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EDITORIAL

Diversitas: the National Dimension

One important issue at the forthcoming General Assembly of IUBS next September, will be to review the progress made in the implementation of Diversitas, the major IUBS programme on Biological Diversity and to decide upon its future course.

In reviewing Diversitas, it is important to recall the very complex situation in which this programme developed. Indeed, it took five years from the original proposal made by the US Committee for IUBS following the 1985 Budapest General Assembly to the formal adoption at the 1991 Assembly in Amsterdam of the IUBS scientific programme on biological diversity. It was decided that the ecological function of biodiversity, its origins, maintenance and loss, its variability in space and time, and the diversity of ancestors of domesticated species would be addressed. This same period saw the upsurge of biodiversity as a key issue in the world debate for environment and development. The adoption of the "Convention on Biological Diversity" at the Rio Summit, in 1992, and the potential connection between biodiversity and biotechnology resulted in a situation where almost every international institution was trying to launch something in the area of biological diversity. This situation presented a number of constraints and difficulties as well as opportunities. Indeed, the convergent interests of IUBS and SCOPE, and later on, those of UNESCO made it possible for Diversitas to be developed as an international collaborative programme on biological diversity.

However, the development of the various Diversitas themes did not follow either the same pattern nor at the same speed. Many reasons can be invoked: the different nature of each of the themes, the political and financial implications of their implementation, and last but not the least important, individual contingencies.

The theme "Ecosystem Function of Biodiversity", which was initially proposed as the central theme for the programme, proved to be the easiest one to execute. Its main goal in this first phase was to produce a 'state of the art' on the ecological function of biodiversity. Indeed, the series of meetings organised since 1991 resulted in a number of very interesting openings, leading to the design of an experimental research programme, to be developed in cooperation with the component on ecological complexity of the Global Change Programme (IGBP).

The second theme "Origins, Maintenance and Loss of Biodiversity" aims at giving a more unitary view of biodiversity. Its main concern is the basic understanding of the unity of biology through diversity, from genes to landscapes. Also, addressing clear questions related to the study of genetic variation, speciation, and life history parameters, as well as extinction processes and their modelling is essential from an applied point of view to agriculture and breeders. In dealing with this theme, the major constraint is of cultural origin. The scientific community in this particular area is mainly composed of individuals, working separately in their laboratories, and are finding it difficult to become interested in a more integrated approach. Moreover, most of the work hypotheses are set on the basic concept of equilibnum. But we know now that ecosystems, as well as most other systems, are non-linear, dynamic and complex systems, and their study requires new conceptual tools.

This theme, together with the previous one on the ecological and biological complexity, almost completely encompass the raison d'être of IUBS.
The third theme on "Inventorying and Monitoring" deals with the changes of biodiversity over space and time. A successful development of this theme requires the establishment of a network of individuals, institutions and sites, representative of the world biomes, and for monitoring to obtain institutional commitment to secure long-term observations.

The main responsibility for committing such institutions and sites lies at the national level. Having neither the necessary funds nor the human resources, the IUBS has no intention of running such an international network for monitoring and inventorying. The main function of the Union is to develop the conceptual framework and the scientific (taxonomic, ecological and methodological) rationale that are needed for a sound and efficient implementation of national programmes, and to provide an international forum and help facilitate the countries coming together.

It is with great satisfaction that we saw a number of countries using the Diversitas model to launch national biodiversity programmes. The present issue of Biology International contains brief reports and information notes on the national programmes and initiatives in France, China, Russia and Hungary. Also, one Special Issue (No 28, 1993) has been devoted to "Symbiosphere: Ecological Complexity for Promoting Biodiversity", a research project coordinated by the Center for Ecological Research, at Kyoto University, in Japan. And more reports of national programmes will be included in the future issues of Biology International.

In parallel with national initiatives, two proposals were made to establish in connection with Diversitas an "Ibero-American Network for Biodiversity" and a "Diversitas West Pacific Asia Network".

Furthermore, the ICSU General Assembly, held October 1993, in Santiago, Chile, made a resolution in support of Diversitas, and the ICSU brochure "Understanding our Own Planet: an Overview of Major International Scientific Activities" clearly stated the recognition of Diversitas as a joint inter-union endeavour on biodiversity, parallel to the other ICSU major initiatives, namely, the World Climate Research Programme (WCRP), Global Change Programme (IGBP) and Human Dimension of Global Change (HDP).

With these new developments, the IUBS now has an increasing demand for assistance and counsel, in order to provide clear and concrete answers to the many questions related to biodiversity conservation and management. We believe that the International Forum "Biodiversity: Science and Development- Towards a New Partnership" organised by the IUBS jointly with its 25th General Assembly, on 5-9 September 1994, at UNESCO Headquarters in Paris, will help answer these questions.

