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CONVENTION ON THE CONSERVATION OF EUROPEAN WILDLIFE
AND NATURAL HABITATS

Group of specialists
for the European Strategy on Invertebrates

Strasbourg, 19-20 May 2005

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Report

Document
prepared by
the Directorate of Culture and Cultural and Natural Heritage

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The Standing Committee is requested to take note of the present report, which summarises progress in the elaboration under the Bern Convention of a European Strategy on Conservation of Invertebrates.

Background

At its 23rd meeting in November 2003, the Standing Committee to the Bern Convention decided, following the advice of its Group of Experts on Conservation of Invertebrates, to include in its programme of activities for 2004 and 2005 the preparation of a European Strategy on the conservation of invertebrates.

During 2004 a consultant, Mr John Haslett, prepared a document with “elements for a European Strategy for the conservation invertebrate animals (excluding marine species)”. This paper – included in appendix 3 to this report – considered a number of issues that might be dealt in the framework of such strategy and opened some questions on the reach and detail of the strategy.

The Secretariat decided to call for a select group of specialists in this matter so that this panel may quire appropriate guidance to the consultant.

1. Opening of the meeting by the Chair of the Group of Experts

The Group of Specialists (list in appendix 1) met on 19 and 20 May 2005 in Strasbourg.

Mr Yves Gonseth (Switzerland), Chair of the Group of Experts on the Conservation of Invertebrates, welcomed participants, noted the interest of the activity for the promotion of invertebrate conservation action in Europe and congratulated the consultant for the document prepared. On his view, it was a good summary of problems relating to invertebrate conservation, but it did not look like a strategy. It asked the right questions but the right solutions or proposals had to be found out.

2. Adoption of the draft agenda

The agenda was adopted as it figures in appendix 2.

3. Introduction by the Secretariat

The Secretariat noted the importance of elaborating a strategy that could help government focuss their priorities in the field of invertebrate conservation. He briefly presented two strategies that had been prepared in the past three years in the framework of the Convention: the Planta Europa-Council of Europe “European Plant Conservation Strategy”, endorsed by the Standing Committee in its Recommendation No. 87 (2001), and the “European Strategy on Invasive Alien Species”, endorsed by the Standing Committee in its Recommendation No. 99 (2003). The texts were different but could serve as models.

4. Présentation of the working documents by the consultant

The consultant, Mr John Haslett, presented the “elements” he had prepared (appendix 3). His intention was not to draft the strategy without input from other experts, but to make its elaboration a participative process. He was interested to receive advice on a number of issues, such as the detail in the objectives or targets, the way to deal with habitat conservation: landscape management issues, how to deal with sectors policies and conservation of invertebrates, etc. He was confident that the discussion during the meeting of specialists could be a great help.

5. Discussion of the different topics raised

During a full day the different topics / questions raised in the document presented in appendix 3 were discussed. The issues were too numerous to report in detail. It was decided that the text would not be too long (more like the European Strategy on Invasive Alien Species) and the recommendation of a general character. Previous recommendation of the Standing Committee and the European Charter of Invertebrates (see appendix 4) will be included in an appendix to the Strategy. The Strategy will be addressed to States and conservation agencies and research institutions involved in conservation of invertebrates and management of nature habitats. The Strategy will link with work of other international biodiversity related conventions and initiatives, trying to connect with existing projects in IUCN, CBD, GBIF, EIS, etc.

6. Next steps

The consultant will produce a first draft of the Strategy by December 2005. The Group of specialists is to meet in January 2006 with the view of having a second draft for circulation to governments and examination by the Convention Group of Experts in June 2006. A third draft will be presented to the Standing Committee for possible adoption in November 2006.

Appendix 1

LIST OF PARTICIPANTS

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Appendix 2

Group of Specialists
for the European Strategy on Invertebrates

Strasbourg, 19-20 May 2005

AGENDA

1. Opening of the meeting by the Chair of the Group of Experts

2.. Adoption of the draft agenda

3. Introduction by the Secretariat

4. Presentation of the working documents by the consultant

5. Discussion of the different topics raised

6. Next steps

Appendix 3

Strasbourg,9 December 2004 **T-PVS/Inf (2004) 17**
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CONVENTION ON THE CONSERVATION OF EUROPEAN WILDLIFE
AND NATURAL HABITATS

Standing Committee

24th meeting
Strasbourg, 29 November-3 December 2004

Elements for a European Strategy for the conservation of Invertebrate animals (excluding marine species)

DRAFT

Document prepared by
Mr John R. Haslett

This document is a first attempt to bring together the problems and requirements of invertebrate conservation across Europe. It is the work of a single person, commissioned by the Council of Europe, with a view to drafting a formal European Strategy for the Conservation of Invertebrates. The present document has been written to provide a framework and to stimulate relevant and creative discussion for all relevant parties and should be read as such. To this end, subject areas or ideas that particularly require further elaboration and discussion or are potential future objectives are given in square brackets [ ] in the text. The document in its present form is not to be taken in any way as a formal Strategy.

CONTENTS

1. INTRODUCTION

Why bother to conserve insects, spiders, snails and other creepy-crawlies?

There are vast numbers of species of invertebrate animals, so many that they make up the greater part of the world`s entire biodiversity. Insects alone are estimated to be about 65% of all species of organisms on the planet, including plants and micro-organisms (eg, see Speight et al, 1999). Not only are invertebrates more numerically diverse than other groups of organisms, they also dominate nearly every kind of habitat that the world has to offer. But perhaps most importantly, invertebrates perform a very wide range of essential *functional* roles in the world`s ecosystems. From the tropics to arctic and alpine, from terrestrial to aquatic, there are massive numbers of invertebrate herbivores, predators, decomposers, parasites, pollinators, seed dispersers and more. Equally, invertebrate animals are themselves the food necessary to support organisms at other levels in the food web (even including carnivorous plants!)

Thus the invertebrates are the motor that drives ecosystem function at all scales of definition, from microsystem to worldwide. This important fact was noted and succinctly summarised by E.O. Wilson some time ago, in the title of his (1987) paper: ´The little things that run the world (the importance and conservation of invertebrates)`.

Yet this pivotal position of the invertebrates remains, even now, largely overlooked, also within Europe. In the public view there appears to be no real need to conserve most invertebrate species. The general attitude towards these animals remains largely negative – invertebrates tend to be closely associated with pest species that bite, sting, spread disease and/or cause illness or eat our crops and food products (eg for insects, see Loxdale, 2004). On top of all this, invertebrates generally have a distinct lack of aesthetic appeal, to the extent that many groups of these animals are seen as repulsive, and some are even the stimulus for psychological phobias.

It is perhaps not so surprising then, that in some European countries, governmental emphasis has tends to have been placed upon conserving human cultural heritage using the values of art and archetecture, rather than on nature protection in general or the protection of invertebrate animals in particular (Balletto & Casale, 1991).

