. Biodiversity may also impact choices indirectly if policymakers are able to shift relative incentives so that decisions are likely to be less destructive for biodiversity rather than more.

But the task of getting the institutional incentives rights is exceedingly difficult. No matter what economists may say, it is more an art than a science. The best science can do is to provide not only measurements of biodiversity but measurements of biodiversity linked to policy relevant human activity at a scale where institutional design may be effective. That will usually be the local community, maybe the scale at which Alan Feest reports successes.

Successful improvements by political activity have in most cases been achieved by trial and error, by small adaptations and judgements of outcomes. To be able to do likewise for improving biodiversity both ordinary people and politicians needs time series of measurements, observations of biodiversity linked to human activity. A behavioural approach to biodiversity politics may be possible without complete understanding of it.

RE: Biological vs. socio-economic studies debate

Alan Feest, Faculty of Engineering, Bristol University, UK

I have been active in politics as well as in consultancy and I know there is goodwill towards our efforts to protect the "human ecosystem" and biodiversity (refer to Robyn Oakley's book "The politics of environmentalism) and that if we can communicate our concerns in an intelligible way some account may be made of our concerns (even if it is only that the largest two voluntary organisations in the UK are the National Trust and RSPB and they have much larger memberships than all political parties put together!). This traditionally very British concern is starting to be equalled by that in other countries and the Dutch can point to their own "prarie" experiment at Ostvarsenplaaten (I think that is how it is spelt) which is a remarkable action for a densely populated country).

What is particularly interesting to me is your paradigm of action at the interfaces (and at lower decision making levels). You seem to have arrived at the same point as Dr Alan Rayner in his book "Degrees of Freedom". A book that could only have been written by a mycologist! So despite my earnest pleas for biodiversity research that allows us to understand what we are trying to conserve and enhance I do understand the need to to ensure that local socioeconomic actions will always be required to support our efforts. I am just trying to say that we need the map first!

RE: Biological vs. socio-economic studies debate

Bob Allkin, Centro Nordestino de Informacoes sobre Plantas (CNIP), Brazil.

Many thanks to James Mallet for his thoughtful and balanced contribution and for having reminded me of how careful we need to be when formulating our contributions and recommendations!

Let me clarify. I am a biologist not a sociologist. I strongly agree that basic research is vital, desperately needed and a priority. Without sound knowledge we will not be able to contribute usefully or speak authoritatively. I agree that many of the underlying biological processes can be studied independently of the human context.

I had further assumed that we all share a common long term goal: the conservation of diversity. I am not convinced that conservation (or indeed all aspects of evolution) can be studied independently of human and environmental factors.

As James imagined I had no intention to denigrate basic research. I did make a plea, however, for our community to lift its eyes beyond the immediate horizon of our research and to also devote attention and energies to the parallel challenges of how to measure the impact (social value) of biodiversity and of how to communicate this.

My view is that we need to engage with these challenges as a priority since:

- we need the support of society to continue and amplify basic research (many contributors have suggested that we do not have this support)

- we will be studying the genetic diversity and the biological mechanisms for a long time and as we study diversity will disappear.
- on the ground, conservation depends upon the behaviour of communities which themselves may have no clear view of the "value" of the diversity in their stewardship or be able to weigh its value against more tangible benefits from logging, mono-culture or whatever.

My own experience in community-based projects in Brazil (involving scientists, development agencies and local technical support organizations) suggests that this requires a multi-disciplinary approach and that we as biologists cannot afford to leave such studies to the "sociologists" alone.

Reflecting upon the debate here raises doubts in my mind as to the validity of my original assumption: that we share diversity conservation as our ultimate goal. Can we agree upon that?

Genetic biodiversity in agricultural and natural systems: Measurement, understanding and management: Closing Comments

Macello Buiatti, E-Conference chairperson, University of Florence, Italy.

As stated in the introduction, the aim of this conference was to open an interdisciplinary debate on the nature and dynamics of genetic variability in natural and agricultural ecosystems in relation to the human impact on it, thus gaining useful information for biodiversity conservation.

The conference was initially subdivided into three sessions (natural genetic variability, intraspecific diversity in agro-ecosystems and the impact of socio-economic factors on genetic biodiversity), but a fourth session on research strategies was later wisely added. The response to keynote contributions was always interesting and the amount of them has been fair for the first three sessions the inputs flow suddenly gaining pace in the fourth, which for this reason has been allowed to continue until the 12th November. There have been 31 contributions evenly distributed in the three sessions and 34 in the fourth. Several people participated in the debate in more than one session and one third of the contributors to the last one were involved in the earlier discussions. This has led to a very interesting process of homogenisation of languages and to the (partial) removal of the traditional disciplinary barriers present in the academic sphere. The implicit thought which emerges from this process is that when we discuss strategies we are forced to abandon our own partial attitude due to the inborn highly interactive character of the object of our discussion, namely biodiversity itself. Having said this, I will not make a summary of summaries of the contributions to all sessions but shall try to offer to further discussion in the Florence meeting some of the concepts that seem to me to have emerged from the e-conference.