Talal Younès
Executive Director, IUBS
How to Measure Arthropod Diversity in a Tropical Rainforest

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Introduction

The number of minute and obscurely-colored beetles is exceedingly great. It is sufficient to disturb the composure of an entomologist's mind, to look forward to the future dimensions of a complete catalogue.


Biologists refer to the global number of species as the "grail number" (May 1992), the quest for which will greatly improve our understanding of diversity patterns on earth. To begin the quest, we face the first and largest challenge: species are not pennies. A machine can be designed to count 30 million pennies, but counting 30 million species is different. The world is filled with individual organisms that are distributed in various ways into an unknown number of species. To count species you have to observe individuals, and for each one ask "Have I seen this species before?" The human capacity to remember distinct objects, though impressive, is limited. Most useful taxonomies that humans have devised have fewer than 1000 taxa (Raven et al., 1971). A person who can identify at a glance any of the more than 700 tree species native to the United States and Canada is truly exceptional. A person with a passion for birds and many years of experience can come to know the approximately 1500 species of birds in Colombia.

The second challenge is that species are not equally abundant. Abundance of species are spatially and temporally variable. Some species are very abundant, some are very rare, and the rest are in-between. Relative abundance relationships may change over time, and as one travels from place to place.

My colleagues and I have started a quest for the "grail number" by focusing on the arthropods of a small patch of tropical rainforest. We have chosen arthropods because they are a vast and largely unexplored pool of species. "To a rough approximation... all organisms are insects" (May, 1988). We have chosen tropical rainforest because that is where the number of species is highest and knowledge is lowest. The purpose of this report is to describe the traditional approaches that two usually separate disciplines, systematics and community ecology, use to count species, and how we plan to combine them to answer "How many species of arthropods are there in a lowland tropical rainforest?"

Systematics and Community Ecology

Taxonomy and systematics are terms used for all or various combinations of the following activities: 1) describing and naming new species; 2) assembling morphology, behavior, natural history, and geographical range data associated with species names; 3) constructing classification schemes which allow identification of species; and 4) estimating phylogenetic
relationships of species. In the "use it or lose it" theory of biodiversity conservation, the perceived value of biodiversity will be greater if it is known and accessible to humanity (Gamez, 1991; Janzen, 1988; 1991). Taxonomy and systematics are the basic tools for this approach. Natural history and range data increase the potential utility of species, the naming and classifying functions provide an information retrieval system, and phylogeny reconstruction has predictive power for locating traits of interest in related species (e.g., Goodman et al., 1987).

Community ecology is the study of patterns in assemblages of species (Diamond & Case, 1986). Community ecologists examine commonness and rareness of species, relationships between species diversity and community stability (Pimm, 1986), contributions of habitat variables to species diversity (Erwin, 1983; Stork, 1988), and relative abundance of species in different feeding guilds or of different sizes (May, 1978; Stork, 1988). An understanding of these patterns is crucial for conservation through land use planning and reserve design.

How Many Species?

When these separate disciplines ask "how many species", the two use very different methods. Museum-based taxonomists/systematists, rewarded for their ability to identify enormous numbers of species, use the "get them all" approach. Their emphasis is on ever more thorough and efficient means of collecting, preparing, identifying, and cataloguing species. If the task is a large one (tropical forest), the response is to enlist more taxonomists, and apply ever greater and more elaborate sampling efforts (e.g., Hammond, 1990). If forced to speculate about the total number of species before the job is done, they make educated guesses based on a qualitative sense of the rate at which additional species are being found (Gaston, 1991).

In contrast, community ecologists, rewarded for seeing the big picture with fewer data, use the "sample a few, estimate the rest" approach (May, 1988; 1992). Their emphasis is on carefully designed and rigorously quantified sampling which allows them to estimate species richness using statistical methods. Time and effort are spent placing plots randomly and sampling within them in a quantified way. No specialized knowledge of the study taxa are needed, or even desirable, because it might bias the taking of samples. No attempt is made to maximize the sampled diversity.

"Get Them All"

I will illustrate the "get them all" approach with my own experience with ants. I have been studying the ants of Costa Rica for over 10 years, and am now working on a fauna of the La Selva Biological Station. This research station comprises 1500 Ha of lowland rainforest on Costa Rica's Atlantic slope (see below). I will describe the methods I use to collect and identify ants, and how I arrive at an estimate of 4-500 species for La Selva.