Of course there are some exceptions to this negative way of thinking. For example, adult butterflies and dragonflies are widely accepted as beautiful animals that help to make nature enjoyable and are therefore worthy of protection. These and similarly regarded invertebrates have achieved the higher status of ´honorary birds` by being so accepted in public and political conservation circles. Although this is useful advertising and has provided a solid basis for future conservation effort for the animals concerned, it fails to solve the general problems of public understanding and support for the conservation of the invertebrates as a whole. To quote E.O. Wilson once again:

So important are insects and other land-dwelling arthropods that if all were to disappear, humanity probably could not last more than a few months. Most of the amphibians, reptiles, birds, and mammals would crash to extinction the same time. Next would go the bulk of the flowering plants and with them the physical structure of most forests and other terrestrial habitats of the world` (Wilson, 1992, p125).

Whether or not one agrees with the time scale, or with the exact order of events, the message is poignant and is not to be disputed.

Invertebrates also provide a richness of medical and technical resources. From medicinal leeches to wound-cleaning insect larvae, from forensic entomology to models for robotics or molecular structures in materials science, the positive commercial potential of invertebrate animals is only beginning to be exploited. Also, there are the delights of such things as eating snails with garlic, or wearing a necklace of pearls from fresh-water pearl mussels. But such commercial exploitation of species creates its own sets of problems, just as with plants.

To summarise, invertebrates need to be conserved at European and global levels because they:

- Contribute much more to biodiversity than any other group of organisms on our planet.
- Dominate in nearly every conceivable habitat

- Are key components of, and perform essential functions in just about every ecosystem
- Are the basic food resource, directly or indirectly, for other organisms higher in the food web
- Provide a valuable and still underestimated resource for commercial use in medicine, technology, food and other services.
- Have aesthetic value and contribute significantly to the beauty and enjoyment of nature

Invertebrate – plant interactions

After the invertebrates, the plant kingdom is the second biggest overall contributer to global (and European) species diversity. The combined empire of invertebrates and plants is vast and this is not without reason. The two groups have existed and developed together through a very long period of evolutionary time. A complex variety of relationships and interdependencies have developed that make them functionally inseparable. Invertebrate animals eat and live on every conceivable part of the vegetation, living or dead, while the plants rely heavily on the invertebrates for their pollination and other aspects of their reproduction, and for recycling nutrients in the soil (Wilson, 1992).

Many invertebrates also have complicated life cycles, with adult and larval stages. These different stages often have very different demands for plant (and other) resources, so that the same species may occupy different niches at different times and may live in completely different habitats and require the presence of different plants or vegetation types. All are necessary for the survival of the species.

The spectrum of close associations between invertebrates and plants creates a `chicken-and-egg´ situation that is particularly relevant to the conservation of both, with each type of organism community relying heavily upon the continued well-being of the other. This means that by definition, invertebrate and plant conservation strategies must also be closely inter-related in their design and implementation. Also, many of the major threats to invertebrates are the same, or similar, to those of plants. Thus an uncoordinated approach to invertebrate and plant conservation strategies is likely to lead to the ultimate detriment of both, and is to be avoided (see scope below).

Present threats to European invertebrates

Levels of knowledge of the invertebrate fauna and its conservation status vary considerably across Europe, but it is widely recognised that a large number of invertebrate species are under severe threat of extinction in Europe, or are already extinct. The main factors responsible may be identified as:

Habitat destruction and fragmentation

Land use changes

Direct impacts of economic activities

Light pollution (for nocturnal species)

Impacts of invasive plant and animal species, native and alien.

[Add detail to this list, eg drainage of wetlands, tourism, competitive impact of invasive species, etc. Formulate specific objectives accordingly, emphasising the specific risks and requirements of invertebrates

How can the effects of the different factors be assessed? Particularly the less obvious factors such as the effects of invasive species (plant and invertebrate, see the European Strategy from Genovesi & Shine, 2004) and light pollution need further attention].

Note that these threats are either the same as, or directly involve, threats to plants and other organisms, including birds.

Scope

Organism distributions and ecosystem functions do not abide by political boundaries. Nevertheless, such boundaries continue to change, causing Europe to considerably expand. This requires any European Strategy to be flexible enough to take account of presently planned and future alterations to the geographical definition of Europe and its constituent States. The Strategy must also be designed to the fit within the fameworks of existing European conservation policy, including the Convention on Biological Diversity (CBD) and those of the Council of Europe and the European Union.

The discussions in this document are limited to the consideration of terrestrial and freshwater invertebrate species. Invertebrates are also of extremely high significance in marine systems (despite the notable absence of the insects), but the ecological requirements of marine species and the threats to their extinction in Europe differ considerably from those inhabiting other types of environment. Thus it is more appropriate that marine invertebrate conservation issues be considered elsewhere, by experts in that field, and the subject is not dealt with any further here.

Similarly, there are some taxonomic limitations to the scope of the present discussions. Issues of conserving biodiversity among very small organisms such as protozoa, many nematode worms and some other lower phyla are not considered, again because their requirements and threats are unique, or, more commonly, completely unknown.

Some of the basic demands and requirements of a European Invertebrate Strategy are very similar to those identified and now in place for practical plant conservation in Europe. Given the close functional associations between plants and invertebrates throughout European ecosystems, the present document for invertebrates has been designed to be integrative with the adopted European Plant Strategy. This serves to promote scientific coordination between the strategies and will also ease practical implementation. However, it must also be stressed that the demands of invertebrate conservation are also unique, and often differ significantly from those of plant protection.

2. THE SPECIES – HABITAT DILEMMA

In the early days of conservation biology, when present instruments such as the CBD, or in Europe the Bern Convention and the Habitats Directive had not even begun to be drafted, emphasis was placed primarily upon protecting particular species that were recognised to be somehow ´rare`, mainly flowers or birds or furry animals. Protecting nature was equated with protecting beautiful and aesthetically appealing species. Thus formal lists were drawn up of species deemed to be particularly worthy of active protection – Red Lists - which served to draw the attention of the public, including politicians, to the importance of ´nature conservation`, and the fact that species can become extinct through human influences. Then some scientists pointed out that species are becoming extinct because their habitat is being destroyed, so it is ultimately the habitat that deserves most of the attention, money, and effort. Now, the dilemma as to whether to use limited and usually inadequate human and financial resources to persue the conservation of particular species or whether to invest in the management and protection of habitats that are of notable biological value remains a critical issue in practical conservation strategy. However, it is clear that in the end, both directions are essential for the protection of biological diversity (Haslett, 2004). Indeed, it may be most useful to regard species and habitat protection as extremes of a continuous spectrum of valid conservation strategies, relevant to most organisms, but depending upon particular circumstances. This must be reflected in any European Strategy for invertebrate conservation.

