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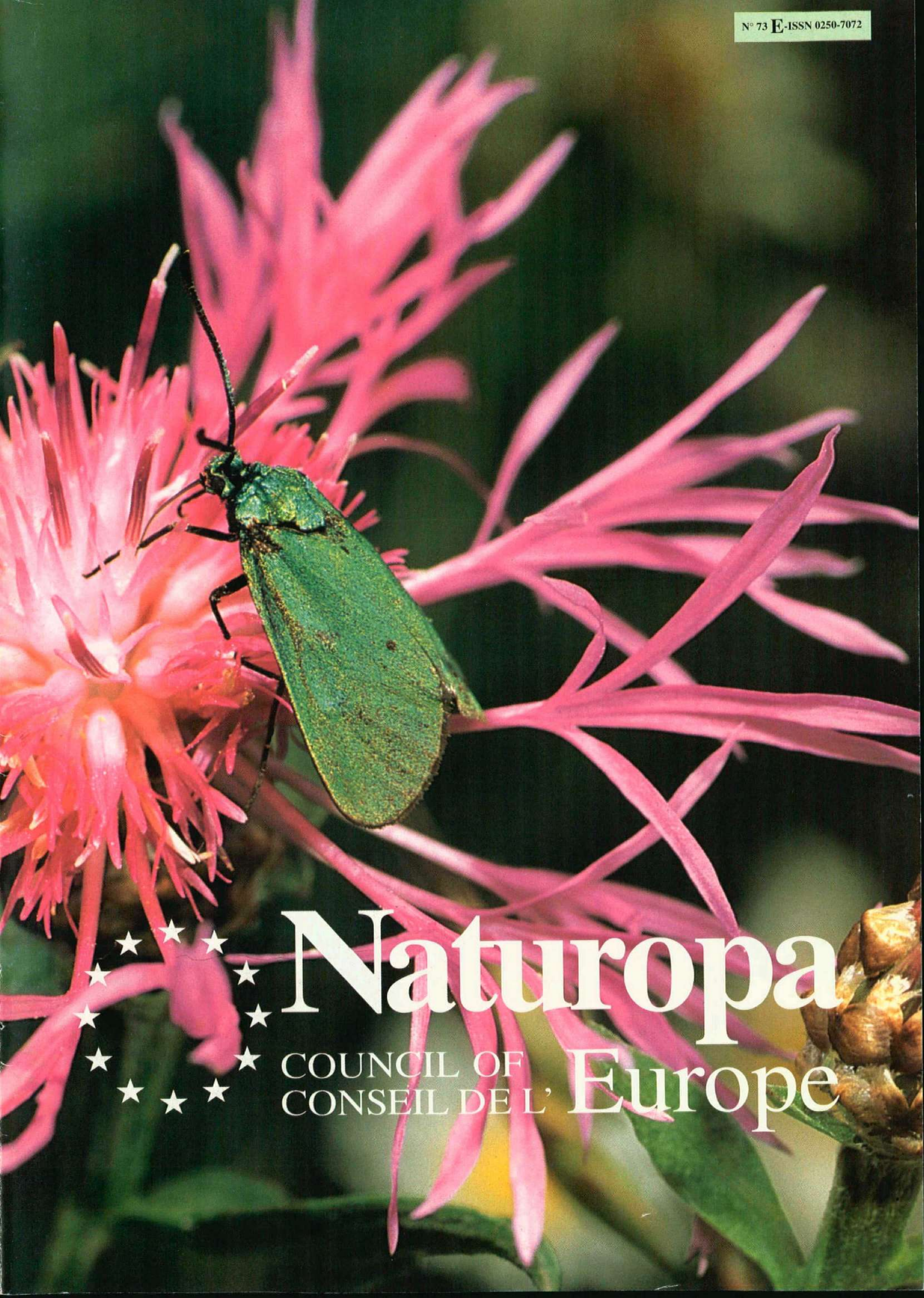

F. Roubert

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The incredible variety of life

It is certain that we shall never know the true extension of the incredible amount and variety of life on this earth. Too many species have already disappeared and many others are following suit. Perhaps this is part of the natural course of events, debatable though this may be.

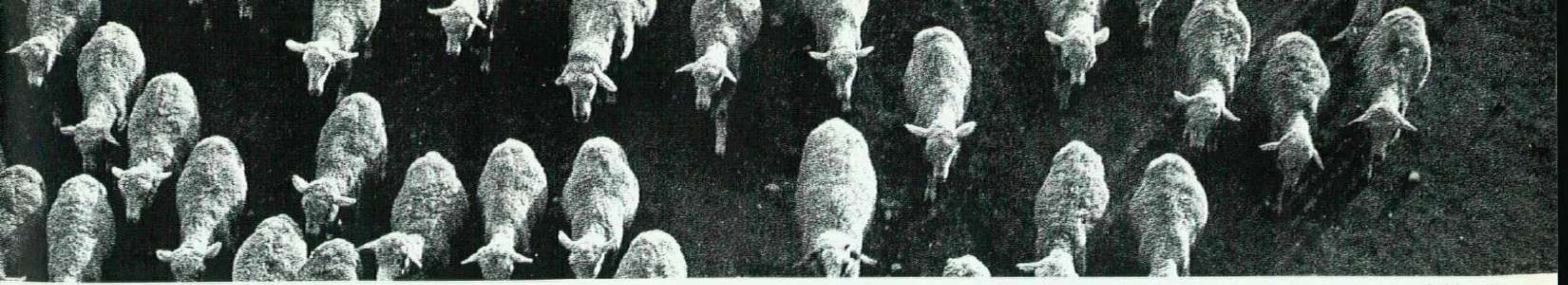
For various reasons, however, man is now becoming aware of the irretrievable loss of species and is trying to maintain and even to recapture this great "biodiversity". This issue of Naturopa reports on some outstanding aspects of this relatively new discipline - where the Council of Europe has also taken up the challenge.

In 1994, Naturopa will devote its first issue to education in the field of the environment, that basic and essential "tool" which attempts to restore respect and understanding of our natural environment, as well as the notion that one need not be a botanist to love a flower.

Naturopa's second 1994 issue, No. 75, will be in support of the Fourth Pan-European Colloquy on Tourism and Environment, to be hosted in Poland, with forests as main theme.

On the very eve of European Nature Conservation Year 1995, Naturopa 76 will prepare a European-wide appreciation of this major Council of Europe campaign. ■

H.H.H.



J. Vassilev

Editorial

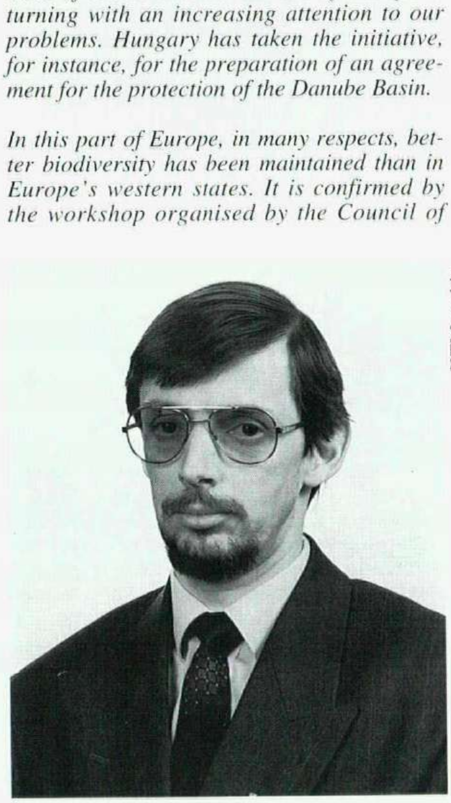
Europe is the continent where natural features have arguably changed to the highest degree in the course of history. But life has its strengths. Considering Europe as a whole, life forms have survived all these changes but most natural ecosystems which were earlier widespread have become confined to "islands". Many species living in isolated residual populations were threatened by extinction, with some indeed becoming extinct. Certain species which were considered as man's direct rivals (such as the larger predators) or which yielded good profits from the sale of their furs, were completely eradicated in many countries.

However, the first good results of nature conservation are connected with this same period, for example, the saving of the European beaver as early as the last century or the results of bird protection in the first half of this century. The loss of biological diversity and that of natural habitats (ecological diversity) which bring about population decreases in species will result in significant losses in genetic diversity. Biology and ecology struggle with a great number of uncertainties, but examinations have shown that at the current speed of biodiversity loss those natural processes which sustain and ensure the life-supporting cycles on Earth will not survive. This is one of the reasons for the UNCED Convention on Biodiversity, which is the result of the common efforts of various world organisations and participating countries. The work of individuals and nations and international efforts are justified by the correct and fair ethical reasoning lying behind them. It is not only that every living organism has the right to live on the Earth, it is not only that wildlife communities should be saved for our grandchildren, it is also in our direct interest.

Europe has set an example by the initiatives and measures taken by the valuable activities of the European Parliament and the Council of Europe in the 1950s and 1960s. When the first campaign was held in 1970 by the Centre Naturopa, many countries responded with new statutes or other national measures. It also motivated the first modern legislation on nature conservation in Hungary in 1971-74 when Hungary was still at a distance from European co- operation.

The Bern Convention, which was accepted in 1979, was an important step forward as it included elements of biodiversity protection, i.e. the maintenance of wildlife habitats with consideration to the impacts of human activities and monitoring of its provisions and recommendations supervised by the Standing Committee of the Convention on a yearly basis. In the communist era several countries of Central and Eastern Europe were precluded from joining for almost a decade. Let me note here that I am delighted to know that at the time of the change of the regime my country was the first to be a party of the Convention in 1990 and since then Bulgaria and Estonia have also followed. I do trust that with a complete future participation of this region, an institution of genuine pan-European co-operation can be realised in the field of wildlife conservation. I am glad to see that our experts are actively participating in the work of teams and the Council of Europe is turning with an increasing attention to our problems. Hungary has taken the initiative, for instance, for the preparation of an agreement for the protection of the Danube Basin.

In this part of Europe, in many respects, better biodiversity has been maintained than in Europe's western states. It is confirmed by the workshop organised by the Council of Europe in Budapest this year and also by the symposium on biodiversity of the Central East European region held by the Finnish and the Hungarian Academies of Sciences. At both meetings there was a complete participation on behalf of the respective countries.



KTM archiv

Maintaining these values is of interest to all Europe. At the same time in these new democracies, the indispensable economic transformation and the free exercise of property rights present a challenge from the point of view of sustaining natural resources and their sustainable use. In this process we should avoid the mistakes that western Europe has committed and recognised but for the time being we need guidance in this respect. Of course we need good laws. Preparation of laws of great significance from this point of view, compiling with the new situation such as the law on land, on the environment protection or on nature conservation have reached their last stage, whereas the ones of primary importance, for example the laws on privatisation, on local governments including restrictions to protect natural resources, have been accepted by the Hungarian Parliament among the first laws.

And we have received so much help through the publications or the colloquium series of the Centre Naturopa, but also in the frame of the PHARE programme or through international organisations and in bilateral co-operation with certain countries.

In the frame of the follow-up of the Rio Conference at the Lucerne Conference a central role was given to Central and Eastern Europe within the Environmental Action Programme for Europe (EAP). Priority, however, was given to reducing and elimination of pollution directly harmful to human health. Thus, sustaining of biodiversity stayed in the background. That explains why we have such high expectations concerning the declaration and the acceptance of proposals of the Maastricht Conference, which has supplemented the conference held in Lucerne, and the implementation of its recommendations will make up an appropriate programme tailored for Europe to implement the Convention on Biological Diversity. The European Biological Strategy and a European Ecological Network, our most important tasks as stated by the Conference, can supply a fundamental basis for maintaining the continent's biodiversity in the course of this decade.

I find it very significant that the Conference has adopted specific motions. It is to be confirmed that the areas of the European Ecological Network should be given priority with regards to the wildlife protection, land use and other activities. It is also significant that problems of Central Eastern Europe and their solutions are given priority in the European co-operation.

All these present a task of great importance for the co-ordinating organisations, the Council of Europe, the European Communities and the European Environmental Agency, also requiring good co-operation on behalf of the respective states. The Hungarian government is willing to promote all this and Hungary, including our prospering NGOs, wants to take an active part in this process.

Dr János Gyurkó
Minister for the Environment and Regional Policy
Hungary

C. Grundsten

M. Viard/Jacana

A global approach enables the environment to be apprehended equally well from the standpoint of landscapes or of the latest technics of in vitro culture

The new science of synthesis

Vernon Heywood

The term biodiversity has only been in use for a few years yet it has now almost reached cult status. Even more important, following the signature by many governments of the Convention on Biological Diversity at the UNCED in Rio de Janeiro last year, it is now widely recognised and used by governments. Its interpretation, however, is open to much debate and it is viewed quite differently by different interest groups such as protected area managers, plant breeders, conservation biologists, sociologists, ethnobiologists, taxonomists and so on. The public perception of biodiversity is coloured very much by the literature of conservation NGOs and natural history films which give the impression that it concerns tropical forests full of exotic birds, myriad insects and bizarre animals and plants containing potential new wonder drugs! In fact the very difficulty of defining biodiversity in a way that is measurable and operational and applicable to the real everyday world has caused considerable confusion and there is already a tendency to dismiss it as little more than a current bandwagon.

On the other hand, what is distinctive about the concept of biodiversity is its all-embracing nature: it is much wider than systematics or conservation or natural history and has social and economic as well as scientific dimensions. It deals with the total range of variation in and variability among systems and organisms from the bioregional and landscape level, through the various taxonomic levels to the populations and genes and covers the complex sets of relationships within and between these levels. Such a complex idea defies a simple definition but in simple lay terms it can be described as the whole variety of life in all its manifestations and relationships.

Different scales

Biodiversity can also be considered at a global, regional, national and local scale. In Europe, little effort has been made so far to consider biodiversity throughout the continent although various aspects have been addressed by a range of European institutions such as the Council of Europe which has played a pioneering role in conservation in developing instruments such as the Bern Convention and the European Community which has agreed the Habitats Directive. It is perhaps strange that there has been no pan-European initiative in biodiversity so far despite the close involvement on many individual scientists and institutions in the fields concerned, although various environmental actions have been proposed, including European Nature Conservation Year which the Council of Europe is organising for 1995 and the pan-European conference "An Environment for Europe" in which the Council of Europe, the European Community and the United Nations Economic Commission for Europe are co-operating. Perhaps Europe can show a lead in the implementation of the Convention on Biological Diversity once it is ratified. Europe, especially in the south, is surprisingly rich in biodiversity if measured in terms of organisms although it has to be said that we do not have accurate overall figures for most groups: there are 12,500 species of flowering plants, 2,100 species of bryophytes and 250 freshwater fishes, and the numbers of mammals, birds, reptiles and amphibians are known for each country, but we do not have adequate information on the numbers of many classes of invertebrates or microorganisms. So even in the most basic terms we do not have a full picture of how many species constitute the biodiversity of our European continent, except for flowering plants and vertebrates. What we do know, however, that for some groups of organisms, the Mediterranean parts of south of Europe are very rich in species diversity with considerable numbers of endemics and while not quite comparable with the tropics, do contribute substantially to global biodiversity.

Drastic changes

Europe has an enormous diversity of landscapes, ranging from coastal dunes and salt flats to alpine peaks, from near-deserts and steppes to lush meadows and rich wetlands. But nearly all of them have been drastically modified by human action over thousands of years through transhumance, grazing, deforestation, agriculture, terracing, road building, urban and industrial development and pollution. In fact much of what are regarded as typical of parts of Europe are in fact cultural landscapes - the result of human alteration of the already modified natural landscapes and their ecosystems. Examples are many of the characteristic grasslands of Europe such as the chalk downs of southern Britain which are dependent on human intervention for their maintenance. The abandonment or reduction of grazing has led to their recolonisation by scrub or forest, thus putting at risk the habitats of orchids and other species that occur there. The typical Mediterranean scrub communities such as maquis, matorral, garrigue and phrygana which to many people characterise the region are in fact also successional communities which will in many cases revert to oak/pine forests if left undisturbed by humans.

Agriculture has had the most profound effect on European landscapes. Examples of this go back to prehistoric times such as the terracing of hillsides for soil stabilisation which is widespread in many parts of southern Europe. Such terraces make an almost indelible mark on whole landscapes and because of their size and scale and the human labour involved represent almost heroic achievements. Today, such labour-intensive methods of cultivation are being gradually abandoned and with them the social and cultural traditions of such systems. As well as arable agriculture which is responsible for many of the cultural landscapes of Europe, vast areas of the natural vegetation of Europe have been cleared for plantation agriculture in the form of olive groves, vineyards, citrus orchards, fruit crops such as apples, almonds, peaches and so on. Some of these such as olive groves which date back to Roman times are so ancient that it is difficult to imagine what the countryside looked like before they were planted although we know, of course, from ecological studies that most of the area today occupied by olive cultivation was covered by oak and pine forests.

Man-made

The systems of hedgerows and other enclosure systems which today provide habitats for many species are human constructs although again so ingrained into our concept of how the landscape should be that it is difficult now to remember they are not "natural". Many people protest at the loss of hedgerows and similar features through the development of large-scale agriculture and there are in fact good reasons for lamenting their loss as they are habitats rich in biodiversity. There is an additional case today for their retention, together with other linear features - as genetic reservoirs of diversity to combat the effects of global warming.

Changes in the landscape level of biodiversity often have serious socio-economic and cultural effects. It is not only farming communities that are affected by changes in land use patterns. The replacement of natural or semi-natural forests for plantations of exotics such as eucalypts may well be justified in purely economic terms but can have serious consequences for livelihood and life style of the communities that live in the areas concerned. Rural people are all too often those who suffer mist from changes in land use and the exploitation of the landscape for the benefit of urban populations and the "national interest". A consequence too is often the loss of local knowledge and traditions which form as much part of biodiversity as the local races of plants and animals that are also replaced by such development.