Biodiversity is relevant for life survival on this planet at all levels of its hierarchical structure , namely genomes, organisms, ecosystems, biosphere, noosphere, the last being , in the definition by Vernadskyi, our own , human network mainly based on individual and collective cultural variation. This means that we must go beyond the widespread conception that conserving biodiversity only implies avoiding the reduction in the number of species and, particularly, of the "easily visible" ones. This bias was partially explicit in some of the contributions that mainly concerned higher plants and animals and within animals mainly insects, but only rarely touched upon lower animals and plants and only once microorganisms. Although the term "species" is known to apply only to animals and with large exceptions to plants, it has a very ambiguous meaning at lower levels. Moreover, higher organisms survival is dependent on the existence of lower forms of life. Finally the very wording "species conservation" does not by itself imply species evolution, probably the reason why the real value of genetic diversity is sometimes questioned on the grounds that single species have been resisting destruction with an apparently low level of intraspecific genetic variation. However, according to most opinions expressed in the conference and to very widespread knowledge, adaptation is indeed a dynamic process and therefore high genetic variability levels, even if not necessarily needed in the short term are the condition for long-term evolvability as defined by Gerhart and Kirschner. As mentioned in a number of contributions, particularly in sessions 2 and 4, higher levels of biodiversity organisation into ecosystems and the global biosphere are also of utmost relevance for biodiversity as shown by the first five mass extinction all determined by global changes, and probably, by the undergoing sixth extinction which may be caused contemporarily by climate changes and another internal global factors, namely us, humans. This is the reason why the dynamical behaviour of the noosphere with its interactions with non-human systems ought to be appropriately studied as we started doing in sessions 3 and 4.

Every level of biodiversity organisation has to be analysed with the appropriate tools taken from a number of disciplines working together as much as possible. Here the distinction between basic and applied science is very ambiguous particularly when the choice between different tools for monitoring and measuring biodiversity is needed. One of the major problems in this case, if we take for granted the need to maintain biodiversity at all its levels of organisation, is the choice of low cost tools which should not be "neutral" but reflect the adaptation capacity of individuals, species, ecosystems, the biosphere. Functional tools should be developed in other words which connect the variability of one level of organisation with the adaptation capacity and evolvability of the higher one. Just to give an example discussed at some length during the e-conference, molecular markers chosen for the measure of genetic variability should be at least partially functional, that is connected in some way with fitness. In the case of natural variability they may measure variation in coding and non-coding sequences of genes involved in development, resistance to stress, fertility etc. When the intraspecific variability of domesticated animals and plants is being monitored, others should be added to these markers referring to diversity in genes relevant for characters related to production and therefore liable to be selected and propagated by humans. Following the same kind of rationale, at the ecosystems level, characters such as "connectance" (the ratio between extant connections and potential ones) or the redundancy of the system may be preferred as they may reflect the buffer capacity of that level of organisation. The same way of reasoning holds for the other hierarchical levels although research becomes particularly difficult when we have to tackle the most difficult problem, that is, namely, the relationship between human cultural-social variability and the natural one in biosphere conservation. In all these cases, so-called basic research is needed to yield the aforementioned tools and others, whose use is bound to start with research itself. Behind that and contemporary to that, "blue sky" research must also be carried out to give the knowledge needed for tools construction. The danger of a low level of connection between what may be called blue sky, oriented and applied research, is that new knowledge, coming from other areas of research is not properly used or not used at all for conservation. A solution to this problem is bound to come from a better dissemination of basic research data to people involved in biodiversity management and the building of specific NOE interdisciplinary projects.

Another positive result of this conference planned by the organisers was the contemporary discussion of problems related to natural and agricultural biodiversity. The relevant outcome of this discussion has been the new attention given to the complex issues related to human impacts in terms of social and cultural variability but also the influence of international and local regulations on conservation and property rights and benefits concerning genetic variability. It seems quite obvious that the scope of research and science is not to give direct socio-political suggestions but to start involving sociologists and economists in studies particularly related to the higher levels of biodiversity organisation on which the noosphere itself has a major impact. The right approach to this area of research has obviously to be interdisciplinary, with sociologists and economists deeply involved in it but always cooperating with biodiversity conservation experts. All academics derived prevalence of one discipline over the others should, particularly in this case, be firmly rejected as harmful for a useful outcome of research. An important level of investigations in this area could be the evaluation ex-ante and ex-post of policies effects on biodiversity conservation with an approach of the kind suggested by the procedures of Agenda 21, involving common planning by the major human actors of economic and developmental management of specific geographic environmentally and socially homogeneous areas.

Last but not least, I would like to warmly thank all those who have contributed to the success of this e-conference showing the high level of scientific knowledge of the vast field analysed present in our community and proposing a series of extremely valuable research recommendations to be discussed in the meeting in Florence.

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