The importance of integrating species and habitat conservation is now beginning to be fully appreciated at the European level through the acknowledgement of both within the Habitats Directive of the EU and in the approaches now adopted by the Council of Europe. However, many of the practical issues of invertebrate conservation in Europe are most conveniently discussed by particular reference to one end of the spectrum or the other, while acknowledging the relevance of both.

3. SPECIES CONSERVATION ISSUES

For invertebrates, the species approach, though of extreme importance, is beset with a variety of disadvantages that are less extremely problematical for most other organisms. Apart from their overall lack of aesthetic appeal, the small to very small size of most invertebrates means that they often go unnoticed, or are not credited as being of any significance.

There are also simply just too many species to deal with. In most European countries, we don`t even know how many species of the different types of invertebrates exist! Of those we do know, in many cases there are still large gaps in our knowledge of the biology of the species, their habitat requirements, and their population dynamics. All this is sufficient to cause an array of practical problems in creating and executing a conservation strategy for particular invertebrate species.

Issues of invertebrate taxonomy in conservation are dealt with in the section on Capacity Building later in this document.

Rare species and ´Red Lists`

To focus conservation effort on particular species requires that those species are somehow known to be under threat of extinction at some spatial scale of interest, (eg locally, nationally, globally). The species are usually thought of as being somehow ´rare`. The important initiative of IUCN to define criteria in a quantitative manner that should allow species to be assigned to a category of threat has been generally accepted as a global standard. Unfortunately, there are major problems in applying these IUCN criteria to many groups of the invertebrates. The main reason is a significant lack of relevant information to allow the criteria to be applied (´Data Deficient`). Despite this great difficulty, use of the IUCN criteria in assessing threat to invertebrate species is required by both the EU and the Council of Europe. Some valient attempts have been made to apply modified versions of the IUCN criteria to whole groups of invertebrates (eg European butterflies: Van Swaay & Warren, 1999). Although such work makes major advances, there is still the inherent problem of forcing quantitative analysis upon mainly qualitative/subjective information.

[The use of IUCN criteria with invertebrates has already been discussed to death! What is needed is a clear consensus as to how to make square pegs fit into round holes – what information do we need to *make* the IUCN criteria work for invertebrates and in which situations will they never work, and what can be offered as an effective alternative?

Is it possible to produce an up-to-date list of threatened invertebrates for Europe, as is being undertaken for vascular plants? If not fully comprehensive, which groups are realistic?

Who should undertake such work?

What additional taxonomic underpinning is needed, within realistic limits?

How often should red lists of invertebrates be updated?

How should the Bern Convention and Habitats Directive lists be modified in relation to European lists?

How can such lists be launched with maximum publicity?]

Widespread species

The rescue of known rare and threatened invertebrate species is urgent, but an equally or perhaps more serious long term problem is likely to be the reduction in abundance and range of the more numerous and widespread ones. This is closely tied to habitat loss, and is likely to be most acute among those species that are associated with specialised habitats or plant species that require traditional management, or that are being destroyed by widespread factors (eg drainage of wetlands). But even present ´pest` species are at risk in agricultural habitats with the intensive use of pesticides and insufficient or wrongly managed set-aside land (see Agriculture section of this document). Such losses will be unlikely to be detected in red data books, but may appear in changes in distributions of the species if monitored.

[How can we convince the public that even widespread invertebrate species are also at long term risk of becoming threatened?

Would a pan-European monitoring programme on just a few widespread invertebrate species (say 10) be worthwhile? These species could be associated with specific habitat types (wetlands, dead wood, agriculture abandonment, etc).

What should governments do? Persuade farmers, foresters and gardeners to use less pesticide? Add invertebrates to the botanical arguments to reduce use of herbicides?

What should protected area managers do?]

Monitoring invertebrate populations and distributions

Changes in the threat status of a species can only be efficiently assessed by monitoring changes in its numbers and in distribution over time. This is lacking at the international level for most invertebrate groups, and although a few European countries have good monitoring schemes, it is poorly performed, if at all in many others.

Even the invertebrate species listed in the Bern Convention and the EU Habitats Directive are not the subjects of efficient, coordinated monitoring in most countries.

[How can the level of monitoring of threatened invertebrate species be increased throughout Europe?

What computer databases of species distributions are available at national and international scales, and how can the information be integrated?

Is there any way to set up standardised monitoring schemes for international red list species across Europe?]

4. HABITAT CONSERVATION ISSUES

Habitat destruction is undoubtedly the greatest threat to invertebrate animals in Europe and indeed worldwide. Direct loss of habitat, habitat fragmentation, changes in land use and/or management are all detrimental to invertebrate survival and are all well known problems in conservation biology generally. To understand the complexity of how such human influences on the environment may affect invertebrate biodiversity particularly, it is necessary to take two different directions of thinking into account: First, how our understanding of ´habitat` has changed over recent years to become a quantitative, instead of merely descriptive, concept and second, the complex demands of habitat and resource use of most invertebrates, particularly those with complicated life cycles.

The idea of heterogeneity over a wide range of spatial (and temporal) scales is the essence of the habitat concept in its modern form. Different organisms perceive and exploit their environment at different scales and it is essential that this be taken into account in conservation management. Thus, when we think of a mosaic of different habitat patches at the scale of looking out of an aeroplane window – the eagle`s eye view of a woodland, a meadow, a lake – this is very different to the habitat mosaic relevant to, say, a beetle that exists within a few square metres, but which experiences equally heterogeneous patches of terrain at that scale (eg Haslett and Traugott, 2000). Within any such habitat mosaics, a variety of parameters become important to conservation, including the shape, size, content and edge complexity of the individual patches. All of these are relevant to how the different plants and animals exist and interact within the mosaics (eg, Haslett, 1994; Wiens, 1995). Recent technical advances in geographical information systems and remote sensing techniques make the practicalities of understanding and managing habitat mosaic dynamics much easier.

Together, all this means that a habitat is really a very complicated entity, and is certainly not simply a vegetational unit such as a ´woodland` or a ´meadow` *sensu* Wilson (1992). To conserve a habitat at the latter, simplistic level is not wrong (one has only to think of rain forest destruction in the tropics, or wetland drainage in Europe), but also requires conserving species, or groups of species, at different spatial scales, independently from any conservation of ´flagship` species that epitomise rarity on a Red List.

For invertebrates, there is a particularly important role of spatial scale in their conservation, because large numbers of species have a small body size, but are also extremely mobile (flying insects, for example). This means that they are required to use a wide range of scales in their daily existence. For example, a bee or a fly may crawl around on a single flower or leaf, or move between plants, or fly kilometres between habitats in a single day.