Biodiversity in terms of species, populations and genes, occurs in the wild in a very wide range of habitats ranging from those that are more or less natural or semi-natural through those that are human modified to the totally artificial. It follows that our conservation policies, in line with the latest thinking, has to be flexible and we can no longer rely on the creation and maintenance of national parks and other protected areas as the major approach to conservation of biodiversity. Most biodiversity will always occur outside protected areas and we will have to plan to save it wherever it is found. As the Global Biodiversity Strategy makes clear, the concept of the "fortress park" from which the local community is excluded or has restricted access has to be modified and mich more emphasis placed on conservation in areas that benefit the local community - that are subjected to human activities such as exploitation and harvesting of plant and animal resources - provided that this is done in a way which does not further degrade the conservation value of the area.

Causes

One of the major factors leading to the loss of biodiversity in Europe, and elsewhere, is pollution. The effects of industrial pollution on biodiversity are manifest and were a recurrent theme at the conference organised by the Council of Europe and the Fondazione Cariplo in Milan in 1991 on "The state of the environment in Europe: scientists take stock", especially with regard to the situation in East European countries uncovered after the recent political changes there. But even in countries like Iceland where pollution does not cause any major problems, there is a risk of increased radioactivity in the sea around the country from the dumping of radioactive industrial waste by other countries. The effects of pollution are limited, as we know, to the countries which produce it. In Norway, there has been extensive damage to freshwater fauna and to terrestrial ecosystems by long-range air pollution and large areas of east Finnmark (north-eastern Norway) are affected by pollution from the heavily industrialised Kola peninsula just across the Russian border. Europe is playing its part in international agreements to phase out the use of ozone-depleting chemicals and reduce the output of greenhouse gases. Much remains to be done and extensive monitoring is needed.

What should be done?

Planning of conservation activities in Europe will need much greater co-ordination than hitherto, both at a national and regional level. We need to co-ordinate our research activities and adopt as far as is practicable common policies. Several European countries have produced or are producing biodiversity action plans or country studies and an overview of these will provide a valuable assessment of the challenges facing us. Although Europe, as we have seen, has a great diversity of human and institutional resources concerned with the different aspects of biodiversity, many of the basic questions remain unanswered and we still need to carry out research into the size and scope of biodiversity in each European state, into fundamental issues regarding ecosystem function of biodiversity, the nature and function of keystone species, sustainable use, integrated conservation strategies, environmental monitoring, biodiversity indicators, and so on.

The implementation of the provisions of the Convention on Biological Diversity will bring many of these issues to the fore. As a contribution to the process, UNEP has put in motion a Global Biodiversity Assessment which will provide an independent, critical, internationally peer-reviewed scientific analysis of the current issues, theories and views regarding the origins, dynamics, assessment, measuring, monitoring, economic valuation, conservation and sustainable use of biodiversity globally. Many European scientists, sociologists and economists will contribute to this Assessment.

Europe does not, of course, exist in isolation and both affects and is affected by action on biodiversity in other parts of the world. There are too numerous historical links with many countries of the tropics and subtropics. In Europe we use a disproportionate amount of resources when viewed on a global scale and contribute massively to global pollution. Any substantial change in such patterns of consumption is unlikely and would have major political, financial and social consequences. It is therefore salutary to remind ourselves that while we probably have the capacity, and even the will, to solve some of our own biodiversity problems, we are likely to continue for the foreseeable future to exacerbate those of other parts of our global community. We must not, therefore, forget the global dimensions of biodiversity as part of our overall planning. ■

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The fruits of the strawberry tree (Arbutus unedo) are edible

The Council of Europe and biodiversity

Jos van der Maesen

In 1989 the Council of Europe established a Group of Experts on Biodiversity and Biosubsistence, whose tasks were to review the current conservation status of relatives of crop plants. Conservation action is needed with priority, as resources to manage all threatened plants cannot be made available. There are 2,200 or more species in Europe either with an endangered, vulnerable, rare or undetermined status. "Only" 27 species are recorded as extinct by the World Conservation Union (IUCN).

Plants for the future

Even as Europe has probably the most manmade environment of all continents, and some of its agriculture only survives with subsidies, crop cultivars (varieties) need to be constantly monitored and usually improvement is needed. This implies replacement of old landraces or cultivars: genetic erosion. Despite the successes of genetical engineering, the engineering parts should remain available. For crop species these parts are the obsolete cultivars as well as wild relatives; wild subspecies or varieties, or other species in the same genus. For European crops genotypes from Europe already have a degree of adaptation, so have less unadapted genes, and as part of Europe's natural heritage, the countries in Europe should protect this germplasm. A list of the main cultivated plants, agricultural, horticultural as well as silvicultural, with their wild relatives, was drawn up for the Council of Europe by the Botanic Gardens Conservation Service in Kew (England), and the expertise of the Group's members added considerably to the number of species and the accuracy of the contents. This list is due to be published this year, 1993.

Some examples

Our agriculture depends heavily on germplasm from other continents. Potato, tomato, fodder and seed maize are of American origin, large numbers of ornamentals came from China and Japan. However, quite a few crops originated in our continent. Some crops, sometimes important only locally or in a distant past, also deserve attention as their use may gain importance. Conservation involves not just maintaining species, but maintaining a reasonable number of genotypes, accessions with differing genetic make-up. Particularly of minor crops germplasm collections are not large. Wild beets (*Beta vulgaris subsp. maritima*) and wild cabbage (*Brassica oleracea*) occur along the coasts and some populations are threatened or have disappeared. *Crocus* relatives from Greece, Italy, Hungary and Balkan countries are part of the ancestry of various cultivated *Crocus*.

Integrated strategies

Two workshops have been planned to substantiate the "Conservation of the wild relatives of European cultivated plants: developing integrated strategies". The first workshop was organised at Faro (Portugal) on 8-11 November 1992, very aptly held in the Ria Formosa Nature Reserve, and addressed the following themes:

- Ecogeographical surveys: in which climate and geographical zones do the plants occur;

- Demography: what populations are like, statistics of size, density and distribution;

- Reproductive biology: particularly small populations that do not reproduce rapidly are under threat, and human and animal interference need to be checked.

The second workshop was held in Neuchatel, Switzerland, on 14-18 October 1993. The themes considered were:

- Interactions among organisms and ecosystems;

- Geneflow in wide-ranging species and spatial problems;

- Environmental stress and survival strategies;

- Synthesis: managing the populations.

Apart from the Group's experts several specialist scientists are invited to contribute. Oddly no funds were available to attract those scientists, but personal contacts and invitations, and aware of the undeniable importance of the need to conserve biodiversity, the speakers have attended and arranged their own travel funds. This makes the final reports even more thorough, and provide backing with a more varied reference list.

Measures to be taken

The scientists' contribution is to back up politicians with firm data. The Council of Europe, with the Group's reports in hand, will decide what priorities can be taken so to have the respective governments move for practical implementation.

The Group wishes to arrive at management and protection plans both *in situ* as well as *ex situ*. Long-term research and critical mass of research bodies is required to continue to provide a sound basis for correct conservation of target species of crop relatives. The classical discipline of plant systematics or taxonomy is the most basic one in biology. With genetics, plant breeding, advanced techniques and mathematics, our knowledge of the relationships between plants continues to grow, and some more knowledge of their evolutionary history can benefit use as well as conservation. However, insufficient means are provided and consequently the knowledge on wild relatives of cultivated plants is uneven and often inadequate. Timely action is required, not necessarily timeless. And co-ordination for an interdisciplinary approach can help economise manpower and resources, not to be translated in involving more bureaucrats. The existing infrastructure (university departments, research institutes, botanic gardens etc) can deliver the goods, but staffing needs to be guaranteed and increased in various places. Awareness is raised, and technical details will be presented in the Group's reports.

How to conserve ?

We know two ways to conserve crop relatives: *in situ* and *ex situ*. *In situ* usually means in a conserved habitat - we are talking of wild species - without or with certain degrees of management. There are legal and socio-economic aspects as well. Where rare animals are protected plants also fare well.

T. McNeilly

Disused mines prove to be open-air laboratories

Weedy species might prefer a man-disturbed habitat, some plants have to grow in such areas. Nature cannot always be depended upon for keeping genotypes, natural selection continues. Nature reserves and protected zones harbour many of the crop relatives, so good inventories and monitoring tell us what is available. This knowledge is unevenly distributed. A major task: for instance the Netherlands alone have some 3,000 protected areas, some smaller than one hectare!

More accessible and convenient to use are *ex situ* collections of germplasm, the seed or "gene" banks, provided the seeds can be kept long and funds are available for upkeep of the stores. Carefully dried and refrigerated seeds of many crop species (cereals, legumes, oilseeds) will keep at least 25 to 100 years. Of the wild relatives seed storage particulars are often unknown, but they will probably resemble their economic siblings in this respect. A good knowledge of reproduction and longevity of seeds indicates what policy to follow. Usually only a minority of samples in gene banks is of wild origin. A good way to conserve crop relatives is by nature itself, provided we give it its chances, without letting it run amok, and are careful to monitor and manage the various habitats. ■

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Natural selection

Tom McNeilly

Evolution conjures up a vision of prolonged, slow, small, steady, adaptive changes over long time periods. Studies in the Poaceae have altered that view dramatically. Normal populations of *Agrostic canina* and *A. capillaris* grew over a site proposed for a zinc/cadmium smelter in northern Germany. Smelting began in 1969, emission of zinc making the immediately surrounding soils phytotoxic. After one year natural selection caused a fourfold increase in the zinc tolerance of those populations. Similar rapid changes have been found in grazed pastures. Plots sown with equal quantities of ryegrasses bred for grazing (S23), hay production (S24), or early establishment (S22), underwent rapid changes in component frequencies due to natural selection. Nine months after sowing, S22 made up 80% of the swards, S24 13% and S23 7%. Twelve months later S22 had decreased to 4%, whilst S24 and S23 increased to 36% and 60% respectively. Change due to natural selection can thus be very rapid.

Heavy metal toxicity exerts very high selection pressures. Boundaries between toxic and normal soils can be very sharp. Distinct metal tolerant and normal populations have been found one metre apart in *Agrostis capillaris* and in *Anthoxanthum odoratum. A. odoratum* populations growing 10 cm apart on adjacent grass plots limed or unlimed since 1903 differ markedly in plant height. Scales of population differentiation reflect the strength of natural selection and the scale of environmental change.

The Poaceae examined in these studies are self compatible and anemophilous. Distinct populations, as we have seen, may occur adjacent to each other. Because pollen dispersal and pollination can be considerable and effective over 5 m, such populations may exchange genes (gene flow) coding for their contrasting adaptive features. This may affect the impact of natural selection on population divergence patterns. Studies within the Poaceae have shown that with high or low gene flow, and high selection pressures, sharp boundaries are maintained between populations. Weak selection and high or low gene flow results in blurred boundaries between populations.

Only a small number of species grow on toxic metal mine wastes. Why? Of 15 grass species growing along the edge of a large copper mine in North Wales, only five grew on the mine waste itself. Artificial selection showed that the remaining ten could not evolve copper tolerance, necessary for them to grow on the mine waste. Many species do not appear to have the necessary genetic variability within them to allow survival at toxic metal levels. This may have wide implications for understanding the ecology of species.

A very large proportion of the fundamental studies of natural selection both within and outside the Poaceae have been carried out on abandoned heavy metal mine sites in Europe. Yet these sites are rapidly disappearing because of reclamation. The plant populations which each site supports are just as unique as those of any endangered species. They can never evolve again once the sites on which they have evolved are "reclaimed to support a further - ecological and academic - desert of amenity grasses, or treated as, or levelled to become, another rubbish tip. We should surely take rapid steps to preserve at least some of these uniquely informative habitats before all have disappeared. ■

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M. Gunther/Bios

Kefalonia

Saving habitats first?

Mark Collins
Richard Luxmoore

Biological diversity, or biodiversity for short, is a measure of the variability of nature at the genetic, species and ecosystem levels. To conserve biodiversity at all three levels is a very complex challenge for conservation practitioners. To illustrate the problem, take the Large Blue butterfly (*Maculinea arion*), one of Europe's species in need of conservation action. The species as a whole flies widely from Europe across Asia to Japan; so protecting it should be easy. But different subspecies inhabit the high Alps (*M.a. obscura*) and the maritime Alps (*M.a. ligurica*). Even individual populations of the principal subspecies (*M.a. arion*) are so genetically dissimilar that experts can easily distinguish them. Clearly the genetic biodiversity in this one species is of interest to the conservationist. Moreover, the ecological, or habitat, requirements are very special, consisting of well-grazed grassland on limestone, with wild thyme and a particular species of ant that tends and protects the caterpillars in return for a sugary secretion. Preparing a conservation strategy for the Large Blue alone is a highly complex business!

If a single species of butterfly can present such difficulties, imagine trying to produce strategies for all 20,000 species of butterflies or, worse still, all one million described species of insects! Even if such a task were possible, it would not account for the millions of other insects still awaiting discovery.

Whilst acknowledging that recovery plans for individual species are an important part of every national conservation action plan, it is clearly vital to ensure that representative habitats are adequately protected. The theory behind this approach is that if a sufficient proportion of each habitat and ecosystem can be protected, a large proportion of the vast number of species will automatically be preserved. A number of different international initiatives recognise this linkage (see Box).

It is impossible to protect all natural ecosystems and so, in practice, decision have to be made and priorities set. To do this requires not only careful national planning but also an international overview. A habitat type that is common in one country may be extremely rare on a worldwide basis. The inhabitants of western Ireland could be forgiven for failing to appreciate that the peat bogs which seep daily over the top of their rubber boots are a global asset, but the British Isles actually hold 18% of all the world's blanket bogs. This type of information may seem simple enough but it is the result of careful study of the distribution and conservation status of key habitats. In practice, much depends on the spatial distribution and size of protected areas, and on the way in which the lands in between are managed.

Measures of success

In order to allow planners to answer such questions as "what is the total area of tropical forest remaining in Venezuela?" or "what percentage of the peat bogs in Europe are protected within national parks?", large quantities of mapped information must be manipulated in different combinations. For this reasons, computerised Geographic Information Systems (GIS) are an extremely useful analytical tool provided they can be supported with sufficient data.

The basic mapped data or, in GIS terminology, "layers" needed for this type of conservation planning include:

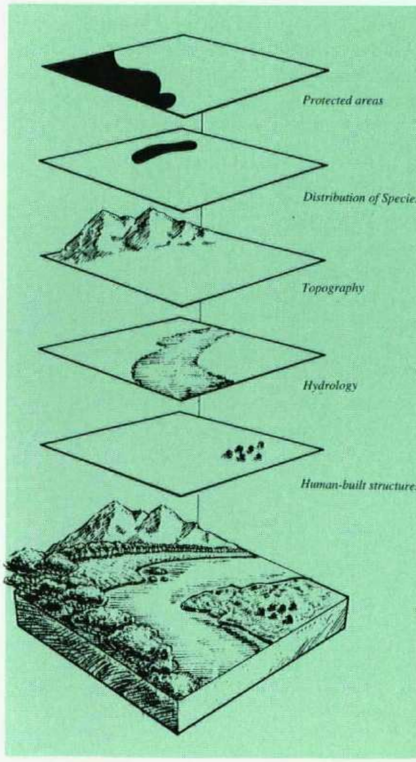
- maps of present vegetation cover;
- estimates of original or "potential" vegetation cover;
- protected areas maps;
- political and topographic maps.

For several years now, the World Conservation Monitoring Centre (WCMC) has been maintaining a Geographic Information System and collecting environmental data of this type. The data have grown to such proportions that they have now been organised within a purpose-built "Biodiversity Map Library". This allows different data layers to be retrieved and displayed in various combinations depending on the question which must be addressed.

Knowledge about the distribution of species can also be used to further refine techniques of conservation planning based on habitats alone. In order to preserve the maximum number of species it is necessary to preserve the habitats which have the greatest biodiversity. For example, when it comes to action to conserve tropical forest biodiversity, Conservation International (CI) calls for a focused approach, concentrating on the "megadiversity" countries (Brazil, Colombia, Mexico, Indonesia, Zaire, Madagascar, Australia, China, Peru, Ecuador, India and Malaysia). CI has established an integrated programme of action on the ground and information management in many of these areas. This approach is useful in the early stages of building a conservation areas network, but comprehensive coverage requires a far more sophisticated approach. For instance, in a country such as Bolivia, the greatest biodiversity can be found in the lowland rain forest, but once representative areas of this habitat type have been protected it may be preferable to devote further resources to ensuring protection of other habitat types, such as the Altiplano which supports a different assemblage of species. This type of approach is being used to great effect in Sri Lanka using the GIS at WCMC (see Box).

Where field data on species distribution are incomplete, it is possible to infer these from a knowledge of the habitat requirements. James Scott's work on the efficiency of protected areas in Hawaii has become a text-book study of conservation analysis. Scott studied the island of Mauna Loa in Hawaii, drawing maps of vegetation cover and protected areas for the whole island. When he overlaid expected

Geographic Information System



Conservation International

distribution data for rare species, he found major gaps in the protected areas system. The US Fish and Wildlife Service was able to recast its plans to ensure better coverage of the island's biodiversity. This use of different data sources to identify gaps in the system is called "Gap Analysis".

Meeting the information needs

In most parts of the tropics, gap analysis remains a hope for the future because the underlying information is not yet available. A number of activities are directed towards collecting the data required for planning habitat conservation.

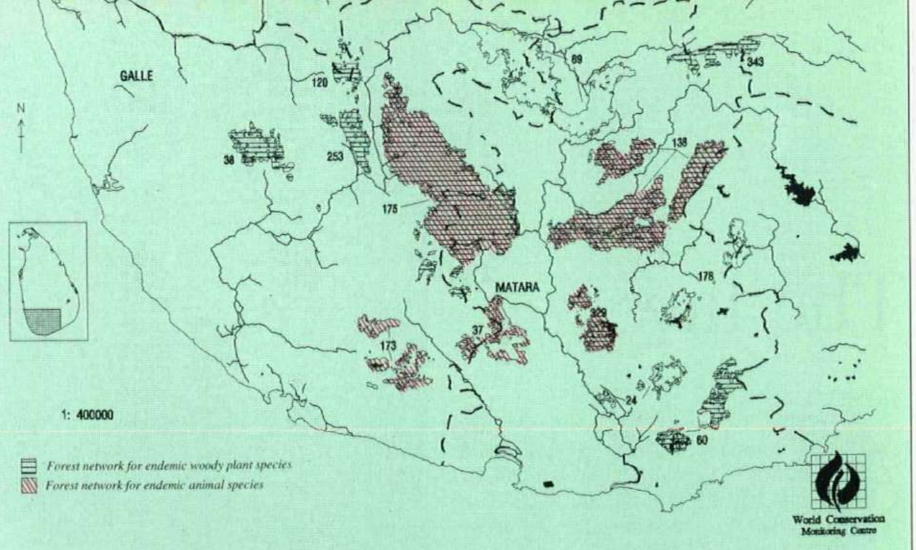
Basic maps showing actual vegetation cover are the subject of national inventories and international remote-sensing studies. The world's most diverse terrestrial ecosystem, tropical rain forest, is still not properly mapped, and it is impossible to judge how seriously the rate of deforestation is depleting biodiversity. WCMC, working with IUCN, has almost completed mapping tropical forests and protected areas for its three-volume "Conservation Atlas of Tropical Forests".

The CORINE Programme

In Europe the CORINE (CoORdination of INformation on the Environment) Programme has taken this approach. The principal objectives of the Programme, adopted in 1985, are to systematically identify and list key threatened species and biotope types of the region to ensure their future conservation. This, in turn, assists the development of an integrated conservation strategy for the region and provides the basis for a co-ordinated framework for species and ecosystem conservation. The data collected are stored in a standard format in a regional database.

Wetlands

The term "wetland" is difficult to define and encompasses a wide range of habitat types from ponds to saltmarshes; however, its persistent recurrence in the jargon of conservation planning reflects its ecological importance as a focus for biodiversity. A number of different initiatives are attempting to inventory wetlands on a national or regional scale. Within Europe, the MedWet project is developing a standard methodology for harmonising the various national wetland surveys around the Mediterranean Basin. IUCN - the World Conservation Union - has begun the process of documenting the world's most important wetland sites in a series of directories.



Conserving Sri Lanka's biodiversity: an optimum approach

Sri Lanka is a small country but rich in biological diversity, much of which is concentrated in the moist forests of the south- west. As part of a national conservation review, species surveys are being carried out in remaining fragments of forest in this region. The resulting data can be analysed on computer in various ways to identify an optimum network of forests needed to meet selected conservation criteria, such as protection of all endemic species and/or representation of each within at least two forests. For example, the map below shows the minimum network of forests required for all endemic woody plant and animal species to be conserved. The importance of this approach for land-use planning is the fact that if one of the minimum number of sites identified is not included in the protected areas network then a quantifiable amount of biodiversity will be lost.

This information has recently been transferred to GIS at the World Conservation Monitoring Centre where it provides another layer available in the Biodiversity Map Library.

Global protected areas network

At the Third National Parks Congress in Bali, Indonesia, 1982, targets were set to protect 10% of all ecosystems and countries. Every few years the World Conservation Monitoring Centre, in collaboration with IUCN's Commission on National Parks and Protected Areas, has prepared the United Nations List of National Parks and Protected Areas in order to track progress towards the target. Recently, the data have been transferred to GIS, allowing a much more flexible tool for analysis.

Conclusion

The fundamental aim of saving biodiversity is to maximise the diversity of genetic material preserved. One approximation of this is to focus on species conservation; a further level of approximation is to aim to conserve the widest possible range of habitats. In the same way as species conservation may not conserve all individual variation (within species), so habitat conservation may not succeed in conserving all species. However, it provides a pragmatic and achievable goal which does not require endless research to quantify the number of species present before conservation plans can be put into action. Furthermore, habitats contain complex assemblages of species which have evolved together. It would be impossible to recreate them simply by re-introducing the correct combination of species. There are, therefore, inherent functions of ecosystems or habitats which cannot be saved by species conservation alone and which further justify their central position in conservation planning. ■

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Habitats Directive

The general philosophy of CORINE is reinforced by the EC Habitats Directive which was adopted in June 1992. This Directive builds on the Birds Directive by making provisions for the conservation of habitats and species (other than birds). In particular, member states are now required to create special areas for conservation (SACs, analogous to SPAs under the Birds Directive) to conserve the sites of a given list of threatened species and of threatened habitat types. The latter aspect, listing literally hundreds of vegetation types from the CORINE systems of vegetation classification, is unique in international law. The countries of the Community now have to implement this Directive by 1995; this can be expected to lead to more protected areas being set up, especially for rare and declining habitat types, and the standards of protection in existing protected areas strengthened.

The law

Michel Chauvet

As biodiversity is a new, general concept, it is not easy today to see clearly how it will fit into the law. The best approach is therefore to determine the areas likely to be concerned and the types of measures envisaged. The future will reveal what is in store for this new miracle word.

Can legislation maintain the diversity of extensive meadows?

To appreciate the novelty of the concept, remember that it was not current in international circles until around 1985. The World Conservation Union then proposed an outline convention on biodiversity with the intention of bringing into a coherent conceptual framework all the sectoral conventions dealing with nature conservation. Some of those conventions were focused on certain species or particular types of habitat or had either regional or international scope; having been negotiated at different periods, moreover, they bore the stamp of the ideas current at the time they were drawn up. The IUCN proposal was taken up in 1988 by the United Nations Environment Programme (UNEP), which convened committees of experts and later a negotiating committee. We all know the outcome: the Convention on Biological Diversity was signed at the Earth Summit in Rio de Janeiro in June 1992 by more than 150 countries. It had already achieved 23 ratifications by June 1993 and will probably come into force in 1994 with the 30th ratification.

A new concept

The first thing to notice, therefore, is that biodiversity was understood as referring to the totality of species and natural habitats. In other words, all the legislation on nature conversation was unwittingly dealing with biodiversity. The cantankerous claimed that the word was utterly pointless as it contributed nothing new. This is not so. It seems clear that the scientific origin of the concept of biodiversity is genetic diversity, which is now established as being the condition for the adaptation of species to changes in the environment and as playing a functional role in evolution. This theoretical model has been extended by ecologists to the two other classical levels of biodiversity, namely, species diversity and ecological diversity (ie diversity of ecosystems). In other words, instead of aiming to safeguard beautiful landscapes (for aesthetic reasons) or populations of spectacular animals (for ethical or even sentimental reasons), nature conservation initially shifted towards a sense of heritage (in which the number of species became a major criterion), and then, in a second stage, towards a view of nature as a system of interrelations at all levels.

The fundamental objective of conservation thus became the safeguarding or re-establishment of the optimal operation of these mechanisms in the long term.

Seen in this light, existing legislation and protective measures appear as discrete elements which need to be reassessed in this more comprehensive context. This is not easy, as is shown by the delays and unwieldiness in implementing instruments such as the Bern Convention (1979) or the EEC Habitats Directive (1992).

Effective conservation means devising efficient tools for measuring the components of biodiversity and amassing enormous quantities of information. In France, for example, an inventory of natural areas of ecological, faunistic and floristic interest, known as the ZNIEFF, took about ten years to complete and occupied numerous groups of scientists, amateurs and managers.

Long-term consequences

The approach in terms of biodiversity has implications which are still far from apparent to everybody. It implies that all living taxa have a priori the same importance: it is no longer enough to say that protecting the habitat of bears or certain birds also protects the plants and insects to be found there. Moreover, in addition to priorities based on how endangered or rare a taxon is, care must be taken to protect representative samples of habitats which are relatively common but in the process of losing their specific character. The whole corpus of legislation and regulations relating to land management is concerned, a point already grasped by foresters.

That is not all. Progress in biotechnology and the debate on the patentability of living forms have profoundly influenced the negotiation of the Convention on biodiversity. To the astonishment of numerous nature conservationists, that Convention attaches considerable importance to the use of living species for the discovery of new medicines and to genetic resources of interest to agriculture and industry. The debate has often boiled down to a confrontation between the "gene-rich" countries of the South and the "technology-rich" countries of the North.

The point is that although everybody agrees about the great value of biodiversity, no one knows how to measure it, how to regulate exchanges of living material and how to ensure that the expected profits and benefits help to strengthen the work of conservation.

Codes of conduct are at present being prepared at FAO, UNEP and elsewhere. Such codes might one day become protocols to the Convention and be transposed into national legislation. At the same time, agreements are being signed to clarify the status of the collections held by gene banks and other repositories.

Concern for diversity

Lastly, the diversity of domestic species, an integral part of biodiversity, is endangered by the globalisation of markets and the spread of high-performance varieties and cultivars over vast areas. We are now aware of the risks of planting monoclonal forests or of using hybrids that all have the same parents. The concern for diversity should be duly recognised in the organisation of seed production (official catalogues of varieties, etc.) and in agricultural policies (planting subsidies, product standardisation etc.). The EEC has taken a first step in this direction by publishing two directives on the protection of local produce.

Biodiversity clearly represents an innovative approach, the effects of which will only be felt progressively. It presents a challenge to conservationists, who must contribute to the debate on the rights of intellectual property and on biotechnology. Conservation has become a serious matter, but vigilance is necessary to ensure that the attention paid to the use of biodiversity is not detrimental to specific conservation projects.

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Useful wild plants

Gert Kleijer

All cultivated species derive originally from wild species. Domestication sometimes sets up barriers preventing the recombination of cultivated plants with their wild forebears. In other cases, recombination allows genetic features from wild plants to be introduced into domestic plants. Wild species are often used successfully to improve cultivated ones.

Gene transfer

Wild species are used above all for their resistance to diseases but also to transfer particular characteristics or male sterility. Breeders have made abundant use of wheat's wild ancestors, and there have been many successful transfers. One of the most interesting is the transfer of a gene giving resistance to cereal eyespot. This gene was discovered in the wild species *Aegilops ventricosa.* Because it was impossible to crossbreed wheat directly with this variety of *Aegilops,* the latter was first crossbred with another wild wheat, *Triticum persicum;* the hybrid was then crossbred with the wheat. French researchers thus produced varieties of wheat with good resistance to cereal eyespot. Wild emmer (*T. dicoccoides*) has also been successfully used to transfer a gene imparting resistance to yellow rust and a gene responsible for its high protein content. Other wild species even further removed from common wheat than *Aegilops* or *T. dicoccoides* can be used to introduce beneficial properties into wheat; an example is *Agropyron,* which carries genes giving resistance to cold, salinity, drought and disease.

Common wheat is by no means the only species able to benefit from the qualities of wild ancestors. The tomato can be crossed with many wild tomatoes which have agronomic advantages. Sugar beet can make use of the advantageous genes of *Beta maritima,* a wild species indigenous to Europe; the male sterility found in a population of *B. maritima* has been successfully transferred to sugar beet. There are currently several varieties of apple on the market with a gene from the wild species *Malus floribunda,* imparting resistance to apple scab. There are many other such examples.

All these examples show that wild species are often carriers of valuable genes which can be transferred to cultivated species, hence the importance of protecting them. The region possessing the greatest genetic variability for a species is regarded as the centre of origin of that species. Throughout the world, there are eight centres of origin for cultivated species. Only the southern part of Europe is among these centres, yet Europe is rich in the wild forebears of cultivated plants. A study carried out by P.W. Jackson and supplemented by members of the Council of Europe Group of Specialists "Biodiversity and Bio-Subsistence" shows that almost 300 wild ancestors of cultivated plants used in food, animal fodder, medicine and flavourings are economically important in Europe. A comparison of these species with the "red list" of endangered plants in Switzerland shows that 30 of the 300 species are endangered to various degrees in Switzerland; seven in the category of food plants, three in that of forage plants, three in the medical and flavouring category and 14 in the category of ornamental plants. Of these 30 species, ten are neophytes, ie they were introduced to Switzerland after 1500.

It is important for each country to draw up this type of inventory, so as to recognise the endangered species which are the forebears of economically important plants. More attention can then be paid to these plants, which can be included as priority species in conservation co-ordination work.

Swiss example

Switzerland is a country that can be divided into four equally important areas of land use. A quarter of the land is unproductive (rocks, buildings, etc.), a quarter is forested, a quarter agricultural, including 300,000 hectares of open ground and 650,000 hectares of both rich and poor grassland, and the last quarter is taken up by the pastures of the Alps and the Jura. A substantial amount of pasture and meadow very rich in plant life, particularly forage plants, is present. In certain types of natural meadow such as rich grassland, ecotypes can be found which are populations resulting from selection in ecological conditions specific to a particular area. The structure of the genotypes is influenced not only by climate and soil, but also by the traditional land use pattern. The meadow fescue and tall fescue ecotypes have been collected and agronomically assessed. The best are used in a breeding programme. All new varieties of these two types of fescue produced in our research establishment are based on the ecotypes possessing advantageous agronomic features. Indeed, breeders from all over Europe converge on the rich grasslands of central Switzerland to collect ecotypes to create productive, hardy varieties. A project is currently under way in our research establishment to determine whether certain minor species of forage plants, such as red fescue, timothy and bird's-foot trefoil are worth an attempt at selective breeding. If so, it would be possible to draw on the wealth of Switzerland's flora to collect basic material for a breeding programme.

These examples show that it is extremely important for Switzerland to protect the richness of its plant life. Its value has long since been recognised by the world of science, and the realisation is fortunately spreading to the world of politics, where a number of measures have been taken. The protection of species in danger of extinction and of species-rich grasslands is closely linked to the continuation of traditional farming. With the intensification of agriculture this type of grassland has become rare. In the current economic conditions, farming cannot be content with the low yield and limited nutritional value of these grasslands. The revised Federal Law on the Protection of Nature and the Countryside (1987) provides a legal basis for closer collaboration between farmers and environmental protection bodies. It is stated that the protection and conservation of biotopes must whenever possible be ensured by agreements between landowners and farmers. The latter are entitled to fair remuneration if they give up intensive farming or carry out additional work which brings no financial return.

Through a system of annual compensation, the Confederation supports farming appropriate to species-rich grasslands. Encouraged by the Confederation, the cantons are also taking similar action. Currently, ten or so cantons have concluded voluntary agreements with the farmers and landowners of species- rich grasslands. Various model agreements tailored to regional needs have been developed. They specify, for example, the date on which the grass may first be cut, depending on altitude. All these measures have provided good results without imposing legal constraints. Nevertheless, it will be necessary to ensure, on the basis of a voluntary system, that traditional farming continues over a sufficiently large area to enable endangered species to be protected and ecotypes evolving under quite specific conditions to be maintained.

The wild ancestors of cultivated plants are therefore a very important and valuable resource for improving currently cultivated species. It is vital to conserve them and to maintain viable populations able to evolve under natural conditions; these will be useful not only to the today's plant breeders but also to future generations. ■

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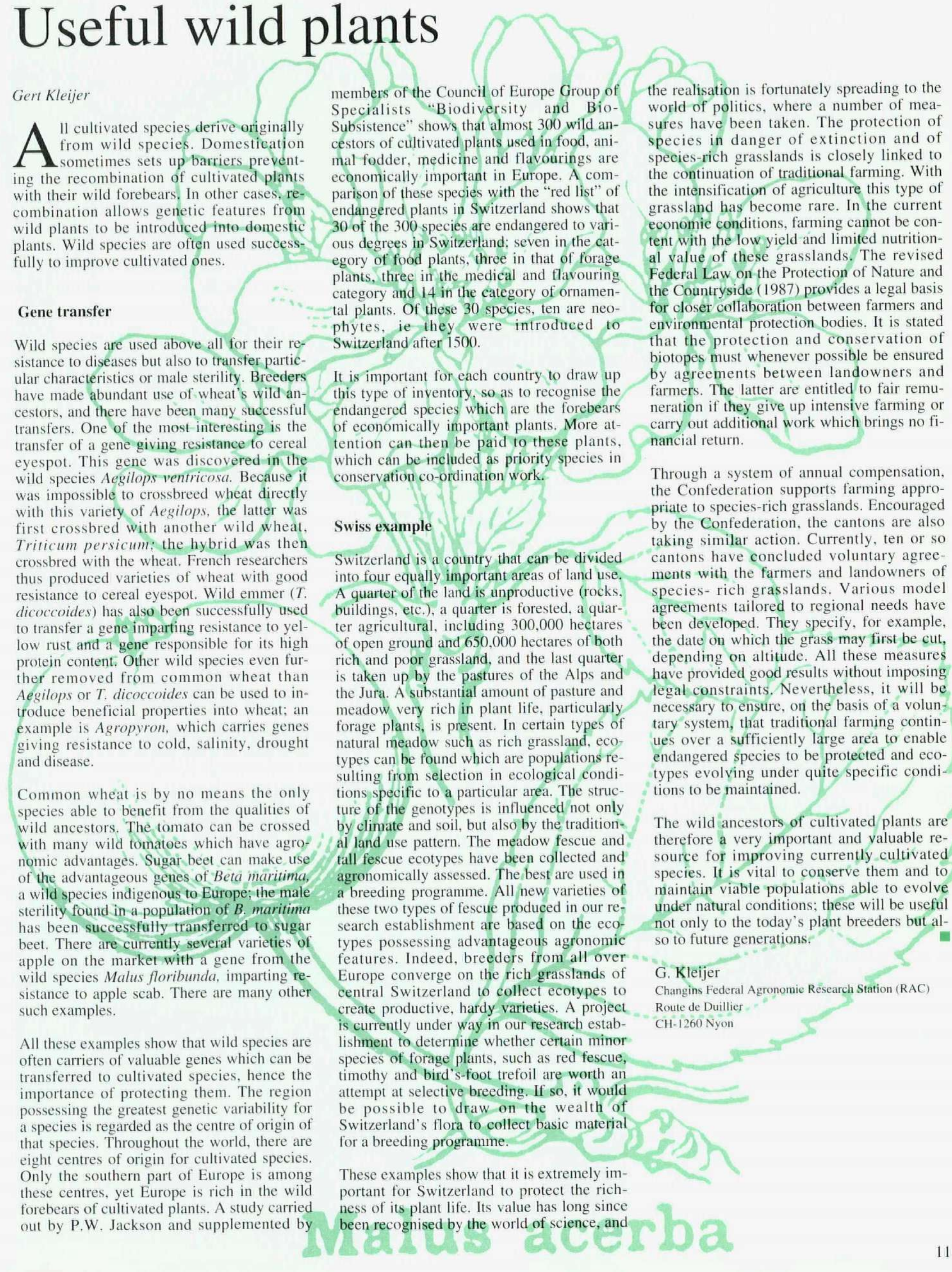


Illustration of French flora by H. Coste (1903)

Know-how

Lyndsey Withers

Ex situ conservation in seed genebanks and field genebanks is complementary to *in situ* conservation of plant genetic resources using reserves and on-farm approaches. Biotechnology, in particular tissue culture (*in vitro* culture), is providing new ways of conserving material *ex situ*. The benefits of these new approaches are especially obvious when resolving serious problems in the conservation of certain crops.