Umbrella or ´blanket` management and indicator species groups

One of the main problems with habitat conservation *per se* is the temptation to adopt a 'blanket protection' approach in which a particular habitat, or a group of habitats within an area, is managed at large, 'human' scales inappropriate for the majority of the species present and for the functioning of the system. This is true at a very general level, and specifically for invertebrate conservation when ´ranges of scales` that are different from our own perceptions are neglected.

To manage areas for the protection of large, or well known species that need large areas for living, in the expectation that this will automatically protect everything under the umbrella was fashionable in the 1980`s and 90`s, but is now considered unrealistic. It is still very easy to succumb to modifications of this way of thinking, including those that relate directly to the use of indicator groups of species for assessing biodiversity value. This creates a very real problem.

It is all too tempting to ´decide` that a particular taxonomic group or an accepted rare or endangered group of species should be used as overall indicators, and to advertise them as such. But there is a range of biological, practical and socio/political factors that make selection of indicator groups more complicated. Although public acceptance, rarity and even ease of recognition (identification) are all very important, full representation of the spectrum of ecological functional roles is essential. Thus it is necessary to find groups of invertebrates that are not only good-looking and famous, but that can also do everything, from eat meat to be vegetarian to get rid of the waste!

[One way forward here may to be to develop and apply the use of known species distributions, biologies and habitat associations, made available on computer, as recently documented for European hoverflies (Diptera: Syrphidae) (Speight & Castella, 2001). Expansion of this, or development of similar methodologies would provide a sound basis for selection of invertebrate indicator groups for biodiversity value areas.]

Important areas for invertebrate protection

In recent years there has been a move to define and formally establish areas of habitat, of variable size, that are recognised to be of priority importance for specific groups of organisms at the European level, irrespective of any formal protection status. Programmes for identifying and managing Important Bird Areas, Important Plant Areas and Prime Butterfly Areas across Europe exist and flourish. All such initiatives aim to conserve their own particular aspects of biodiversity, and are beginning to achieve this aim. All also benefit from significant public interest in the groups of organisms concerned, which lends considerable backing and provides a strong lobby in political circles.

Invertebrates are an important cross-cutting issue in this set of initiatives. They are important in the identification and management of important areas of *any* type of organism because of their dominance in both ecosystem function and their contribution to species diversity.

As a very high proportion of invertebrates are so closely associated with plants, or provide essential nourishment for birds, they again have a pivotal role in habitat conservation and management.

Because of this overall importance in all types of habitat it would seem pointless, indeed confusing, to try to try to establish a system of ´Important Invertebrate Areas` or similar as an extra European initiative.

[Instead, it is essential to find out the extent to which plant areas, bird areas and now also butterfly areas (Van Swaay & Warren, 2003) overlap with the geographical areas and management needs of invertebrate habitats/sites in general.

So, no new invertebrate areas,- but how can invertebrates benefit, and existing important area schemes be enhanced, by taking more notice of invertebrates and their functional roles in different habitats and ecosystems]

This integrative approach to invertebrate habitat conservation will require international manpower and financial backing, but would greatly save on the ´doubling up` characteristics of uncoordinated conservation effort between organism groups.

The above brings attention to a new major stumbling block – how to decide which areas of Europe, large or small, are important for the protection of invertebrates? There are simply too many invertebrate species to attempt to make area appraisals taxonomically universal, so indicator groups must be sought, tested and engaged.

[Establish a palette of ´indicator groups` of invertebrates that reflect the biodiversity and the full range of ecological functions of the existing fauna. This to supplement existing ´rare` species indicators already in use. Is this realistic? How could it be achieved?

What types of research projects are necessary to establish the degree of correlation between invertebrate protection using invertebrate indicator groups and established important area schemes for other organisms?

Are there other areas or types of habitat that are of particular importance to invertebrates? Are these being reduced and if so how fast and why?]

Protected Areas - policy and networks

Effective area-based conservation requires adequate government policies on protected areas. Every country in Europe has a system of protected areas, many long-established, but integration and harmonisation of policies is relatively new. The first ever pan-European strategy for an adequate, effective and appropriately managed network of protected areas in Europe was developed by IUCN in 1994 in their *Parks for Life*. Implementation was taken over by IUCN`s World Commission on Protected Areas (WCPA) in close collaboration with the EUROPARC Federation. Despite considerable interest, little was achieved initially, to the extent that IUCN held a WCPA European Members meeting in 2002 to review the situation of protected areas in Europe. A strong marketing approach and clear audits of management efficiency were identified as two important ingredients for improving conservation in protected areas, and appropriate initiatives are being put in place. IUCN categorises protected areas by management category, with six categories defined with increasing levels of intervention.

[How can the full range of IUCN protected area categories be best employed in the conservation of invertebrates and their habitats?]

Conservation areas need to form a vast interconnected network across Europe, rather than be thought of in isolation. The initiatives of Natura 2000, The Emerald Network, World Heritage Sites, Ramsar Sites and designations of protected areas that are not legally binding are doing much to define the size and extent of the network, and ecological corridors are generally considered to be very important to achieve the linkages. However, for invertebrates, there is concern that the spatial and temporal scales appropriate to the animals impose restrictions to corridor efficiency; promotion of directional movement of individuals may be much less than expected (eg Haslett and Traugott, 2000).

[How is it possible to better understand and improve the efficiency of ecological corridors for invertebrates across Europe`s protected areas? A colloquium of the European Invertebrate Survey exposed the problem in 1999, but no solutions have been found].

5. SECTORAL POLICY

The future success of invertebrate conservation is dependent upon many factors. Scientists may continue to lobby politicians to save threatened species and to establish and appropriately (?) manage nature reserves. But behind all this lies the world of economics. Biodiversity conservation depends upon having friendly policies in key sectors of the economy, including agriculture, forestry, industry and town and country land planning, including transport. Most invertebrate biodiversity occurs outside the areas that are designated for their protection, so sectoral policy is paramount. However there is a need to be realistic: Issues of agricultural policy and transport are areas in which conservation is only one of many voices. The role for invertebrate conservation is, just like plants, one of lobbying and advertising rather than delivering on specific targets.

[Why have the botanists been so much more successful than invertebrate zoologists in lobbying and gaining support at European and global levels – this is a major issue to be analysed].

Economy sectors such as agriculture and forestry are seen as major threats to nature, a view that is well justified. The decline in biodiversity – invertebrates, plants and many others – was unprecedented, is unrelenting and is continuing to increase. But now there is the important realisation that it is possible to design policies that will be of short as well as long term benefit to the economy and peoples` livelihoods, without devastating nature at the same time. The time is ripe to focus on new opportunities, it is presently ´easier` for politicians to give more priority to the environment, but only if they are pushed hard enough to do so!

Strategic planning on biodiversity at national and international levels is essential to ensure that the damage caused by these powerful sectors to invertebrates, plants and other organisms is kept to a minimum, and new opportunities for win-win solutions developed.