Most agricultural crop and temperate forestry species produce "orthodox" seeds which can be stored dry and at low temperature.

However, the seeds of cacao (*Theobroma cacao*), coconut (*Cocos nucifera*), mango (*Mangifera indica*), and many tropical fruits and forest trees, cannot tolerate desiccation and die when exposed to low temperatures. They are called "recalcitrant". Seed storage is not considered suitable for clonally propagated crops because they are highly heterozygous or because they are infertile. Examples of clonal crops include many important staples such as potato (*Solanum spp.*), cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*), yam (*Dioscorea spp.*), and bananas and plantains (*Musa spp.*).

The conventional solution to all these problems is to use the field genebank, which has many drawbacks including risks of disease and weather damage (Withers and Engels, 1990). In the face of these problems, *in vitro* culture (tissue culture) has been explored as an alternative.

In vitro conservation

The main focus of conservation work is storage itself, but *in vitro* culture and associated techniques can resolve problems and improve efficiency and security at other stages of the overall conservation process from collecting through to its distribution to users.

Collecting

For the problem crops, described above, the material collected in the field (seeds, shoots, suckers) is often bulky and heavy.

It may carry diseases in attached soil. For example, if suckers are collected as in the case of banana, this may spread soil-borne pathogens including nematodes, or insects. Collected material may also lose viability or even decompose before reaching the genebank. These impediments to successful collecting can be overcome by adapting *in vitro* propagating techniques to field conditions. For example, cacao shoots, which have a life span of only a few weeks, can simply be sterilised using drinking water purifying tablets and then put into bottles of culture medium containing fungicides. Several weeks later, the cultured shoots can be transferred to an *in vitro* genebank or grafted onto seedlings.

In the case of coconut, the seeds are recalcitrant as well as very bulky. Fortunately, most of the nut itself is superfluous; only the embryos need be collected. They can be extracted in the field and either transported in a bag of coconut milk back to the tissue culture laboratory or put into culture in the field using very basic equipment.

Storage

In vitro propagation techniques have been used for many years to clonally multiply species including many of the problem crops identified above. However, cultures can be maintained under normal propagation conditions without subculturing for only days or weeks. For effective storage, it is necessary to extend the subculturing interval by slowing down the rate of growth or suspend it by cryopreservation in liquid nitrogen.

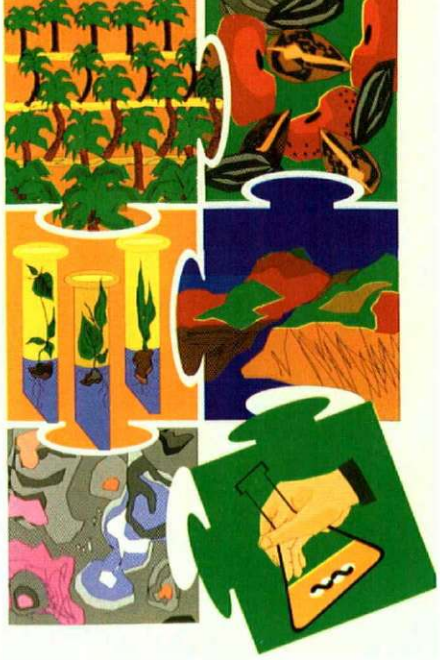
Slow growth can be achieved by reducing the culture temperature or adding osmotically active solutes such as mannitol to the culture medium. Slow growth is being used routinely in a number of genebanks for shoot cultures of crops including potato, cassava, banana and plantain. These can be maintained for periods of between six months and two years without subculturing. However, it is necessary to experiment to find suitable slow growth conditions for each species and sometimes each variety.

The most promising method for the secure, long-term storage of cultures lies in cryopreservation. At the temperature of liquid nitrogen (-196 °C), no metabolic reactions take place, therefore, time effectively ceases. The first successes with plant cell cultures were achieved in the early 1970s. Survival was achieved by treating the cells with cryoprotectant chemicals and cooling them slowly to allow extracellular freezing to dehydrate the cells. However, cell cultures are not generally the material of choice for genetic conservation because they may be prone to genetic instability ("somaclonal variation" - see *Monitoring* below).

Cell cultures can be induced to form structures that resemble seed embryos but that are all of the same genotype. These are termed "somatic embryos". These cultures have some potential applications

In situ plantation of cacao-trees

L. A. Withers



Different storage methods can be brought together in a complementary way to conserve a genepool. Clockwise from bottom left: pollen storage, storage of in vitro cultures, the field genebank, seed storage, in situ conservation, DNA storage

in conservation, as in the case of banana and plantain but attention has generally focused on shoot-meristems and shoot-tips which are thought to be inherently more stable.

However, when treated similarly to cell cultures, the latter cultures often suffer serious structural damage, as recalcitrant seeds and their embryos. Fortunately, some new cryopreservation techniques have emerged relatively recently that seem to reduce cryodamage dramatically.

In one of the new methods, vitrification, the specimen is frozen very rapidly and the cellular water forms a non-crystalline solid (a "glass"). A quite different technique has been used for recalcitrant seed embryos which can be cryopreserved after careful air drying. Successes have been reported for several species including coconut.

The new development that is perhaps the most promising and intriguing involves artificial seed technology. Shoot-tips or somatic embryos are encapsulated in alginate gel and then dehydrated before cooling rapidly (Dereuddre et al., 1991). This seems to be very widely applicable, giving much higher survival levels and less structural damage than other approaches to cryopreservation.

Monitoring

Plants lose many of their distinguishing physical characteristics once they have been transferred to *in vitro* culture. This, and the risk of somaclonal variation underline the necessity to incorporate stability monitoring into *in vitro* conservation.

Isozyme analysis and molecular techniques such as RFLP (restriction fragment length polymorphism) and RAPD (random amplified polymorphic DNA) can provide new ways of identifying genotypes and assessing genetic stability. The potential benefits of applying molecular techniques are illustrated by the case of banana and plantain. Some varieties have inherently unstable genomes, leading to high levels of somaclonal variation *in vitro*. This is often only evident once the plant reaches the flowering or fruiting stage in the field and produces a poor yield. Rather than lose the advantages that rapid *in vitro* multiplication can bring to conservation and use, scientists are looking for ways of detecting instability as early as possible. An RAPD marker for one undesirable variant has now been identified. This opens up the possibility of detecting some somaclonal variants using an overnight procedure at the culture stage.

Germplasm distribution

Germplasm movement entails the risk of spreading pests and pathogens. To reduce the risk, indexing and treatment procedures are available, and quarantine procedures must be observed. In vitro procedures such as meristem-tip culture in combination with thermotherapy can be used to eradicate pathogens, particularly viruses. Pathogen-tested cultures can be exchanged without the risk of reinfection or contamination. There are now many examples of the successful distribution of material from genebanks as plantlets or even mini-tubers such as in potato.

Integrating new techniques into conservation strategies

A range of conservation techniques are available but no one of these is satisfactory on its own. *In situ* conservation is particularly appropriate for wild relatives of crops and has obvious applications in forestry. The genetic resources are open to evolutionary forces but are not very accessible. Field genebanks are relatively accessible but can entail risks as illustrated earlier, and are extremely costly to maintain. Seed storage is efficient and relatively secure. However, it cannot be used for recalcitrant seeds or clones.

The benefits of *in vitro* conservation for some problem crops are evident, but methodologies need to be worked out for more genotypes and species, especially in the case of cryopreservation. Also, problems of genetic instability need to be clarified and resolved. Two other methodologies deserve mention in the context of developing a conservation strategy.

Pollen storage has considerable underutilised potential but it only conserves the paternal genotype, not maternal (including cytoplasmic) genes. DNA storage is simple to carry out and should be widely applicable. However, strategies and procedures for the utilisation of stored DNA need to be devised. It has yet to find a clear niche in the genetic conservation of any one crop, although as biotechnology breaks down the barriers between genepools, DNA storage may assume wide application for gene if not genome conservation.

The combination and balance of techniques used for the conservation of a genepool will be arrived at by assessing a number of factors. These include the reproductive biology of the genus/species, the breeding strategy employed, the need for storage of genes or genotypes, the available storage technologies and the infrastructure and economic environment in which conservation is to be carried out.

For material that is traditionally clonally propagated but for which many genotypes are in fact fertile, for example potato, it may be possible to conserve genes in the long-term through pollen or seed storage. Only those clonal genotypes for which access is essential in the short to medium term need be maintained as clones in the field genebank or *in vitro*. Conversely, in the case of seed-propagated species such as cereals, some genotypes which are being improved through genetic manipulation might well be stored *in vitro*.

Thus there are few rules to designing a complementary conservation strategy except that it should be need-driven rather than technology-driven, focusing on the genepool as the target.

The most effective and appropriate combination of conservation methods both *in situ* and *ex situ* should be used to meet the aims of security, efficiency, accessibility and sustainability, balancing the advantages of one method against the disadvantages of others. ■

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The carob tree
An exemplary plant

Fernando Catarino

The carob tree (*Ceratonia siliqua L.*) and its domestication over a period of some four millennia offer an excellent illustration of the way in which, from the very birth of agriculture, man carefully learnt how to use nature's living resources.

Thus, he invented new forms of cultivation. New products were consumed either directly or after processing. Social contacts between geographically dispersed groups led to a gradual accumulation of experience and was accompanied by the transfer of plant genetic resources beyond their natural frontiers. In so doing, man forced nature to accelerate its evolution, thus diversifying the natural heritage.

Botanic history

Ceratonia siliqua is the botanical name of this remarkable plant, which is found throughout the Mediterranean basin and of which there are now numerous varieties. The name which Linnaeus gave to this bush was suggested to him by the shape of the fruit which, in certain varieties, resembles a goat's dropping.

However, the extreme hardness of the seeds may explain the adoption of the Greek and Arab roots in the scientific and popular names.

Since the carob is the only species in the *Leguminosae-Cesalpinoideae* group, there was some surprise when the botanical world learnt, in 1980, of the discovery of *Ceratonia oreothauma* in Arabia and the Republic of Somalia. This now offers a new basis for an understanding of the carob's origins. Extremely hardy carobs which are considered to be wild are found throughout the Mediterranean basin; in the same way as olives, they differ from their domesticated equivalents which are propagated artificially, sometimes through grafting. These so-called wild plants are probably simply spontaneously wild forms dispersed naturally by animals.

Nowadays, these plants must be genetically very different from the carob's original stock, with the new species discovered in Arabia appearing to be the ancestor of the group.

Carobs also display enormous variations of biological form and floral type. The shrub-like forms with multiple stems are confined to certain very unfavourable habitats. In other cases they are trees which in ideal climatic conditions may rise to a height of up to 20 metres.

There are characteristic differences in terms of reproduction and the morphology of the flowers. Nearly all the cultivated varieties are dioecious, with male and female flowers carried on separate trees. The male inflorescence of various colours may have long and slender or short and thick styles. In both cases each male flower possesses a vestigial pistil which will abort.

The female flowers also possess non-functional embryonic stamens surrounded by the carpel. More rarely, there are plants with both male and female flowers on the same stalk and even flowers which are completely hermaphrodite.

Certain varieties which have been known for a long time are the subject of great interest since they only have hermaphrodite flowers. These trees are also very interesting on account of the quantity and properties of their fruit and seeds. They are all the more appreciated for not requiring pollinating trees when they are in plantations. This makes their cultivation more profitable since all the space is occupied by fruit producing trees. There are fewer problems arising from sterility and the aborting of embryos as a result of a shortage of pollinating insects or poor climatic conditions at flowering time, factors which can cause a substantial drop in production in dioecious varieties.

A significant potential

It is interesting to note that although the carob is generally thought of as an example of perfect morphophysiological adaptation to typical Mediterranean conditions, it in fact retains the memory of its tropical origins. This is evident in numerous physiological and biological features while the species' sensitivity to low temperatures places strict limits on its area of distribution. It also achieves high levels of photosynthesis at significantly greater temperatures than other typically Mediterranean plants and can maintain such high rates when there is a significant water shortage, thanks in part to its root system which is capable of searching out water at great depths.

In adapting to a Mediterranean climate, the plant appears to adopt a strategy of avoiding hydric stress. The seeds normally take root in autumn and spring or where the climatic conditions are more favourable, for example relatively close to the sea, where the climatic extremes are less pronounced. The xerophilous leaves, protected by cuticular coatings and protective tissues against extremes of heat and brightness, cope well with the light intensity and high temperatures characteristic of a Mediterranean summer. The carob also has an effective foliar system formed from composite leaves equipped with a mechanism for adapting the lamina to optimise the angle of incidence of radiation so as to increase its exposure to light during the ideal growing periods.

At other times, and particularly in summer, the carob can arrange its leaves in such a way as to expose only a minimum surface area to the sun's rays.

Extensive culture of hermaphrodite carob-trees in the Algarve

In conditions of extreme drought, the trees can shed a large part of their foliage. They can survive for long periods without leaves, drawing on reserves of water stored in the trunk until a period of rain permits the rapid replacement of the foliage.

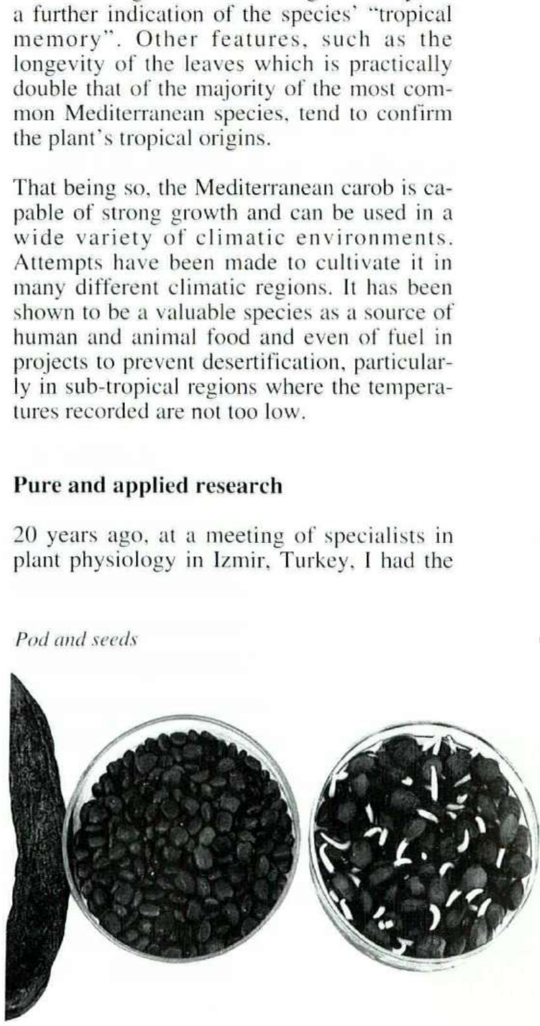
It should be stressed that in more thermophile Mediterranean conditions, in the absence of an excessive water shortage, these plants - unlike genuine xerophiles - can maintain their exchange activities throughout the year: a further indication of the species' "tropical memory". Other features, such as the longevity of the leaves which is practically double that of the majority of the most common Mediterranean species, tend to confirm the plant's tropical origins.

That being so, the Mediterranean carob is capable of strong growth and can be used in a wide variety of climatic environments. Attempts have been made to cultivate it in many different climatic regions. It has been shown to be a valuable species as a source of human and animal food and even of fuel in projects to prevent desertification, particularly in sub-tropical regions where the temperatures recorded are not too low.

Pure and applied research

20 years ago, at a meeting of specialists in plant physiology in Izmir, Turkey, I had the

Pod and seeds




F. Catarino (2)

(Portugal)

opportunity to join a small group charged with carrying out pure and applied research into the physiology of Mediterranean plants. This group of academics and researchers, largely drawn from the countries of southern Europe, very soon identified a need to expand our basic knowledge of the physiological reaction of Mediterranean plants. Environmentally related constraints with a substantial impact on biological productivity are frequently observed in regions with a Mediterranean climate. Moreover, these regions generally suffer more than most from the effects of man's destructive activities on their productive potential.

Those of us involved in the exercise sought a better understanding of the physiological bases and adaptive techniques of Mediterranean xerophilous plants faced with a hostile climate.

The ultimate objective was to use the knowledge gleaned from this research to assist the development of plants and forms of agro- industrial activity which would be of economic benefit to the southern regions of Europe.

Ceratonia siliqua was the species chosen. It is interesting to recall that the high sugar concentration of the carob's fruit, despite a high tannin content, has formed the basis for animal feedstuffs in the region for thousands of years. In time of war, the carob came to be considered a strategic material. Its owners and those who controlled the trade in the product enjoyed a clear advantage on account of the "concentrated force" contained in the fruit, which can accumulate up to 50% of its weight in sugar.

Moreover, the fruit is particularly suitable for storage and conservation. Animals are very partial to this food, which gives them the strength for both combat and work.

Man thus selected a plant with a high sugar concentration. After grinding, the pods provided a flour which when mixed with cereals or other carbohydrate rich products served as human foodstuff in times of shortage. Partial roasting produces an aroma similar to that of cocoa.