Agriculture

Agriculture has a massive effect on invertebrates and their habitats. Farming accounts for 60% of the land surface of the European Union and of Central and Eastern Europe (Planta Europa, 2002), though the proportion is much less in Scandinavia and northern Russia where forestry predominates. Most modern farming practices have proved deeply harmful to nature and the landscape in general, including invertebrate diversity. To raise output, numerous rare habitats have been destroyed, particularly by drainage of wetlands and irrigation of drylands. The effects of intensive use of pesticides, fertilizers and herbicides damage farms and spill over to neighbouring land.

Some farmland is of intrinsic conservation value as its flora, fauna and landscape depends on the continuation of low intensity, often traditional farming practices (eg mountain agroecosystems). Abandonment of this kind of farming is perhaps one of the greatest causes of loss of hitherto common invertebrate animals and plants in Europe. Invertebrate and plant communities flourish best where pesticides and herbicides are not used, where fertilizers are used in moderation or not at all, and where land is undrained. When the present older generation of farmers dies, the sons and daughters will not be around to continue the struggle for the traditional existence – most prefer to seek other careers. This, in turn, causes local depopulation and the abandonment of the farming landscape mosaic which is often of high biodiversity value. The landscape undergoes detrimental successional change towards woodland because of the lack of traditional management.

The introduction of genetically modified (GM) crops

The introduction of GM crops To Europe has been hugely controversial. In general, European citizens and governments have taken a much more precautionary approach than the United States, the origin of most GM crop plants. In Europe, unlike North America, natural areas are very close to and integrated with farmland, rather than thousands of kilometers apart. Thus there is deep concern over release of GM crops into wild ecosystems. Although usually discussed in relation to the effects on other plants, the potential effects of GM plants on invertebrate pollinators and herbivores are also relevant.

[What are the true implications of genetically manipulated (GM) crops for invertebrates?

What practical things can zoologists and conservation bodies do about this issue?]

Agricultural policy of the European Union

The common Agricultural Policy (CAP) of the European Union is of decisive importance within the EU and increasingly in the accession states. EU policy also has a great effect on non-EU states through its effect on farm prices and through its assistance programmes.

The view that farming and nature conservation can be compatible is not being put across in many places. Farmers often resent being told by the authorities what they should do on their own land, and their short times for relaxation are often used up by filling in forms. The payment of subsidies to farmers is often not enough to curb this resentment.

Now, the CAP is under reform, and it appears that some money is being removed from subsidies. It is imperative that this money should be used for conservation purposes in agroecosystems. Financial support for set-aside land would probably be one of the top priorities.

[Can we tie our demands to timetables and targets already set in the reform package?

Can zoologists do more to provide data on decline of invertebrate species in farmland and be more active in the conservation networks lobbying for agricultural change?

Can zoologists work directly with individual farmers to help them reduce the damage to invertebrate communities on their land?

What can we do to promote organic farming, which is usually far more friendly to invertebrates (and plants) than non-organic approaches?

How can we ensure that money removed from subsidies be used to support set-aside conservation land?]

Forestry

About 46% of Europe is forested (Planta Europa, 2002) but the proportion of forested land varies greatly from one country to another - from about 1% closed forest in Iceland to 60% in Finland. The extent of forest in Europe is increasing as marginal land is abandoned and reverts to scrub and woodland. Moreover, there is now a great trend to plant trees rather than let trees regenerate naturally in the landscape as before.

Much of the forest land is intensively managed, often for non-native and/or coniferous species in plantations, and the homogenous crop of trees that results is of little biodiversity value. Lack of rotting dead wood in the forest removes the habitat for the whole spectrum of saproxylic invertebrates, many of which are rare and which maintain the essential ecosystem function of recycling (Speight, 1989). Lack of even small patches of open habitats also removes the heterogeneity of the habitat mosaic necessary for the survival of many invertebrate species, particularly those that have complex life cycles and occupy a number of different ´partial niches`. Out of this vast area of forest, only small isolated fragments of truly natural forest survive, mostly in Fenno-Scandia and South East Europe. These are of the greatest value for invertebrates, especially for the saproxylic species.

Forest management differs greatly across Europe. In the Atlantic seaboard countries with little remaining forest, afforestation on moorlands, heathlands, raised bogs and other valuable habitats has been a major threat to biodiversity. In Scandinavia and France, most natural and semi-natural woodlands have been converted to more intensive production forests. In the Mediterranean region, forest fires and grazing continue to devastate forests. In Central and Eastern Europe, forests have suffered particularly from air pollution, as well as from conversion to monocultures.

However, there are some welcome trends. In Scandinavia, there has a surprisingly sudden shift in the forestry sector towards more conservation-minded practices. Other countries, especially in Central Europe, have long-standing traditions of ecologically beneficial forest management.

[How can we best latch onto the various intergovernmental commitments and processes on forests, such as the Ministerial Conference on the Protection of Forests in Europe and its associated Pan-European Work Programme?

What can we do to ensure that afforestation does not occur on land of high value for invertebrates and that foresters adopt more multiple use policies in all forestry operations?

What can be done to promote more sustainable forestry practices?

What should be the policy on fire be in Mediterranean forests?

.What can we do for saproxylic invertebrates in the forestry agenda?]

Town and country planning

Land-use planning is particularly important in Europe because of the great pressures on the land for agriculture, industry and other uses. Some countries have strong traditions of planning, resulting in a firm delineation between town and country, whereas others have a relaxed approach, often with devastating visual and ecological effect. Even where countries have effective land-use planning systems in place, implementation can be difficult and is often jeopardized by strong political and other pressures.

In towns and cities, the planning framework can encourage an invertebrate-rich environment by emphasizing the need for human settlements to be part of the balance of nature.

For nocturnal invertebrates, particularly night-flying insects, there is a new and important threat from the increasing levels of lighting in towns and also in the countryside. This is becoming particularly significant in cases of advertising or commercial light shows that take place in otherwise near natural areas.

[How can we influence planning processes, indeed should we try to do so?

How can we safeguard key invertebrate sites from damaging planning decisions?

How can we draw attention to the problems of light pollution?

The development of ski facilities has become a major threat to mountain invertebrate communities (eg Haslett, 1991) which has now spread to the Mediterranean countries. How can this be halted and reversed?]

Industry

Industry has two main impacts on invertebrate diversity and abundance: damage from pollution, (which may also induce melanism in some species) and direct physical damage to the landscape by using space for buildings or for mining and other extractive industries.

Invertebrates may be directly poisoned by industrial pollutants or, more commonly in terrestrial environments, affected by the ill health of the vegetation. The European Commission's annual 2000 report on Europe's trees concluded that only a third of Europe's trees are healthy. It found an improvement in western and central countries but a deterioration in the Mediterranean region, where defoliation of nearly all tree species has increased considerably. Pollution is the cause. The implications for invertebrates that rely on the trees for food or living space are clear.

Protected areas and important invertebrate sites may coincide with areas that could be used for mining and other extractive industries. Modern Europe has an insatiable appetite for aggregate for roads and limestone for concrete and cement. This is especially true at present in southern Europe, where large areas of the landscape are scarred by mining operations. Inevitably some of the limestone hillsides being removed had rich invertebrate biodiversity. Substrates rich in minerals are naturally attractive to the mining industry but usually support a unique and endemic fauna and flora.

[Is there anything we can do more than react to individual proposals from industrial firms?]

Transport

Transport, especially road transport, has an increasing impact on natural habitats. Many of the most contentious issues in conservation over the last decades have been over road schemes, which, by avoiding towns and villages, all too often are plotted like a line joining up one natural area to another. Increasingly, too, the new high-speed railways are devastating to landscapes because of their need for new track alignments that are level and straight. Often, the damage done to natural sites, and especially protected areas, is ignored or under-estimated in the planning of transport infrastructure.

[How can we make sure key invertebrate sites are not damaged by such schemes?

More directly, how significant is the cull of flying insects that occurs as a result of collisions with windscreens and radiator grills etc, particularly in areas of known importance to invertebrate conservation?]

6. CAPACITY BUILDING

It has often been remarked that invertebrate conservation suffers from a lack of invertebrate conservers. Whereas a large number of people in the environmental and zoological community support and assist invertebrate conservation, there are very few people whose jobs are actually to conserve invertebrate animals. This is a major stumbling block.

Invertebrate conservation requires people with a wide range of skills. Above all, it needs practitioners - people who will actually go out and achieve invertebrate conservation, rather than just advise or assist in it. Of all aspects of the environmental protection, invertebrate conservation seems to most lack adequate ´front-line troops`!.

[Might a first and urgent step be to find out the level of invertebrate conservation expertise across the region, as a sort of capacity audit?]

Invertebrate conservation institutions

There are relatively few institutions created specifically for invertebrate conservation. However, many conservation agencies include staff zoologists and/or zoological teams, who are charged with providing an invertebrate input into conservation activity. This has the advantage of integrating invertebrate conservation with other functions but the disadvantage that invertebrates rarely, if ever, receive the attention they need.

[In each country, would an NGO for invertebrate conservation be appropriate, either or both as a cost-effective mechanism to deliver government-funded conservation work and/or as a campaigning force?

Do the official conservation agencies in each country have sufficient invertebrate expertise and involvement to make sure invertebrates receive the attention they deserve?

Scientific capacity

Capacity is also uneven in the science of invertebrate zoology. The former communist countries often had large biological infrastructures and supported traditional zoology, but these departments are now deeply weakened by lack of resources and funds. Across Europe, few universities now have zoology departments, which have been replaced by institutes focussed on biotechnology or molecular biology. This is a tragedy for biodiversity conservation as the expertise to identify and classify animals (and plants) is disappearing at precisely the time that governments are waking up to the vital importance of biodiversity conservation, which all acknowledge cannot be delivered without that expertise.

Recently, a strong case has been made for ensuring that conservation decisions are ´edvidence based`, in other words, that conservation management decisions should be made on the basis of scientific evidence, rather than on feelings or previous experience of experts (Sutherland et al, 2004). This idea promotes the exchange of known information between workers, and exposes the difficulties of computer database incompatibilities!

However, arguing for more science *per se* can be a dangerous ploy in that it gives an argument to opponents who can then say that necessary conservation action should be postponed until the science is complete - a point which they know all too well never happens. Therefore all arguments for more science to underpin invertebrate conservation should guard against this actuality by making the point that most of the key actions needed for invertebrate conservation do not depend on more science being undertaken. And the precautionary principle can also be invoked.

Science has been mentioned in many places in the previous sections but there are two scientific disciplines that receive special mention here:

Taxonomy

It is ironic that just as governments are accepting biodiversity conservation as a valid political goal of rising public interest, taxonomy, the science that provides the basis for identifying species, in in deep decline in much of Europe, especially Western countries. Many eminent scientists have written countless erudite reports on the problem but little is done. And in the absence of a strong framework for invertebrate taxonomy, taxonomic approaches from one country to another are diverging, making the essential continent-wide synthesis more rather than less difficult.

The problems of identifying invertebrate species are very familiar to all workers in the field. Without a high level of specialist knowledge it is often impossible to know which species are present in an area, or how common or rare they are. Species new to science continue to be described frequently. Even apparently ´well known` groups such as butterflies suffer from the problem of requiring expert opinion for the correct identification of certain ´problem` groups of species. Of course, this is not a difficulty unique to the invertebrates, but it is significantly more widespread and intense in many invertebrate animal orders and families than for other organisms. Unfortunately, such experts are themselves now a very `rare species´ and the threats to taxonomist extinction are severe and increasing. It is of utmost importance to invertebrate conservation in Europe that sufficient numbers of competent taxonomic experts continue to be trained and provided with places of employment at high scientific levels. The work of these experts underpins the entire invertebrate conservation effort. Knowledge of which species are present is prerequisite to their protection!

Present governmental policy throughout Europe does not appear to regard invertebrate species identification as a valid enterprise in modern biodiversity conservation. There is little or no support for the future career of an invertebrate expert who can identify species efficiently in the field or back in the laboratory. Some European countries still have a small core of such ´traditional` invertebrate zoologists that continue to undertake the essential work, but most are either old and retired, or are young and full of enthusiasm but accept short term, inexpensive projects with little hope of full time employment in their field.

[What might make taxonomy more attractive again, to both students wishing to make it a career, and funding agencies, and start a taxonomy revival?

How can taxonomic approaches be standardised across Europe?]

Funding

Funding is a frequent stumbling block for invertebrate conservation, which lacks the high profile and better political awareness of more prominent organisms and/or parts of the environmental agenda. Lack of funding has been particularly acute in developing international cooperation for invertebrate conservation, such as in the development of the European Invertebrate Survey (EIS).

Invertebrate conservation will only succeed if new and enlarged sources of funding are found. These will have to come in two ways. First, from increased funding by existing donors and supporters, such as the funding provided by government to its conservation agencies. Political will, fuelled by public attitudes, is the main driving force here.

But funding will also have to come from new and innovative mechanisms, such as trust funds, charitable events, sale of produce and the like. In doing this successfully a high public profile is greatly desirable. Awareness about the needs of invertebrate conservation is the crucial driving force.

[How can we help revere this situation? How can we persuade international funding bodies to look upon the needs of invertebrate conservation more favourably?]

Education and awareness

Environmental education is a relatively new discipline, but it is growing in importance as people realize the seriousness of biodiversity loss. The imperative of education is stressed in all major international conservation strategies, including the CBD and Agenda 21. There is a clear call for environmental education to train and promote environmentally responsible citizens. People need to understand ecological systems in order to make the best decision on natural resource use.