However, the carob fruit contains an excessive quantity of tannin which protects it against herbivores attracted by such an appetising carbohydrate concentration. These phenolic compounds, which can represent between 16 and 20% of the fruit's dry weight, restrict the use of carob flour because of their inhibiting effect on protein assimilation. Nowadays, the principal benefit from its cultivation lies in its seeds, which make up barely 10% of the dry weight of the pods. The seeds' value is in large part attributable to their endosperm constituents, accounting for 30 to 40% of their weight. These are the polysaccharides known as galactomananes forming the well-known carob or locust bean gum, E410 in the list of food additives. It is used for manufacturing the finest ice-creams. Carob bean gum is also used as a stabilising agent, thickening and additive in the food processing, pharmaceutical, textile, paper and, more recently, petroleum industries.

Global production of dry pods, some 400,000 tonnes per year, is mainly concentrated in Spain, Italy and Portugal. The cultivation of carob trees and the commercial exploitation of their products has developed significantly in a number of North African countries, such as Morocco. The endosperm, which represents barely 4% of the fruits' weight, fetches up to six dollars a kilo on the international market.

The future: pods or seeds?

The development of biotechnology opens up good prospects for food processing and other industries based on carob cultivation.

Although direct use of the sugars is constrained by their high tannin content, enzymatic processes capable of extracting and separating the tannins and which also have potential industrial applications are currently being developed. Another well- developed technique uses certain micro-organisms (xanthomonas) which are capable of producing xanthene extracelluarly from carob sugars as a unique source of energy and carbon. The principal industrial use of xanthenes, whose properties resemble those of galactomananes, appears to be in petroleum extraction since their injection into oil wells helps to improve the extractive yield, particularly before the wells run dry.

Carob cultivation, which has experienced significant fluctuations over recent decades, can therefore probably remain viable. It is an increasingly important activity from both an economic and a social point of view. Research on the subject needs to be stepped up and methods of cultivating and managing plantations introduced to improve their competitiveness and productivity.

Recently conducted experiments in pilot regions in southern Spain and Portugal have yielded encouraging results regarding the potential contribution of irrigation, mechanical picking, the destruction of parasitic insects and the improvement of products for industrial use to the development of carob cultivation.

The carob tree and its environment

The carob also plays an important part in the protection of natural and aesthetic resources in numerous regions of the globe.

Its adaptability and the ease with which it can be grown makes it an urban plant of great aesthetic value.

The soil beneath carob plantations benefits from the constant protection of these trees, with their remarkable life span. Such soil is rich in organic matter and has a balanced structure. The plant cover offers natural protection against the erosion which is of great concern in Mediterranean regions.

The carob tree, cultivated for thousands of years and well adapted to the European Mediterranean region, continues to play a key role in the social and economic environment and can help to make the protection of natural resources more effective.

These resources can be as important as the serene, harmonious and beautiful landscapes which were the cradle of our civilisation and which accommodate a wealth of animal and plant life, as well as forms of cultural expression rich in social and human value.

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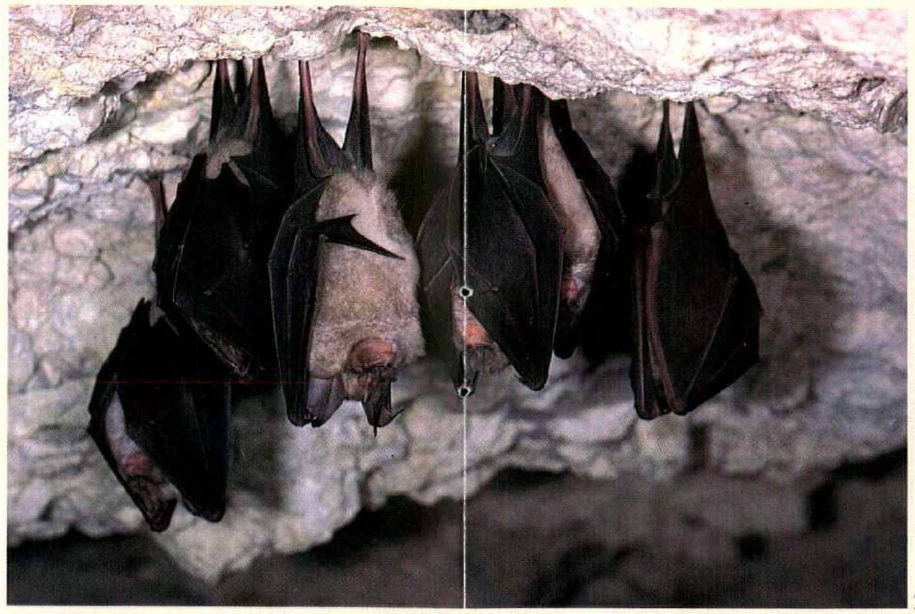

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May none of these forms
and colours be lost forever

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Evaluation of cereal genetic resources

CIRP

Wild relatives

Toby Hodgkin

Many of the species from which cultivated plants were selected continue to survive in the wild, even to the present day. So also do many closely related species. Together these wild relatives of present day crops constitute a rich source of variation of immense value. They have continued to evolve under natural selection and to adapt to meet the demands of the natural ecosystems in which they occur. They may possess characteristics such as resistance to floods, to drought and to extremes of heat and cold. Often they have been shown to possess new and valuable resistances to pests and diseases that are severely damaging existing crop varieties.

In some cases, wild species may themselves be developed as new crops as in the case of jojoba (*Simmondsia chinensis*) which provides a substitute for sperm whale oil or oil producing *Limnanthes* species. They may also have significant medicinal properties as in the case of the European *Digitalis* spp. and species such as *Chichorium intybus* (chicory). The wild relatives of crops have also proved useful in developing new plant breeding methods. A barley relative, *Hordeum bulbosum*, has been used to obtain fully homozygous barley lines for development as new cultivars.

New characters

By far the most common use of the wild relatives of crops has been as a source of new characters required for modern agriculture. A well-known example is that of *Orysa nivara*, a relative of rice, some plants of which were found to possess resistance to a viral disease called grassy stunt which is spread by the brown planthopper. The gene responsible for this resistance was bred into new rice varieties at the International Rice Research Institute in the Philippines. There are many other examples and European species have also played a significant part in the process. For example, *Triticum turgidum* var *dicoccoides* from the Eastern Mediterranean has been used to increase protein content of bread and durum wheat and resistance to fungal diseases has been obtained from the wild relatives of cabbage and lettuce.

Europe possesses a considerable number of species that are related to our major crops and which need to be conserved. All the major European grain crops (wheat, barley, oats and rye) have European wild relatives as do many important legume species (both grain legumes and forages). A wide range of fruit and vegetable crops also have wild relatives some of which, such as crab apple, wild cherry and rughetta (*Diplotaxis erucoides*), are still being collected and used in their own right. Important industrial crops such as flax and sugar beet also have wild relatives which have been used in plant breeding programmes.

The way in which wild relatives can be used in providing new sources of variation for important characteristics depends on the relationships between the crops and their wild relatives. In some cases the species are fully interfertile. Wild *Brassica oleracea* from the Atlantic coast of Europe can be crossed directly with cabbage, cauliflower and other *B. oleracea* vegetables to give fertile offspring. In other cases the species can only be crossed with extreme difficulty. Artificial culture *in vitro* of the hybrid embryo and a complex and lengthy period of backcrossing may be necessary to obtain fertile progeny with the desired character from the wild species. However, recent developments in genetic engineering and in tissue culture have greatly extended the opportunities for using the genetic diversity of wild relatives and increased their value to us.

Long-term and important task

The importance of conserving wild relatives of crop species has been recognised by a number of national and international agencies concerned with conservation. Organisations such as the International Board for Plant Genetic Resources (IBPGR), the World Conservation Union (IUCN) and the World Wide Fund for Nature (WWF) have collaborated with national research and conservation bodies in a number of initiatives concerned with collecting and conserving wild relatives of crop plants. The Council of Europe's initiative in this area is, however, unique in a number of important respects. Firstly, it is a specifically European initiative focusing on wild relatives which occur in Europe and which are important constituents of the total genepools of European crops. Secondly, it has involved the collation of information on European wild relatives of crop plants, identifying the species involved and their distribution. This will result in a valuable source of information on the species of concern. The Council of Europe has also brought together specialists with a wide range of expertise to focus on conserving Europe's wild relatives (see report in Naturopa No. 71-1993). Conserving these species raises specific problems which have often been somewhat overlooked and the multidisciplinary approach adopted by the Council of Europe should provide a sound basis for future action.

Conservation is a long-term process requiring an integrated strategy in which different methods complement each other effectively. For most wild species, and many wild relatives of crops, *in situ* conservation will probably be the method of choice supported by effective *ex situ* conservation to safeguard the diversity and ensure that it is available for future users. Recently, wild beet collected in Europe in the mid-1930s has been used by American plant breeders because of its high resistance to certain important pests and diseases. This material had been conserved for over 50 years before it was used; it is important that we make effective plans to ensure that future workers can carry out similar activities whenever it becomes necessary.

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In Central Europe

Helmut Wittmann

Central Europe has been transformed by human land settlement and anthropogenic activities to an extent unparalleled almost anywhere on earth. Large areas of land were urbanised and the region has a population of almost 200 million people. An extremely dense road and rail network and other infrastructure typical of "highly developed" countries went hand in hand with this process. Massive inroads were made in the Central European landscape for extracting raw materials, producing energy and developing industrial production. Even agriculture has moved away from its function as caretaker of the landscape, particularly in the last 50 years, and gone over to intensive methods, thereby depriving many animal and plant species of their natural habitats by the use of fertilisers and pesticides together with the drainage of peatbogs and wetlands. Nor should we overlook tourism in this respect, which can pose dire threats to vulnerable ecosystems particularly in areas that are still close to their natural state. Although these dangers are present in many places, they rarely occur on such a cumulative and massive scale as in Central Europe.

Exceptional features of flora

The flora of Central Europe is relatively poor in species as a result of the last glaciations which only ended 12,000 years ago. Nevertheless - or perhaps for this very reason - this region deserves the particular attention of nature conservation. For one thing, there is a whole range of species the core of whose area of distribution lies in Central Europe or which are endemic to the region. Examples of these are *Dianthus lumnitzeri, Doronicum cataractarum, Draba ladina, Myosotis rehsteineri* or *Orobanche lucorum*. A few tribes have not yet become morphologically differentiated to the same extent as, for example, endemic tribes in south-eastern Europe, as a result of the relatively short natural history of Central European flora. For this very reason, some plants, such as *Cochlearia bavarica*, have only recently been recognised as full, independent species.

What is more, there is a whole range of species that have isolated populations in Central Europe which lie far away from their north, east or south European or Asian distribution area. In the case of these tribes, it may be assumed that they have gained a degree of independence through their geographical separation and this is why they are to be regarded as well worth protecting in terms of maintaining as large a "biodiversity" as possible. A similar claim can be advanced for species that are present in Central Europe but located on the edge of their range and as a result of the associated "peripheral phenomena" mostly have greater genetic variability. Furthermore, there is also a number of species, characteristic of specific phytosociological units, which only occur in this form in Central Europe. The disappearance of these plants from the central area of the European continent would also mean the extinction of an entire plant community, although the species itself may be frequent elsewhere. Lastly, it should not be forgotten that many Central European species fulfil specific roles in the ecosystem, which are of vital significance for the other indigenous flora or fauna. All nature conservation strategies should therefore aim to maintain or rather re-establish a Central European flora as rich in species as possible and with the widest possible biodiversity.

The traditional concept of nature reserves

The laws on nature conservation in most Central European countries are or were designed to protect areas of varying size, in which the use of the countryside is regulated in favour of the endemic animal and plant life. Various categories of protected areas are provided for in legislation, depending on the stringency of the regulations concerned. This principle has, however, proved to be of only very limited suitability and has been unable to prevent increases in "red list" species. Furthermore, the conservation provisions enshrined in the regulations were often not very effective as they generally ignored distinctly negative factors such as farming. The most problematic aspect of the entire protected area concept was, however, that the network of small and very small biotopes, which is at least as important for natural diversity as larger, coherent classifications, was not included at all.

New strategies

Legal measures

a. Protected habitats

A few Central European states (Switzerland, Germany, Austria) have reformed their laws on nature conservation to statutorily protect various types of habitat over the whole country. Thus activities that would have negative effects on these habitats are either permitted only subject to authorisation under nature conservation law, or totally prohibited. The Salzburg nature reserve act (in Austria, nature conservation is the responsibility of the federal provinces and there are thus nine different nature conservation acts) might be highlighted as one of the most recent and in this respect most comprehensive pieces of legislation protecting, throughout the whole province: all peatbogs, marshes, water meadows, fen woodlands, forests and other woods bordering streams, rivers, lakes and the like; all stretches of running water above ground including dams with their 30-year flood catchment area; all stretches of natural surface waters covering a minimum of 20 m^2 and a maximum of 2 000 m^2 including their banks and shores; sedge areas and reedbed areas; barren Alpine land including glaciers and adjacent areas; ad lastly - once the biotope mapping is complete - all dry and sparse grasslands. Thanks to this legislation, protection is available for those habitats or biotopes whose widespread disappearance from Central Europe has decisively contributed to the depletion of species.

b. Introduction of comprehensive compulsory authorisation

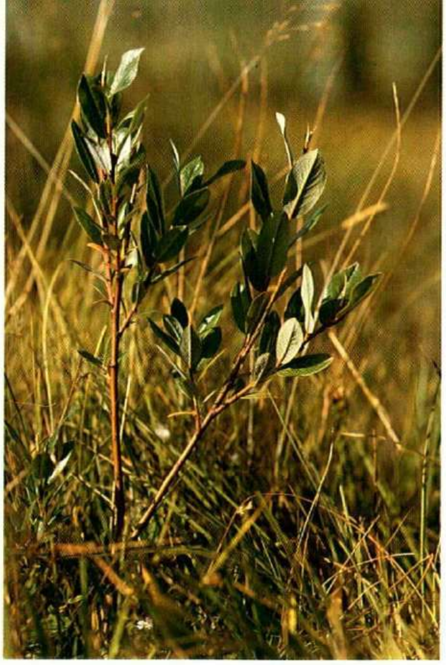
Many European states have brought their nature conservation legislation into line with ecological requirements in this respect too. Thus more or less all activities that impair the natural environment, such as road building, mining, power station construction, ski lift installation etc, have been made subject to approval by nature conservation authorities through corresponding statutory regulations.

c. Amendment of species protection regulations

In this respect also, legislators in the various countries are paying closer attention to the scientific findings of the last few years. Whilst regulations to protect plant species until recently merely prohibited flower picking, although this really only applied to attractive flora and only to a limited extent to threatened species, legislative reforms are now tending to take account of the respective "endangered" lists and to incorporate the protection of the relevant species' habitat. Thus, when a plant is designated as a protected species, not only the plant but also its habitat enjoy legal protection.

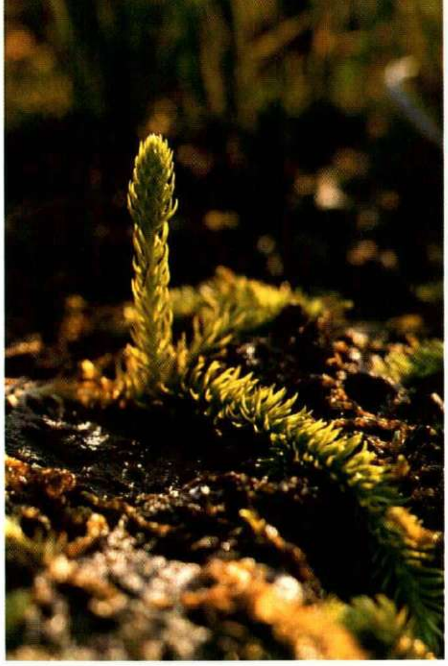
d. Creation of a legal supervisory body

Legislation is only effective if it is actually implemented - this is particularly true of nature conservation laws. Many decisions are taken on political grounds are legally incorrect or at least questionable. Legislators in many Austrian federal provinces have taken account of this situation by setting up a provincial supervisory body: the environmental law bar association. They have - sometimes very comprehensive powers to control proceedings - the opportunity to push through the interests of their client - nature - in nature conservation proceedings. As a rule, this type of body enjoys a politically independent status and cannot therefore be manipulated through political interference. The creation of a provincial association of environmental lawyers in some Austrian provinces has proved to be a milestone in the effective implementation of nature conservation legislation.



Salix myrtilloides

H. Wittmann (2)



Lycopodiella inundata

Biotope mapping

We can only protect what we know exists. This is particularly relevant for the conservation of species and biotopes. Many European countries have therefore begun biotope mapping, which has indeed already been completed in some regions. Such maps are essential not only for the implementation of legal provisions but also as a basis for spatial planning and development, systems of conservation incentives, species promotion programmes and special biotope management strategies. Although the quality of the biotope mapping is extremely variable from one region to another in many countries it is done so meticulously that its findings can be implemented with no legal objections.

Creation of agricultural assistance programmes

On the one hand, no one denies that farming in Central Europe has a certain role in maintaining the rural ecosystem, but on the other, restrictive statutory measures with no offer of financial compensation are very difficult to sell politically. For this reason, various European states (eg Switzerland, Germany, Austria) have begun to offer farmers financial incentives to encourage the maintenance of the countryside. This additional income for the crisis-ridden farming sector makes the legislative measures considerably more acceptable and at the same time promotes the continuation of traditional forms of farming.

Public relations

All of the strategies and activities described above are integrated with an overall public relations programme in the individual states. This is absolutely essential, since the best and most binding legal instruments can only be enacted and implemented if the country's population fully supports the objectives behind the law. It should also be stressed that the commitment of individual citizens - either through one of the many European nature conservation movements or in their behaviour as tourists or consumers - is of no mean significance for the protection of species and habitats.

Concluding remarks

As these comments show we are - at least in many areas of Central Europe - on the right track towards acting on scientific findings relating to the depletion of species and biotopes by applying counteractive measures. In view of the fact that a third of all plant species throughout Europe are to some extent endangered great urgency is called for in enforcing these strategies.