[How can we achieve public acceptance of the importance of invertebrate animals to the well-being of the world and ourselves.

How can we influence the curricula of what is being taught in schools?

How do we make creepy-crawlies more interesting on television and in magazines?

Could we involve the arts, and people so inclined, such as poets, writers, artists, to help make the case for invertebrates?]

International cooperation

In an increasingly interdependent world and in a region where more and more nations are conceding their sovereignty to agreeing action in a multilateral framework, whether it be the European Union, the Council of Europe or the CBD process, international cooperation is of central and growing importance.

Zoology has always been an international science, but cooperation on animal conservation, especially of invertebrate animals, is relatively new. Yet at both governmental and non-governmental level, international cooperation has become ever more complex, in part due to the complexity of the various policy initiatives and in part due to a splintering of organizations into smaller components. A process of integration is needed, to harmonize disparate policy instruments that have similar goals and to bring together as partners organizations that have common goals.

[All this sounds good, but what needs to be done, and what can invertebrate conservationists do?]

7. INVERTEBRATE CONSERVATION AND GLOBAL CHANGE

Climate change is a reality. Plants and photosynthesis are directly affected by the increase in carbon dioxide concentration in the atmosphere, which also directly affects all invertebrates associated with the vegetation. Clmate change also has important direct effects on the sets of abiotic conditions that organisms experience. in any particular place: climate or microclimate as relevant at any particular spatial scale.

Much has been written about biodiversity and climate change in the scirentific literature. One major fact comes forward in relation to invertebrates: individuals are mobile, albeit at different speeds and over different ranges. This means that in situations of change, it is not so much the mathematical average of the change that is important, but more the variance of that average – the liklihood of an extreme situation. Invertebrate populations may be decimated by exposure to an extremely cold winter, hot summer, unexpectedly long period of drought or of flood much more than geographical averages. The degree of mobility of the organisms is an index of their chance of actively escaping the climatic event, a situation very different from most plants, that can only stay rooted and weather the storm, or send propagules for the next generation.

The Kyoto agreement is only one of a number of political instruments that has focussed recent attention on climatic change from human influences, and the subject is now high on the political agenda. The repercussions go well beyond invertebrate conservation.

[What is the impact of global climate change on European invertebrate faunas?

How does climate change affect invertebrate/plant interactions?

How will climate change affect the problems associated with invasive species?

What can be done by invertebrate zoologists to reduce the problems associated with global warming?]

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Appendix 4

RECOMMENDATION NO. R (86) 10

OF THE COMMITTEE OF MINISTERS TO MEMBER STATES

CONCERNING THE CHARTER ON INVERTEBRATES

(adopted by the Committee of Ministers on 19 June 1986 at the 398th meeting of the Ministers'Deputies)

The Committee of Ministers, under the terms of Article 15.*b* of the Statute of the Council of Europe,

Considering that the aim of the Council of Europe is to achieve a greater unity between its members;

Having regard to the resolutions of the European Ministerial Conferences on the Environment;

Considering the recommendations by the Committee of Ministers of the Council of Europe and particularly the one related to the reintroduction of wild indigenous species (No. R (85) 15);

Considering that the diversity of wildlife is essential to the maintenance of the biological balance of the biosphere and that invertebrates here play a vital role;

Considering that the too-often harmful effects of human activity on the environment in Europe as elsewhere in the world urge us to revise our relationships with nature and demand severe controls on such activity with the aim of avoiding damage or reducing it to a minimum;

Considering that concerted action at an international level is necessary, because plant and animal life, primary productivity – plant – and secondary productivity – animal – depend directly and indirectly on the existence of a diversified invertebrate fauna and that, in consequence, the perenniality of its existence is essential to the survival of mankind,

Recommends to the governments of the member states that, when drawing up their management policies for the natural environment, they should take account of the appended charter.

Appendix to Recommendation No. R (86) 10
Charter on Invertebrates

1. Invertebrates are the most important component of wild fauna, both in number of species and biomass

The number of scientifically identified invertebrate species in the world is well in excess of a million, whereas there are only some 51 000 species of vertebrates. In Europe the invertebrate fauna can be put at between 150 000 and 200 000 species, while the vertebrate fauna includes 902 species.

Invertebrates comprise microscopic protozoa (25 000 species), worms (20 000), molluscs (over 100 000), arthropoda (925 000 known species), which include spiders (34 000), crustaceans (25 000), myriapoda (10 000) and insects (approximately 850 000).

However, it is now believed that the tropical arthropod group alone may in reality consist of at least 30 millions species (including 22 million insect species) or 600 times the total number of vertebrate species. Every year science discovers and describes 15 000 to 20 000 new species of invertebrates.

The greatest animal production (biomass) can be ascribed to soil invertebrates; in Europe it may be as much as one tonne per hectare, well in excess of the average biomass of wild vertebrates. This is an enormous potential of which man knows and uses only a tiny part, but, on the other hand, destroys to a large extent.

To these terrestrial invertebrates may be added the biomasses of flying invertebrates, which may exceed 100 kg per hectare in a temperate European forest zone, and marine invertebrates whose quantity defies calculation, between 9 and 10 million tonnes of which are fished every year for human food (molluscs and crustaceans).

These huge quantities of invertebrate biomass consist largely of species which degrade and mineralise primary (plant) and secondary (animal) organic matter, putting it back into circulation for biological use.

2. Invertebrates are an important source of food for animals

Terrestrial and aquatic invertebrates are the principal source of food for large groups of vertebrates, including many species of fish, amphibians, reptiles, birds and mammals.

They are therefore a basic element in the food chains and networks which underlie the general balance of nature. Their existence and full development are essential for the overall biological equilibrium.

3. Invertebrates may also constitute a source of food for mankind

Particularly in tropical regions, arthropoda and other invertebrates may constitute a large direct food reserve for man, either in normal times or, especially, in case of shortage. Marine and freshwater crustaceans (crabs, lobsters, crayfish, etc.), marine molluscs (mussels, oysters, clams, octopus, cuttlefish, etc.) and terrestrial molluscs (snails) are universally employed as foodstuffs and sustain considerable farming, harvesting and commercial activity.

Termites, grasshoppers, the larvae of wood beetles and butterflies, spiders of the Mygale family, etc. are invertebrates widely used for human consumption in four continents. Honey, which is produced by insects, is also fo great importance as a foodstuff.

4. Invertebrates are vital to the fertility and formation of the soil, and to the fertilisation and production of the vast majority of cultivated plants

In both temperate zones and tropical climates invertebrates are preponderant among terrestrial fauna and are vital to the formation of the soil and humus and to keeping them fertile; invertebrates which bury the carcasses of small animals help in both this and the cleansing of the environment.

Approximately 80 % of plants cultivated for the production of fruit and vegetables, textile fibres, medicinal preparations and various other things are fertilised via invertebrates (especially by bees, but also by many other pollen-bearing insects).

Furthermore, invertebrates are one of the crucial factors in plant productivity, through their physical action on soil or their elimination of processes which restrict soil productivity.

For instance, the effect of earthworms on the soil stimulates grass growth, which is necessary for conserving the soil, rearing domestic animals and preserving wild fauna: transplanting them from Europe to Australia has improved the production of grassland and boosted stockbreeding results. Dung beetles break up and consume the excrement of wild and domestic mammals, which would otherwise form a layer, choking the soil and slowing down production.

Coral reefs and atolls are formed from invertebrates, and their importance for humanity cannot be overlooked.

Since invertebrates encourage vegetation, they are of irreplaceable benefit to all agriculture, forestry and animal husbandry and enhance the richness and variety of wild fauna, soil conservation and the beauty of the landscape, the regulation of water systems, atmosphere purity and the fitness of the environment for habitation.

5. Invertebrates are useful in protecting farming, forestry, animal husbandry, human health and water purity

Biological pest control, which exploits natural patterns of competition between living organisms, is an effective system of defence for limiting damage by harmful animals and plants. For instance, red wood ants, which prey on tree-damaging insects, protect forests and can be mass-produced and transplanted for the purpose of such protection. In Europe, they destroy 700 000 tonnes of forest insects, the majority of which are harmful.

The minute insect *Prospaltella berlesei*, introduced into Europe to act as a control against the *Diaspis pentagona* ladybird, which destroyed the mulberry tree and accordingly spelt the end of silkworm breeding, has wiped out the *Diaspis* and saved the silk industry.

The undisturbed presence of invertebrates is fundamental for preserving the purity of surface and groundwaters.

6. Invertebrates are valuable aids for medicine, industry and crafts

Invertebrates may be the source of medicinal preparations; in this respect they are still a poorly known and under-exploited resource. There is, for instance, the European coleoptera *Paederus fuscipes*, which produces pederin, a substance used successfully in homepathic doses in the treatment of ulcers, or bee toxin used in articular diseases, royal jelly, manna, and the use of such invertebrates as leeches in certain medical therapy.

Many species play an important part in industry and crafts: silk and beeswax; earthworms and other species used in agriculture and for fishing, or as protein in fish-farming; pearls, coral, mother-of-pearl, etc. for the manufacture of jewellery and trinkets; the fishing and harvesting of natural sponges, etc. Invertebrates are also highly sensitive indicators of environmental quality.

7. Many invertebrates are of great aesthetic value

Butterflies and dragonflies are very often taken as symbols of beauty and many other invertebrates are of great aesthetic value.

The large number of species and their great morphological variation make invertebrates a major source of inspiration for both ordinary people and artists.

8. Some invertebrates may harm human activities but their populations may be controlled naturally by other invertebrates

Periodic pullulations of certain species of plant-eating invertebrates, especially defoliator insects, may result in major damage to crops and forests; in addition, the harmfulness of certain invertebrates as parasites and in the transmission of diseases to man, domestic animals and cultivated plants is recognised and justifies measures for the defence of human interests.

However, such measures can be implemented in such a way as to respect as far as possible the integrity of the environment and of its plant, animal and human components.

98 % of the arthropoda potentially harmful in the above-mentioned areas are in fact kept under control by other arthropoda which are their predators or parasites, permanent, free and non-polluting natural factors in biological equilibria and biological pest control. The following are examples: Ladybirds destroy plant lice, and cochineals, which are immensely harmful to agricultural crops. Coleoptera of the *Calosoma* species are an effective brake on the pullulation of lepidoptera which defoliate forests in Europe. Certain species of microhymenoptera protect the olive tree from *Dacus oleae* diptera, which is a parasite of such trees in the Mediterranean region.

9. Mankind can benefit greatly from enhanced knowledge of invertebrates

In the field of biology, medicine, chemistry, physics, and so on, invertebrates lend themselves to research in aquatic, terrestrial and aerial environments both on and in animals and plants, and to educational operations; they have remarkable possibilities for adaptation, sensibilisation and reaction; they may often be easily bred to great quantities and they have little bulk. These qualities have encouraged basic research, experiments and their practical applications and will enable new research to be conducted on a vast scale.

In particular, the known successes achieved by the use of invertebrates to control harmful animals and plants biologically hold out the greatest hopes of further achievements, and research in this field should be encouraged, promoted and given every support.

It is also worth noting the case of cave-dwelling animals and their importance when it comes to studying changes in climate and fauna in the different continents, such animals being genuine examples of live fossils.

10. Terrestrial, aquatic and aerial invertebrates should be protected from possible causes of damage, impairment or destruction

Invertebrates provide humanity with important irreplaceable sources of food, work and welfare. Their presence must therefore be protected and preserved from all causes of damage or destruction or must be promoted by development, that is, by the reintroduction of suitable species according to the principles approved by the Council of Europe.

The natural fauna of invertebrates is diminishing continually and many species have either disappeared or are in the process of disappearance because of man’s action, without man even having been aware of their existence or having studied their characteristics and possible uses.

As the equatorial forests are destroyed at an estimated rate of 30 hectares per minute (160 000 km² per annum), without being replaced, millions of animal species are doomed. In temperate zones too, owing to urbanisation and other action with a disturbing effect on the land (fertilisers, agriculture, monoculture, consolidation and division of land holdings, deforestation, fires, hydrographical changes, insecticides, weedkillers, pollution, etc.), the wild fauna of invertebrates is constantly dwindling and is in danger of extinction. A single example suffices: 96 species of butterflies are threatened with extinction out of a total of 380 European species. This situation calls for urgent protective measures.

Places where the fauna of invertebrates is threatened, or is of interest for other reasons, should be protected, because species cannot survive unless their habitats and environment are preserved. A considerable proportion of the conservation measures to be taken will therefore relate to the establishment of nature reserves (primitive forests with specific fauna, wetlands where threatened insect species are found, etc.); areas constituting the habitats of a fauna of invertebrates unique in Europe will have to be given special priority.

In the fields of spatial planning, urban development, agriculture, forestry, animal husbandry, health, industry, trade and recreation, methods of intervention should be devised which interfere as little as possible with the environment in order to spare wildlife, including invertebrates.

In the fight against invertebrates which are prejudicial to human interests, preference should be given wherever possible to systems of biological control based on natural patterns. Other, that is, chemical or physical types of intervention must be reduced to a minimum, practised as selectively as possible and entail the adoption of methods which are strictly and solely aimed at the target agent and have short-lived effects. Where invertebrates have been exterminated, they should be reintroduced in accordance with the approved principles for the reintroduction of species. In view of their practical value to mankind, research on invertebrates in all branches of science must be encouraged.

No animal or plant species must be allowed to disappear because of man’s activities.