Perhaps this will still allow the estimated disappearance of 850 species of Central European flora this century (Engelhardt 1983) to be revised downwards by a few species. ■

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Botanic gardens

Fernando Catarino

Botanic gardens play a key role in genome conservation. A strategy based on the protection principle has recently been developed to provide guidance for their activities and objectives. The approach makes use of the accumulated knowledge and experience of botanic gardens and similar institutions.

It has been the practice - in some cases for centuries - for each garden to publish what is called an "index Seminum". These indexes, whose main purpose is to encourage exchanges of seeds for botanical experiments and studies, have from their inception constituted remarkable instruments of communication between the different botanic gardens and institutes, making it possible to secure, free of charge, the genes of indigenous and cultivated plants from across the globe.

In a world where natural ecosystems free of human influence have practically disappeared, the genetic resources of our wild flora have a significant contribution to make alongside "domestic" and cultivated plants in the development of agriculture, plant life and bio-industries.

Moreover, the speed with which the habitats of wild species are altering and shrinking has led to an increase in the number of species threatened with extinction as traditional forms of land use change. It is therefore possible that the future preservation of these plants will be largely dependent on the development of strategies for their cultivation and conservation *ex situ* in botanic gardens, arboretums and other settings designed to protect biological diversity.

Global responsibility for preserving wild species and their genetic diversity devolves on the entire scientific community, since an ever wider range of plant resources is required to counter soil erosion, combat desertification and restore the damaged plant cover in many regions.

Strategies are also needed to guarantee the present and future supply of foodstuffs, fibres and other plant products with an actual or potential use. This means placing the free trade in genomes through the index Seminum on a permanent, rational and viable basis, as well as increasing the stability and protection of plant populations in their natural habitats. ■

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In Turkey

Tuna Ekim

Pamukkale

It is common knowledge that Turkey is an extremely rich country floristically. Out of about 9,000 vascular plant species, 3,000 are endemic, comparing with a total of about 12,000 in whole Europe. Geographically distinct regions also give rise to a great variety in the vegetation. Mostly East Mediterranean elements are encountered in the lowlands of Mediterranean, Aegean and Marmara areas and some parts of south-east Anatolia. Some Mediterranean mountain species will occur in the higher ranges of the Taurus Mountains mixed with Irano-Turanian elements. Mainly Irano-Turanian species grow in central and eastern Anatolia, and species belonging to Euro-Siberian vegetation occur in the Black Sea region. In Anatolia proper a series of enclaves are found along most of the Black Sea, the Mediterranean and the Aegean coasts. The fact that three main phytogeographic regions meet in Anatolia is one of the main reasons for its floristic richness. In addition, Turkey is recognised as a primary or secondary genetic centre for some plant taxa.

Turkey is a very large country. Anatolia, its Asiatic part, covers about 290,000 and Thrace, its European part, 9,250 square miles, or a total of 779,000 km2, an area which is about a third larger than France or the Iberian Peninsula. This huge size raises some difficulties from the conservation point of view.

National parks and protected areas

In order to protect biological richness, attempts are being made to expand zones of nature preservation. The first national park was established in 1958 at Yozgat, in central Anatolia, in order to preserve a *Pinus nigra* ssp. *pallasiana* relict in a steppe area. Later, as many as 23 national parks were established in different regions of the country. Their surfaces vary from 64 hectares for the Bird Paradise to 69,800 for the Olympos Bey Mountains, reaching a total of about 500,000 hectares.

Among the national parks, the famous Bird Paradise National Park established in 1959 is particularly characterised by a significant ecological structure. Situated in the south of the Marmara region, this is one of the first-class wetlands of the country. Because of the effective conservation and administration of this area, which is small but has a great ornithological significance, it was awarded a "Class A European Diploma" by the Council of Europe in 1976. This award was renewed in 1981, 1986 and 1991.

Nature conservation areas

The growing consciousness that Turkey enjoys a special status from the point of view of biological diversity has led to the designation of 23 more areas as nature preserves between 1987 and 1991. Their scales vary between 86 hectares (the Haci Osman Forest near Samsun) and 17,200 hectares (the Sultan Sazligi near Kayseri, which is the other important and first-class wetland). Most of these nature preserves are, if smaller, part of the national parks, thus warranting for their enclosure and set-up of more efficient protection.

By means of legislation adopted in 1990, the Turkish government has taken 12 areas under protection and granted these the status of Special Environmental Protection Areas. These areas have been selected not only according to biological criteria, but also in order to prevent tourism and construction. The Dalyan area near Köyceğis-Muğla has been taken under protection because it is the habitat of loggerhead turtle (*Caretta caretta*) which has recently become the focus of world public attention. Pamukkale, another one, is protected because of its world-famous calcareous sediments. The Ihlara valley has come under protection for being one of the earliest settlements of Christianity and the numerous churches and temples containing precious paintings and frescos.

In addition to the various areas of environmental protection already mentioned, zones of minor size were also put under preservation. These regions are mainly meant to protect animal species as fallow deer, roe deer, bald ibis, pheasant, frankolin, partridge, wild goat and waterfowl which are either rare or under danger of extinction in Turkey as in the world. A small area was also established in 1987 for a *Gentiana lutea* relict which has been highly damaged by export activities.

Other official measures

Turkey has accepted to join the Paris Agreement (on protection of birds), the Bern Convention and the Barcelona Convention on controlling the pollution of the Mediterranean Sea.

Two gene banks have bee established at Izmir in the 1960s and Ankara (in 1991). The more important of the two is settled at Izmir-Menemen and preserves the seed or reproductive parts of cultivated plants. Later the collecting of seed of wild plants, particularly of endemics, was started.

Although Turkey has not joined the Ramsar Convention, an effort to protect wetlands is undertaken by the government and NGOs with the participation of interested scientists. As a result, total drying and conversion of wetlands into agricultural land has been stopped. An effort to stop pollution and degeneration of such areas is also under way.

Turkey has applied for membership to CITES at the end of 1991 as well as to Ramsar. In order to join CITES, Turkey has imposed restrictions to the collecting of geophytes from their habitats, thus reducing their trade. For instance, the export of *Galanthus elwesii* which suffered from heavy trading has come down from 40 to 12 million bulbs within the last two years.

Restrictions have also been imposed on the export of the snake *Vipera kaznakowii* and several species of predatory birds.

I have tried, in short, to describe the measures, mostly official, taken in order to preserve the biological diversity and the natural sites of Turkey. Despite all of these efforts, it would be preposterous to assume that everything runs smoothly in the country. Our aim is to preserve the country's riches. This is not easy, considering for instance the country's size. We are all happy to see that people at large, starting with pupils of all educative levels, spontaneously grow more and more conscious of environmental needs and problems and this looks very encouraging to all of us. ■

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P. Pernot/Bios

Montfragüe Natural Park

In Spain

Benito Valdés

Spain was quick to apply the international policy of protecting natural areas and established several national parks, which were created primarily on the basis of landscaping and zoological criteria. The Covadonga park in Oviedo province, which is the oldest Spanish reserve, dates from 22 July 1916, when a ministerial law set side an area of 16,925 ha in the heart of the Picos de Europa mountain range as a National Park. Among the next parks to be set up were the Ordesa y Monte Perdido National Park in the Pyrenees (c. 16,000 ha) in 1918, the El Teide and Caldera de Taburiente (Canary Islands) parks (13,571 and 4,690 ha respectively) in 1954, the Aigues Tortes y Lago San Mauricio park (9,851 ha), also in the Pyrenees, in 1955, and the Doñana park (50,720 ha) in 1969. These national parks, with a total protected area of 122,689 ha, form the initial nucleus of a complex which is to include many other areas with varying levels of protection. The total area of these nature reserves represents only 0.24% of the total area of the country (505,200 km2), which is far below the European average. However, the percentage varies greatly from one Spanish region to the next.

Natural areas

The Spanish law on protected natural areas defines five categories in order of importance, each with a different administrative structure and type of management.

Fully protected reserves

These areas are small in size but are of exceptional scientific importance. They are set up for the purpose of protecting and conserving all the ecosystems and the species contained in them. They include the Doñana biological reserve (Huelva), the Tablas de Daimiel (Ciudad Real) waterfowl reserve and the Fuente de Piedra lagoon (Málaga).

National parks

These are very extensive areas largely unaffected by human activities; examples are the Covadonga, Ordesa y Monte Perdido, El Teide and Caldera de Taburiente parks mentioned earlier.

Nature areas

These are particularly important areas which serve to protect a specific natural feature or landscape. Examples are the valley of the Poblet monastery, the Pedraforca massif and the Odiel salt marshes.

Nature parks

These are areas of great value, to naturalists, where human presence is encouraged with an eye to conservation. Examples are the Antequera caves (Málaga), which are among the oldest such parks, and the Cazorla y Segura mountains park.

Hunting reserves and other protected areas include biological reserves, natural monuments and parks on the outskirts of towns.

Management

National Parks are governed by national regulations, and the Nature Conservation Institute (ICONA), which comes under the Ministry of Agriculture, Fisheries and Food, is responsible for their management and conservation. However, responsibility for virtually all the natural areas has been devolved to the different autonomous communities making up the political map of Spain.

One of the autonomous communities which is most active in this field is Andalusia. In 1983 the Environment Office (AMA - "Agencia de Medio Ambiente") of the Andalusian Regional Council ("Junta") was set up. Since then this body has pursued a broad environment protection policy, thanks to which protected natural parks now cover 17% of the area of Andalusia.

Conservation of plant species

One fundamental aim of nature conservation is to preserve genetic diversity. Losing plant species means losing their potential future use for agricultural, medicinal and ornamental purposes. Since plant species are components of established communities, their disappearance is also a threat to the stability of ecosystems, although in most cases it is a direct result, rather than a cause, of damage to the latter.

Plant species can only be effectively conserved *in situ* if the communities to which they belong are protected. Nonetheless, the first step towards their conservation is to enact strict laws for the protection of each individual species.

The first recommendations for the protection of Spanish species derive from the Bern Convention on the Conservation of European Wildlife and Natural Habitats, which came into force in 1982.

Also in 1982, a Royal Decree was issued on the protection of threatened species of forest flora. It lists seven protected species, including *Artemisia granatensis* Boiss. and *Atropa baetica* Willk. The list was extended under a 1984 ministerial order, and subsequently the different autonomous communities issued a whole series of orders and decrees to protect various plant species.

Protection of habitats

If habitats are to be effectively protected, it is vital to establish scientific criteria for defining which areas are important for flora and plant life. In 1988, therefore, the National Institute for Nature ("Instituto Nacional de la Naturaleza") held a meeting of 25 experts from all over Spain in order to establish these criteria. Twenty-four criteria were defined, some of them relating to diversity of ecosystems and others to diversity of species.

These criteria have enabled the authorities to identify 179 biologically important sites requiring priority protection, 45 of which are already included in protected nature areas. It is to be hoped that this protection policy will be pursued by Spanish authorities in the future.

Habitat rehabilitation plans

Legislation on habitat rehabilitation plans, which involve *in situ* and *ex situ* techniques, is very recent. In 1989 a law was published on the conservation of natural areas and forest flora and fauna, setting out plans for the rehabilitation, conservation and management of habitats. The precursor of these was the plan to reintroduce plant species launched by the ICONA in 1981 in the Garjonay (La Gomera) and El Teide (Tenerife) national parks, which successfully rehabilitated a variety of phanerogams threatened with extinction. These plans, however, call for substantial prior investment in the biological study of the species to be reintroduced. This is currently proceeding in a number of Spanish regions. ■

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In Greece

Georgia Kamari

The geographical position of Greece, its dissected topography as well as its complicated geological history and multitude of rock substrates have created a great variety of habitat conditions, which have contributed essentially to the creation of an amazing diversity of flora and fauna.

According to a rather conservative estimate, there are c. 4,900 species of vascular plants in Greece, one of the highest figures for any comparative territory in the Mediterranean area and much higher than the figures for countries in Central and Northern Europe. With respect to endemic species, Greece heads the European and Mediterranean list with c. 730 (followed by mainland Spain with c. 500). No less than 500 of the endemic species should be classified as rare or threatened. The Greek fauna is equally rich.

The need for protection of this valuable genetic material becomes imperative not only for aesthetic reasons and the general equilibrium of the natural ecosystems, but also for practical and utilisation reasons.

Legislation and other measures

Below, we shall try to present in brief the legislation and other measures taken for the conservation of the natural heritage of our country.

1937 can be considered as the starting point of the Greek State for seriously encountering matters concerning natural protection. That year the Law 856 was enacted, recommending the establishment of up to five national parks all over the country to protect the flora, fauna, forest, natural formations and also for scientific research to be carried out there. The first National Park, created in 1938, was on Mt Olympus.

In 1971 (Law 996), an amendment to the 1937 law, resulted in the established of ten national parks (aggregate area: 68,732 ha), 19 aesthetic forests (aggregate area: 33,109 ha) and 53 protected natural monuments (aggregate area of the 18 non-isolated natural monuments: 1,585 ha). Details concerning the above sites are cited in an article by K. Kassioumis (1990) published in the "International Handbook of National Parks and Nature Reserves".

The first decisive turn concerning natural conservation matters in Greece was made in 1975, with the ratification of the Greek Constitution, which comprised a provision on the protection of the natural environment. Specifically, Article 24 imposes as a basic state commitment the protection of the natural and cultural environment, of the forests and forestal areas of the country.

The numerous international conventions, which refer to matters of environmental protection, obviously contribute greatly to this aim. Greece, participating in most of these conventions, has undertaken special international commitments for the protection and conservation of its natural heritage. Special reference must be made to the Ramsar Convention, in which 11 Greek areas have been included among the internationally most important wetlands. The "Man and Biosphere" Programme and the World Cultural and Natural Heritage Convention are also two of the most important international conventions, in which Greece participates. In the latter convention, many well-known monuments of our country (Akropolis, Delphi, etc) have been characterised as International Cultural Goods, while Meteora and Agion Oron are declared as Natural and Cultural Goods.

Greece, being a member of the European Community, implements all the relevant EEC directives. For example, according to Article 4 of the EEC Directive 79/409, 26 areas of our country, comprising the National Parks, the internationally important wetlands, etc, have been included in the Special Protection Zones.

Turtles and seals

Greece is also making endeavours for the successful application of the recent EEC Directive 92/43, concerning the conservation of the habitats as well as of the wild fauna and flora. For that reason, two very important wildlife biotopes were recently added to the protected ones. The first biotope is the sea turtle nesting area in Zakinthos (a strictly protected zone, covering an aggregate area of approximately 400 ha), where the loggerhead turtle is breeding. The second is the Marine Park of Northern Sporades Islands (aggregate area: approximately 100,000 ha), which is one of the few strongholds of the endangered monk seal (*Monachus monachus*). The park includes five small, but very important for their flora and fauna, islands.

Concerning the list of the rare and endangered species of the Greek fauna and flora, significant progress has already been made.

The Red Data Book of threatened vertebrates of Greece was published in 1992 jointly by the Hellenic Zoological Society and the Hellenic Ornithological Society, and it was financially supported by the WWF and Hewlet Packard. Furthermore, the preparation of a Red Data Book on Greek Plants, financed by WWF, is currently in progress under the supervision of an editorial committee consisting of D. Phitos, A. Strid, W. Greuter and S. Snogerup. This book is expected to appear by the end of 1994. These two major works will certainly constitute an important contribution to the conservation of the Greek flora and fauna.

After having read the above, one could hope that the numerous existing laws, international conventions, etc, would be a real shield for the protection of the Greek natural heritage. Unfortunately, this still remains a mere expectation. In fact, many of the above commitments are not being implemented. The search for the reasons causing the inefficiency of the above laws, conventions etc has to be a main care for the authorities. On the other hand, it is evident that without arousing common awareness on conservation matters through proper education, the imposition of the laws alone would always be an ineffectual way for the protection of nature.

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Capra aegagus f. hirus, protected endemic wild goat of the island of Gioura (Sporades Marine Park)

G. Kamari

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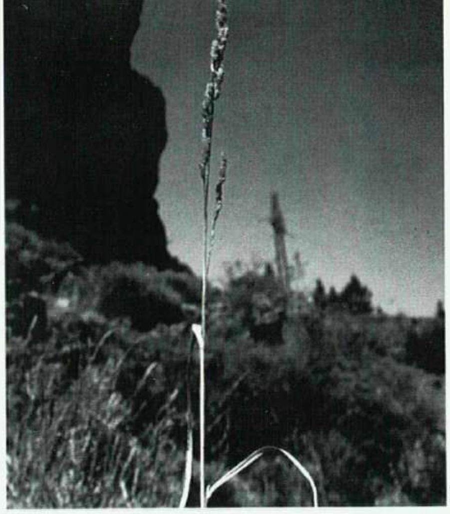

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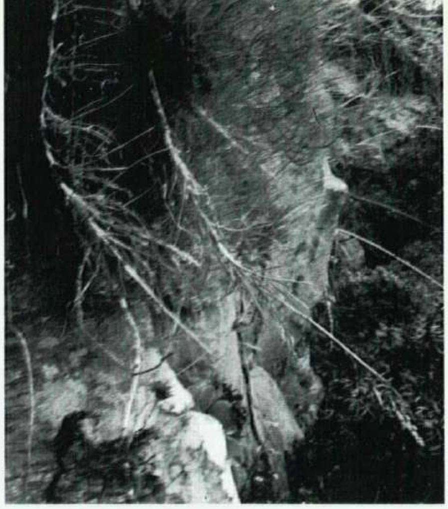

R. Lumaret (3)

3

The background to some plants

Diversity of orchard grass
1. Alpine orchard grass (70 cm, panicles of 8 cm); 2. from the Gran Canaria island (1.20 m, panicles of 25 cm); 3. on the island of Tenerife (woody, 2 m, panicles of 8 cm)

Roselyne Lumaret

The activity of human beings, ever since they evolved, has had a highly varied impact on wild species, depending on whether they were periodically by humans themselves, eaten by game or domestic animals, or else, from the time of the first agrarian civilisations, constituted the fundamental basis of food. These species were then propagated in the wake of human migration, while undergoing successive selection processes, firstly empirical, and later carried out in laboratories. Three examples of species studied in our laboratory will illustrate this point.

Orchard grass (*Dactylis glomerata L.*): a forage species which is still primarily wild

This perennial grass with Eurasian origins dating back to the Tertiary period has, since then the Miocene era, undergone enormous adaptive spread, resulting in the development of numerous types (subspecies), all diploid, of which 16 still exist today. Genetically they are all very different and each one is able to colonise a specific environment. Certain large-leaved summer-growing types are confined to the damp, temperate, deciduous forests of north-eastern Europe, northern Iran or China; other varieties with narrow leaves, which grow in winter or spring, have colonised the drier, evergreen forests of the Mediterranean. Yet others have spread across the Central Asian steppes, dry mountain grasslands (the Alps or the Sierra Nevada in Spain) or wet mountain grasslands (the Himalayas), sometimes at altitudes of up to 3,000 or 4,000 metres, whereas others flourish in the rocky coastal regions of the Mediterranean and the southern Atlantic (as far as the Cape Verde Islands), being able to make direct use of moisture extracted from the air by the leaves. This same ability has enabled certain woody orchard grasses, branching and sometimes several metres long, despite the virtual absence of soil, to colonise crevices in volcanic rocks in the Canary Islands, using moisture from the clouds which gather in the "windward" parts of the mountainous islands.

Since the end of the last Ice Age, orchard grasses with a different genetic composition, less specialised and better adapted to unsettled environments with dense herbaceous vegetation, have developed through sexed polyploidisation of the diploids, followed by multiple hybridisation of the resultant tetraploids. The development of these tetraploids was greatly favoured by land clearance and cultivation which, in contrast, contributed to the gradual regression of the diploids, and indeed to the virtual extinction of certain types through the destruction of their habitats. This decline has accelerated dramatically during recent decades because of overgrazing in countries with booming populations or more rapid urbanisation of tourist areas. For a long time, tetraploid orchard grasses have been one of the many components of natural or semi-natural grassland. Only those of the tetraploid subspecies, from humid, temperate climates (subspecies *glomerata*), have been transferred (as hay or seeds) from western Europe to the Americas, Australia and New Zealand in the course of their colonisation. Not until the beginning of our own century was any work done on selection and genetic improvement with, it must be added, quite serious problems arising from preferential cross-fertilisation and genetic inertia, linked to the tetrasomy of the one tetraploid subspecies used (*glomerata*). Throughout its (very wide) natural distribution, this subspecies accounts for approximately one third of the genetic variability of the species. In all the improved varieties together, only about one-sixth of the latter's genetic diversity is to be found, but the figure is even lower amongst American varieties. Genetic enrichment of the orchard grass varieties is nevertheless possible, thanks to the development of advanced technology using controlled polyploidisation and a higher number of diploid subspecies, often with interesting agronomic potential, especially for more extensive grazing in more varied environments, principally in southern Europe and the Maghreb. The economic value of orchard grass, and consequently work to improve this species, has decreased significantly in most western countries, even though the traditional commercial varieties continue to be used, especially in mountain regions where they sometimes genetically pollute the local ecotypes. Only Eastern Europe, New Zealand and Japan are still pursuing research into orchard grass and systematically gathering research material from natural populations, particularly in Western Europe. So orchard grass is still a mainly wild species of which the oldest (diploid) varieties, weakened by lengthy specialisation and rapidly approaching extinction, should be protected, for they represent the genetic base and the key to the extraordinary adaptation potential of this species.

The holm oak (*Quercus ilex L.*): used quite differently from one region to another

The holm oak is a tree with evergreen leaves, characteristic of the sclerophyllous forests of the western half of the Mediterranean basin. Natural populations also grow along the en-

Klein/Hubert/Bios

tire Atlantic coast of France as far north as Brittany, and up along the Rhône valley until just south of Lyons. In the eastern part of its range, from north-western Turkey to the Nice region as well as in the Atlantic part, the holm oak is limited to coastlines where, in a relatively mild and humid climate, it presents a variant form with long thin leaves, called "ilex".

In central Spain and the Maghreb, where climates are drier, it presents a variant with small, thick leaves called "rotundifolia". The holm oak is undemanding as regards the type of soil. It readily shoots from the base after felling or fire, and it burns well. The development of this species has been assisted by mankind. Over most of its range, growing either as natural coppices or from locally produced and planted acorns, it has mainly been used, directly for firewood or to make charcoal. However, in central Spain where the "rotundifolia" variety is found, plantations of widely spaced and evenly trained wineglass-shaped trees have been used for a very long time to produce acorns for pig fodder. This type of use has been accompanied by a long process of empirical selection focusing, for example, on the acorns' sweetness. In this allogamous species, with a longlife span and broad overall genetic diversity measured by means of several different types of marker, a considerable reduction in diversity has been observed among the cultivated populations of central Spain, as compared with those in regions where the species is used mainly as a fuel and has not been subject to the pressure of artificial selection to the same degree.

The olive tree and oleaster: two indissociable partners belonging to the same species (*Olea europaea L.*)

The oleaster (wild olive) is indigenous to the Middle East and the whole of the Mediterranean basin. It is an essentially allogamous, and very long-lived, species. Its domestication probably began in prehistoric times in the eastern part of the Mediterranean, through the empirical selection of individual trees remarkable for certain characteristics of their fruit (often the oil yielded). These individual trees were increased in number by vegetative propagation using cuttings, or else grafted on to indigenous oleasters. From all these propagated individuals have come the different varieties of olive trees that have been distributed by various human migrations, especially from east to west, among the countries round the Mediterranean. Recent work using genetic markers shows that because of the multiplicity and complexity of movement between countries, it is probably impossible to correlate the genetic variation of the olive tree with its geographical distribution. The weak genetic diversity of each variety, characterised by a single genotype, or at most a handful of genotypes, bears witness to the intensive selection (inbreeding) undergone, originally to obtain particular characteristics in the olives, sometimes at the expense of the trees' strength. In the case of grafting, the effect of inbreeding is compensated for by the vigour of the oleaster (stock), whose populations, by contrast, show wide genetic diversity, the heterozygotes benefiting increasingly with the age of individual trees. The genetic diversity of oleasters can be enhanced still further by taking alleles from (introduced) varieties of olive trees, as trees grown from olive stones are almost always oleasters. Thus the oleaster is an important source of genetic diversity, vital to the improvement, and indeed the very future of the olive tree. ■

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A Board for development

Ruth Raymond

The International Board for Plant Genetic Resources (IBPGR) is an international scientific institute whose mission is to strengthen the conservation and use of plant genetic resources worldwide, with special emphasis on the needs of developing countries. IBPGR was established in 1974 under the aegis of the Consultative Group in International Agricultural Research (CGIAR). The institute has its headquarters in Rome; there are eight offices around the world. Its professional staff collaborate with scientists in genebanks, research centres, universities and intergovernmental and non-governmental organisations throughout the world.

Plant genetic resources contain the genetic material of plants which is of value as a resources for present and future generations of people. The conservation and study of plant genetic resources has evolved rapidly over the last 20 years. In 1974, there were fewer than ten countries holding collections of plant genetic resources. Now, in part due to the efforts of IBPGR, there are over 120 and the number is growing every year.

In many countries, IBPGR has encouraged and supported the establishment of plant genetic resources programmes. It has raised general awareness of the issues related to plant genetic resources, which in turn has stimulated the demand for training and research, for technical publications, and for scientific assistance to national plant genetic resources programmes.

Since 1974, IBPGR has funded the training of about 1,600 scientists and technicians throughout the world. The institute has been involved in the collecting of 206,000 samples of crops in 129 countries. In the area of research, understanding the genetic diversity of genepools, the retention of diversity in collections, conservation technology and plant health have been major topics for several years. More recently, IBPGR has moved into new areas such as indigenous knowledge and forest genetic resources.

In the field of information technology, IBPGR has developed computerised databases covering a wide range of topics. These databases include information on national genetic resources programmes, *ex situ* germplasm collections worldwide, and germplasm collecting carried out with IBPGR support.

In October 1992, representatives of the governments of Kenya, China, Switzerland, Denmark and Italy signed an agreement to establish an international institute for the conservation and utilisation of plant genetic resources. Since that time, the agreement has been signed by an additional 11 countries. It is anticipated that the new institute, called the International Plant Genetic Resource Institute (IPGRI) will take over the duties of IBPGR (which is currently administered as an FAO field project) late in 1993.

A new strategic plan, "Diversity for development", spells out four major objectives which will form the basis of IPGRI's activities. First, the institute will assist countries, particularly in the developing world, to assess and meet their needs for the conservation of plant genetic resources and to strengthen links to users. Second, it will build international collaboration in the conservation and use of plant genetic resources, mainly through the encouragement of networks on both a crop and a geographical basis. Third, it will work to develop and promote improved strategies and technologies for the conservation of plant genetic resources; and finally, the institute will provide an information service to inform the world's genetic resources community of both practical and scientific developments in the field. ■

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The Twelve and genetic resources

Dionyssios Dessylas

The European Community's 10 million farmers are among the most productive in the world. Much of their success is founded on the exploitation of genetic resources in the past 20 years - cereal yields, for example, have doubled. About half of this increase has been contributed by better methods of controlling diseases, pests and nutrient deficiencies. And about half is due to new, genetically more productive varieties, produced by the controlled crossing of different germplasms.

Thus the exploitation of genetic resources has enabled Community agriculture to achieve substantial increases in agricultural productivity, which itself was the first objective of Article 39 of the Treaty of Rome, signed in March 1957. 30 years of work by farmers and scientists have achieved the given policy objective.

After some years of discussion and debate the Community now has a new agricultural policy. The new policy continues to uphold the basic principles of the Rome Treaty, of the unity of the market, Community preference, and financial solidarity. It introduces important changes in market mechanisms for individual products. And it establishes a series of flanking measures, aimed at encouraging farmers to use less intensive methods and to take on a more explicit role in the conservation and management of the countryside.

Take, for example, the particular case of cereals. The target and the intervention prices for cereals will be reduced progressively over the next three years. These reductions will be offset by compensatory payments - provided that 15% of the farmed area is withdrawn from production (this applies to the larger producers). The aid scheme (Council Regulation No. 2078/92) establishes a series of premiums for, for example, rearing endangered breeds of livestock and for the cultivation and propagation of useful plants adapted to local conditions and threatened by genetic erosion.

The reform of the Common Agricultural Policy, with lower unit prices, with set-aside, quotas and other regulations, establishes new constraints and new incentives for Community agriculture. We have seen that agriculture has proved itself very responsive to policy requirements, and that one of its principal means of response was provided by its suppliers, such as plant and animal breeders. What are the implications of the reform of the CAP, and of other policy developments, such as the Treaty of Maastricht, for the future conservation, characterisation and exploitation of genetic resources in Europe?

When policy called for higher levels of production the breeders gave farmers what they needed. Now we need a decreased reliance on chemical inputs and an increased quality of the end product. There is every reason to believe that we can breed for these characters too. But genetic change requires sources of the appropriate genetic characters. Collections of germplasm exist, but keepers of germplasm collections report that much of their stored material is under-characterised, for lack of funds and personnel.

Historical and international perspectives

The first action to conserve and utilise genetic resources was by farmers and gardeners. In 19th-century France, at the "Époque des terroirs", there was a vast genetic diversity in gardens and on farms. For at least a century, specialist associations of gardening enthusiasts in northern England have preserved particular varieties of onion and gooseberry, which give prize produce. More recently a number of regional and national associations have been established, with the objective of conserving collections of particular races of fruit trees, or poultry, or even bees. There is also a substantial effort by various regional and national associations in the conservation of wild habitats.

Genetic resources are a truly international resource, extending from country to country across national borders. European collectors have gone across the world in search of germplasm for our farms and gardens. By the same token, collectors have come to Europe in search of germplasm; for example, an Australian collection mission has been established in France for many years, collecting potential agents for biological control on Australian farms. These efforts have given rise to important national and international collections of stored material.

The first germplasm collections were set up by scientists interested in the study of genetic diversity. The collections soon took on a second role, of conserving material which is threatened with extinction in its native habitat. The argument was that such germplasm is irreplaceable - at least in the form of an integrated genome, and accompanying cytoplasm. It is a natural resource, and there is much evidence that the resource is disappearing.

Since the start of the first scientific research on the origin and extent of genetic diversity, scientists have made informal working contacts across national borders. As the number of workers increased, various international secretariats have been set up to establish standards and to help co-ordination of effort in germplasm collections. Important efforts in these areas have been and are made by, for example: the Food and Agriculture Organisation, Rome; the International Board of Plant Genetic Resources, Rome; the European Association for Animal Production; the World Council for Nature and the Botanical Gardens Conservation Secretariat; the United Nations Environment Programme. The early workers would be amazed to see how far their subject has advanced. Indeed genetic diversity, and genetic erosion, have become important subjects of political debate; see, for example, the Convention on Biological Diversity, signed by the Community and its member states on 9 June 1992 at the United Nations Conference on Environment and Development, in Rio de Janeiro. The subject has been debated in European forums for longer; see the European Parliament's Resolution on the genetic diversity of cultivated plants, of 20 February 1986, and the discussion in the Council of Agricultural Ministers on the conservation and utilisation of plant genetic resources, on 26-27 March 1990.

Genetic resources in Europe

In 1992 the Commission made a report to the Council on the conservation and utilisation of plant genetic resources (SEC (92) 874 final of 8 May 1992). The report lists a wide range of actions already taken by the Commission, in various programmes of scientific research and technological development. It also lists various problems that had become apparent during these programmes. The report found that there a certain overlapping of programmes between the member states, with a duplication of effort and of conserved material. There was also a tendency to put material into store without information on the detailed characters that are of interest to potential users. Almost all collections report that they need more facilities and staff simply to finish the job of characterising the material already in store.

There is thus a need for action. The principle of subsidiarity in the Maastricht Treaty lays down that responsibility for action at national level lies primarily with national authorities. Much of the effort in germplasm resources lies in this category. But here is also a need for action at Community level, in order to coordinate the existing efforts, to fill gaps, and to improve the efficiency of the work. These are the objectives of our proposed new Regulation, currently being processed within the Commission, and shortly, we hope, to be sent to the Council of Ministers for public discussion. The Regulation would lay the basis for a five-year programme, complementary to the work already being undertaken in the member states. The programme would be oriented exclusively towards practical actions: scientific research and technological development are excluded (these are in principle already covered by the Community Framework Programmes). The programme would aim to help the routine tasks of conservation, characterisation and utilisation, provided that they be undertaken on a Community basis (the support of individual collections is a matter for the individual member states). The work programme has been written in such a way that each project will follow a logical pathway in six steps:

1. Establish a conservation and documentation workplan
2. Characterise the various collections which make part of the project, and assemble the passport data
3. Evaluate other characteristics, in particular, run screening data
4. Sort the collections, identify duplicates and gaps
5. Harmonise and rationalise the collections
6. Acquire and collect missing germplasm

At the same time, each project will include practical work on the evaluation and utilisation of stored material. We hope that at the end of five years, there will be concrete results in the form of a better knowledge of what is available in the European collections, and a better utilisation of that material, to the benefits of European agriculture. ■

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A. Naevra

Norwegian salmon

Børre Pettersen

More than 500 rivers and streams in Norway support Atlantic salmon (*Salmo salar*). 30 stocks have become extinct and an additional 64 stocks are severely threatened by human activity. The most serious problems are acid rain, the parasitic fluke *Gyrodactylus salaris,* river regulations, pollution and most recently the potential impact of a large number of salmon escaping from fish farms.

In 1992 141,000 tonnes of Atlantic salmon were produced by the Norwegian salmon farming industry. In comparison, the nominal annual catch of wild salmon has been about 1,000 tonnes in recent years. Salmon escape from the fish farms at all life stages. About 1.5-2 million fish have escaped each of the last five years. Investigations in rivers have revealed that escaped farmed salmon comprises a substantial proportion of the mature salmon present in the spawning grounds in autumn. The average proportion of farmed salmon for all investigated spawning stocks has varied between 24% and 38% during the period 1989-92. A potential for large-scale genetic introgression thus exists. There is increasing evidence that farmed salmon do interbreed with local stocks.

Dangers of crossbreeding

Norwegian management of wild salmon is based on the "stock concept". The fundamental biological reasoning behind this concept is that the wild stocks of salmon are most typically independent reproduction units with limited geneflow between each other. A genetic structure of this nature is known to be favourable for evolving genetic adaptations to local environmental conditions. Many genetic and biological differences between salmon stocks have been shown to exist.

Farmed salmon is derived genetically from several wild populations and is subject to an intensive selective breeding programme. Crossbreeding between farmed and wild salmon in nature is expected to lead to the loss of genetically determined characteristics and adaptive traits in local wild populations. The expected practical effect of this will be reduced production in the local stocks, and for the salmon as a species an evolutionary reversal of, at the worst, several thousand generations. One of the major objectives in the management of Norwegian salmon is therefore to protect the genetic structure of the wild salmon and its evolutionary potential from this undesirable influence.

In immediate response to the danger of genetic impact the government decided to establish a gene bank for Atlantic salmon. The gene bank was initiated in 1986 and is based on deep freezing of salmon sperm and living gene banks (hatchery-maintained populations). The purpose of the gene bank is to secure the genetic diversity of the Norwegian wild salmon in compliance with the precautionary principle. The gene bank will also be used in the re-establishment and enhancement of threatened stocks. The gene bank has until present collected sperm from 4,403 fish from 161 different stocks. 25 severely threatened stocks are now maintained in captivity in especially designed fish stations.

Norwegian authorities have implemented several steps to reduce the intermixing of escaped farmed fish with the natural stocks. There have been established geographical zones where no new farming licences are issued. Such protective zones encircle the outlets of important salmon rivers. In most cases they cover an area within 20 km of the river outlet, and the largest zone covers a fjord-area of about 120 km in length. Recent data suggest that rivers within the larger zones have lower run of fish farm escapees. It is assumed that the number of escapees can be greatly reduced by technical improvement of fish farms. The environmental authorities contribute to this development by funding a research programme on new technology for coping with the environmental problems in aquaculture. Efforts to reduce the number of escapees by catching them in the sea and in the rivers have not proven to be successful.

Norwegian authorities participate in the further development of an ecological sustainable aquaculture industry. Environmental aims for the industry have been determined, both in short and long term. These aims include topics like the problem of fish escaping from farms and the spread of infectious diseases together with problems concerning the release of organic matter, nutrients, antibiotics and chemicals into the natural environment. Concerning escapes, the short-term goal is to reduce the number of escapees by 75% in the course of the next two years. The long-term goal is to remove the problem. ■

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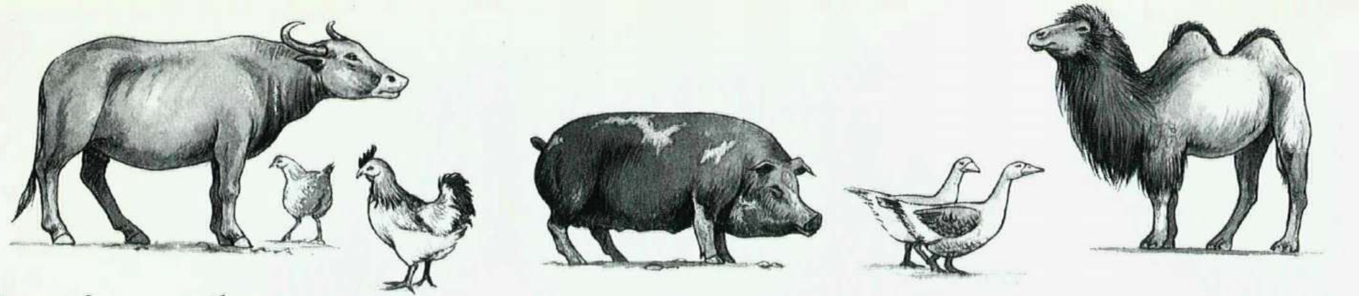


Animals too

John Hodges

We live in an era of extinction for some of the estimated total of 1.4 million species. About 50,000 of these are vertebrate animals. Within this group are the domestic mammals and birds, which numerically may appear to be insignificant, since those of consequence number only about 15 species of the former and about six of the latter. This is in contrast to the larger number of plant species which mankind has domesticated. In the case of animals, starting about 10,000 years ago, mankind chose these few species for domestication. Since then, by close association with man, they have had an enormous impact in a variety of ways on the development of human civilisations. They have been very closely associated with mankind in his geographic migrations and in his progression from primitive lifestyles to those of today where one of the marks of high quality of life is a relatively high proportion of animal products in the diet. Although today animals may now be valued most in advanced societies for their contribution to food, in more primitive communities they still have other values. Even today in most developing countries these values include wool, leather, tallow, bone, manure for fuel and for increasing the fertility of crop land and, perhaps most important of all, draught animal power. Without domestic animals, the majority of mankind in the developing world would still be slaving to survive by hard physical labour. It has often been mused that mankind has risen from drudgery on the back of the domestic cow who has also been his foster-mother. She has also been man's security, his bank and his resource for times of leanness and poor crop harvests.

Of the 15 species of mammals chosen by mankind for domestication, even fewer are dispersed widely and used by most of mankind. They are cattle (both *Bos taurus* and *B. indicus*), buffalo, sheep, goats, pigs, horses and donkeys. Others of the 15 mammalian species are mainly used by minority human groups in specialised situations; they include species like the Asian elephant, the various species of camelidae, including the one and two humped camels, and the Andean camelid species, the yak and the domestic rodents. The common domesticated poultry species are chickens, turkeys, guinea fowl, domestic ducks, Muscovy ducks and geese.

In Western Europe man is principally interested in cattle of the *Bos taurus* type, pigs, sheep and chickens. These animals are a major interest, shown by the fact that in the developed world the livestock sector is responsible for over half of the output of agriculture. Moving farther east through Europe to Asia, we find other species of importance for maintaining human lifestyles; these include goats, donkeys, buffalo, *Bos indicus* cattle, and the Camelus species (both *C. bactrianus* and C. *dromedarius*).

Domestic animal breeds in Europe

In terms of species survival, we may quickly and rightly conclude that none of the common domestic animal species of Western Europe is endangered. However, it would be wrong to conclude that biological diversity in domestic animals is not threatened. The issue is not loss of species, but the loss of breed diversity within the species. Each of the few domestic animal species has enormous genetic variation within it. For example, there are throughout the world 800 breeds of cattle and 900 breeds of sheep. These breeds, which are quite distinct within their species, have been produced by mankind, often in unconscious ways during human migrations over thousands of years from the centres of origin of domestic species. In the course of slow human travel, domestic animals became adapted to the new environments. Natural selection, combined with human selection for preferred types, gradually brought about distinct breeds of cattle, of sheep, of goats and of pigs. While these breeds are still able to interbreed within a species, their geographic isolation over several thousand years ensured their genetic isolation. Breeds of the few common species mentioned earlier are found throughout the world. For example, cattle and sheep are found in all climatic conditions from the Arctic to the tropics. They are also adapted to wide differences of vegetation for food, they have specific resistances to endemic diseases and pests and they are adapted in many ways to the economic and social needs of the local human populations.

Loss of animal biodiversity

The long and complex human history of Europe with its many ethnic and social divisions has produced an extraordinary large number of breeds of these few species of domestic animals. Europe has 1,250 breeds of common domestic animals. This amounts to more than a third of all the breeds in the world. Why are they threatened today ? It is not by the common causes of habitat destruction, by pollution or by changed natural environment. It is due, rather, to powerful economic development, driven by the market economy with its single-minded emphasis upon productivity and profit. Livestock are, after all, one of the major resources of the livestock producer. Most consumers in Western Europe today are no longer enchanted by the variety of breed sources from which meat, milk and eggs come. The demand is for uniformity and relatively low price. Variations in flavour, product and design are made in the processing sector rather than on the farm. The farmer is under economic pressure and naturally he chooses to keep the most efficient breeds of animals within a species. If these are genetically defined by cross-breeding, then he will keep crossbred animals rather than the traditional breeds. So, in travelling across Western Europe today, one sees few of the old local breeds. The livestock landscape is dominated by the few, highly productive, profitable breeds and crosses. The traditional breeds with their specific genetic traits such as hardiness, longevity, suitability to higher elevations, ability to produce slowly on poor quality feed such as seaweed are rare today.

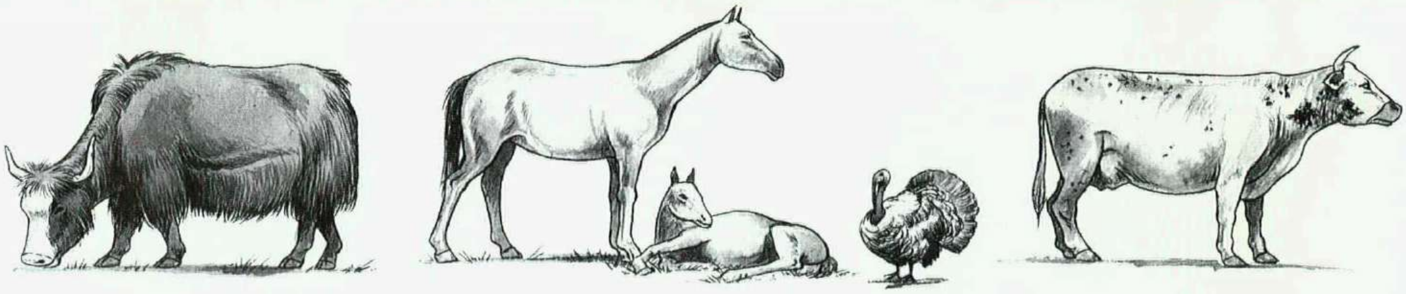
The final loss of these genetic traits, controlled by unique sequences of DNA, would be a terrible loss for mankind. They cannot be reproduced at will. All the arguments about lost biological diversity which are applied to wild species apply here, plus the strong economic and social rationale that our generation cannot possibly know what future generations may need either for survival or for revised quality of life considerations. In the midst of this technological age, we have an obligation to conserve for our children the biological diversity which we have inherited from generations of our ancestors. The threat to domestic animal biodiversity results, along with other effects of unsustainable development, from single-minded and large-scale devotion to low cost and high profit. If continued without restriction, without regulation or without planned sustainability, such practices lead inevitably to the depletion and loss of the natural resource base needed for future production. While the developing world is often accused of unsustainable development, in fact this type of development is progressing at a far greater speed in Europe and other regions of the developed world. The threat to animal breeds in Africa, Asia and Latin America is great, but one may still find many local breeds in traditional locations. In Western Europe it is already too late to find most local breeds in commercial production units.

Worldwide numbers of breeds of domestic animals

Cattle	800
Sheep	900
Goats	600
Pigs	400
Buffalo	100
Horse	400
Ass	150
Total	3 350

Conservation programmes

Fortunately domestic animal conservation of threatened livestock breeds is already in



progress in Western Europe, although it was mainly initiated by the activities of minority groups of concerned people, by NGOs and by professional groups of scientists. Two main techniques are used. Firstly there are farm parks and networks conservation plans which harness the enthusiasm of many individuals who are willing to keep a few animals of threatened breeds. The new non-governmental organisation called Rare Breeds International is the voluntary group which is now supporting local and national groups in their activities. In most European countries the local groups are privately organised and are financed by public donation and by entry fees to view the animals. In other countries, particularly the former centrally planned countries of Central and Eastern Europe, conservation activities have been organised by governments. A second and supplementary method of conservation is often used for endangered breeds, namely the storage of semen and embryos at very low temperatures in liquid nitrogen. The availability of this technique varies from species to species, but with most domestic species common in Europe it is now possible; the advantage is the relatively low cost and the possibility of indefinite long-

Numbers of domestic animal breeds in each region

Europe	1 250
Former URSS	350
Asia	900
Africa	475
North and Central America	200
Latin America	100
Oceania	75
Total	3 350

term storage. Increasingly, another step is also taken, by preserving DNA from the blood of endangered breeds. This is a long-term insurance policy, which costs very little and which may, in decades to come, be useful when the genome maps of domestic livestock are complete. At that time, with improved gene transfer techniques, it may be possible to reintroduce into existing breeds, the segments of DNA from extinct breeds which code for specific traits of value.

Another important aspect of conservation of livestock breeds of Europe is the assembly in a systematic manner of census and genetic characterisation information for all breeds. This data collection is vital to permit monitoring of changes of population sizes, to identify the level of risk of individual breeds and to offer a service on genetic aspects of livestock. Fortunately, such a European animal genetic data bank has been established at the Veterinary University of Hanover in Germany. There, in a computerised system, the population and genetic records of all the livestock breeds of Western Europe and of some Eastern European countries are maintained and analysed. The scientific initiative for this came from the European Association for Animal Production, a professional body of scientists.

A new major problem

It may be thought from this description that the problems of conserving animal genetic diversity are well under control in Europe. However, this is not so. A major new problem is now with us. It concerns the former centrally planned countries, especially those new countries of the Commonwealth of Independent States (CIS). Some of these countries are European in culture and history; many of them have expectations of one day joining the European Communities. Certainly, the future of Europe cannot be envisaged without taking account of their needs and aspirations. They have much to contribute in the longer term to the wealth and development of Europe. In the realm of domestic animal biodiversity they have much to contribute. But, in fact, they are now in deep trouble and in need of technical assistance and practical help.

The former USSR has 350 breeds of cattle, sheep, goats, pigs, buffalo, horses and asses. This represents a unique genetic resource of great interest to the whole world. These domestic animal genetic resources were documented and made available as public information for the first time on a comprehensive scale in the late 1980s as a co-operative project between the Food and Agriculture Organisation (FAO), the United Nations Environment Programme (UNEP) and the (then) USSR All-Union Academy of Agricultural Sciences. Original studies of all the breeds of 17 major and minor species of domestic mammals and birds were made by 25 Soviet scientists. I was privileged to be the Editorial Co-ordinator for this task. The results were published by FAO (1989) in a publication entitled "Animal Genetic Resources of the USSR".

Under the centrally planned economy of the former USSR the threat to these indigenous breeds was not great for two reasons. Firstly, the former Government of the USSR maintained some conservation programmes, particularly in state reserves. Secondly, the centrally planned economy put no pressure on state and collective farms to increase productivity nor to reduce costs nor to maximise profit. The pressures of the market economy which lead to mono-breed production were absent; many families kept the traditional local breeds on their household plots.

However, since the political breakup of the USSR and the end to central planning and control, livestock populations have been greatly depleted and continue to diminish. In the transition economies which are struggling to move into the free market, livestock naturally have low priority. Livestock breeds in the CIS are now threatened. This threat comes from limited government resources to maintain the existing state animal reserves and from the disorganisation and distortions in the economy. Livestock farms lack feed for their animals; inflation and unemployment reduce consumers purchasing power and livestock products take second or third place. By the time the economies are stabilised many breeds may be lost. An example is the world famous animal conservation reserve at Askanyia Nova in the Ukraine, which was established at the end of the 19th century and maintained by the Soviet Government. It is now the responsibility of the Ukrainian Academy of Agricultural Sciences, which is struggling to find its own identity and budget within the new Republic of the Ukraine. The President of the Academy told me in Kiev in the summer of 1993 that he has no funds to maintain the programme at Askanyia Nova and that soon he will have to arrange to start killing animals. He said he desperately wants technical assistance and funding to get through this critical period of the next few years. Otherwise some unique animal genetic resources may be lost from this famous animal conservation centre.

The Republics of the CIS need help now for the conservation of their domestic animal genetic biodiversity. They are threatened, not by the creeping threat to breeds which comes with prosperity as in Western Europe, but they face the sudden and rapid threat which comes from the breakdown of the economy and of the infrastructures of society. In such situations, people can only think of today and tomorrow. Conservation is always concerned with the long-term future and therefore is low on their list of priorities. In the shrinking world of biodiversity and the enlarging world of Europe, there is need for Western Europe to invest in conserving the animal genetic resources of the former USSR quickly. ■

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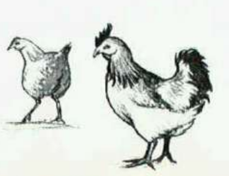

At the Council of Europe

1995: European Nature Conservation Year

The first Council of Europe campaign to promote nature conservation was in 1970. It led to a widespread increase in awareness in Europe, launched the idea that our environment needs protection and created close links between the Council of Europe and the countries of central and eastern Europe. It made the very notion of nature conservation acceptable and gave protected status to the most outstanding natural areas, through the creation of national parks and so on.

25 years later, Europe has evolved and transformed, while our environment still faces increasingly serious threats. Once more it is necessary to affirm the need to conserve nature throughout Europe, and not just in protected areas. This is why the Council of Europe has decided to declare 1995 "European Nature Conservation Year" and to focus in particular on nature conservation outside protected areas.

A pan-European campaign from the Atlantic to the Urals

All the countries of Europe are invited to take part in European Nature Conservation Year (ENCY) 1995 - the Council of Europe's 32 member States and other countries which co-operate with it: Andorra, Albania, Belarus, Croatia, Latvia, Moldova, Monaco, Russia and Ukraine.

A total of more than 40 countries will be combining their efforts to make 1995 the European Nature Conservation Year and to ensure that the natural environment is taken into account in all man's activities.

The campaign's goal

Nature conservation and management within a context of sustainable development must apply throughout each country's territory and be conceived from a global perspective, rather than simply involving the creation of protected areas. European Nature Conservation Year will focus its activities on all the areas which have no legal protection in order to create the best possible conditions for reconciling human activities with nature and wildlife.

Giving the most outstanding natural areas protected status is no longer sufficient. ENCY hopes to encourage a new concept of nature - one in which man has his place, an active but respectful place.

An appropriate set of themes

From the Atlantic to the Urals, from Lapland to the Mediterranean islands, the threats to our environment vary greatly: the growth of tourism, the problems of desertification, the development of industry and of transport infrastructure and so on. To enable the countries taking part in ENCY to adapt the overall theme "nature conservation outside protected areas" to their problems a set of specific themes has been drawn up.

ENCY activities and events might, for example, focus on the following environments:

- water - forests - agriculture and the countryside - the urban environment - tourism and leisure - industry - transport infrastructure - military and demilitarised areas.

Target groups

ENCY will concentrate its efforts on four important groups:

- local, regional and national authorities

These are the levels at which key decisions and steps affecting the environment are taken. They are the important decision makers. They should therefore be the priority audience for ENCY.

- the users of the environment

Numerous individuals and groups "use" the environment as part of their work or leisure activities: farmers, foresters, fishermen, hunters and so on.

- major consumers of space

This covers such sectors as tourism, the building and other industries and civil engineering.

- young people

Greater awareness and commitment among young people are critical for the environment's future.

Each of the national contributions and activities can therefore be targeted on one or other of these groups.

A wealth of activities and events

The campaign will comprise a wide range of national and international events.

Each national committee will organise events on the theme or themes adopted to reach a particular target group. Some committees will co-operate and mount bilateral projects.

The Council of Europe will be organising international seminars and colloquies.

Overall, there will be a very full programme: media related activities, including the national and international press, the publication of brochures and leaflets, special stamps, the organisation of photographic competitions, seminars and conferences and so on.

Who to contact?

National and international bodies have been set up to organise this pan-European campaign:

- at the national level

Organising committees have been established. These bring together partners from the public, private and voluntary sectors and are responsible for the implementation of ENCY 95 within each country.

- at the Council of Europe

An International Organising Committee has been created, with all the national organisations represented. The committee's task is to take decisions and offer guidance on all the campaign activities.

You can also take part in this campaign. The Council of Europe has allocated a special secretariat to the ENCY.

Please contact the following address for all information:

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