One of the most productive methods is "general search". I look for nests in rotten logs, in dead stems, in live stems, under stones, on tree trunks, on foliage, and in bare soil. I look during the day and I look at night. I have a collector's intuition, such that if I and an inexperienced person go out collecting, I will find more ants.

Recent tree falls are a rich source of canopy ants. When a large tree falls, ants swarm over the wreckage and stream up lianas, returning to the canopy. Even nocturnal ants are active, running between fragments of disrupted nests. If I find a good tree fall, I may spend an entire day in it. Forty to fifty species of canopy ants is routine for a large tree fall at La Selva (see also Wilson, 1987).
I sample litter ants by sifting leaf litter and extracting the ants in Winkler bags (Besuchet et al., 1987; Olson, 1991). Bulk litter is sifted over a coarse mesh, and fine material, including the arthropods, sifts through. This fine material is suspended in mesh bags above a cup of alcohol, and over a period of days the ants (and many other arthropods) work their way out and drop to the alcohol. I use intuition to judge which litter to sift, the objective being to maximize diversity in a sample. I include leaf litter, chunks of rotten logs, and anything else I can scrape up from the forest floor. Accumulations near tree buttresses are good; so is litter near rotten logs, or pockets of moist litter when conditions are dry. For one of my samples, I typically sift approximately 100 l of bulk litter, to produce approximately 6 l of fine material. My La Selva samples typically yield between 30 and 50 species of ants (see also Olson, 1991).

There are certain specialized habitats where I know I can find a set of ant species that occur nowhere else. Obligate ant-plant associations represent a specialized habitat for ants. Five species are found only in Cecropia trees (Longino, 1991). One species is found only in the live stems of a few understory trees in the avocado family (Stout, 1979). One species is known from the live stems of a single tree at La Selva. Another specialized habitat is the cafeteria! Several species of pest ants are found only there.

One factor that increases my efficiency is that I have learned the 10 or 20 most common species and ignore them. If I did not, 90% of the ants I collected would be duplicates of these common ones.

There are about 80 genera of ants known from Costa Rica, and most of these are known from La Selva. Many of these have fewer than five species. Of the larger genera, some are well-known, and one can confidently state a fairly accurate number of species. Others are taxonomically difficult, and the number of species very uncertain, but the range of guesses is limited, between 50 and 150. In my experience I now recognize about 350 species from La Selva. By going through each of the genera and making "educated guesses" about the expected number at La Selva, I estimate no more than 500 species. There will not be more, unless there is some large pool of species that has been overlooked due to sampling bias. The rate of species accumulation would have to take a sudden leap, relative to the rate of species accumulation over the last ten years.

Sample and Estimate

Estimation of community species richness has not been a primary focus of ecological research, and relatively few methods have been devised to do so (Clench, 1979; Heitshe & Forrester, 1983; Miller & Wiepert, 1989; Coddington et al., 1991). Two that will be discussed here are (1) estimates based on the lognormal distribution, and (2) estimates based on species accumulation curves.

To an ecologist, species diversity has two components: the total number of species (species richness); and relative abundance (May, 1975; Taylor, 1978). Diversity in a biological community is illustrated in one of two ways: with an abundance-rank plot, or a frequency-abundance plot of number of species by abundance class. Either depiction illustrates both the total number of species and the relative abundance of species.

I will illustrate this type of community description with a data set on ground beetles (Carabidae). During October and November, 1992, my Biodiversity class at the Evergreen State College sampled ground beetles on the 400 ha campus. We placed a total of 351 pitfall traps, in 7 transects of approximately 50 traps each. Each transect was about 750 m long, with traps spaced every 15 m. We opened the traps for one 24 hr period each week for 7
weeks, and harvested all the beetles.

We sampled a total of 3060 individual beetles, distributed in 24 species. In the abundance-rank plot (Fig. 1), the 24 species are arranged on the horizontal axis, ranked from most to least abundant.

Figure 1. Abundance-rank plot for carabid beetles sampled in pitfall traps.

The abundance of each species is plotted on the vertical axis, on a log scale. In the frequency-abundance plot (Fig. 2) the horizontal axis is abundance category, on a log scale, and the vertical axis is the number of species in each abundance category. Students were struck by how many of the beetles were the single most-common species: two-thirds of the community sample was one species, *Scaphinotus angusticollis*. It vividly illustrated the cost of such quantitative methods when it is necessary to kill the organisms. For arthropods in particular, killing them is usually necessary, either to sample them in the first place, or to properly identify them afterwards.

Figure 2. Frequency-abundance plot for carabid beetles sampled in pitfall traps.

One reason ecologists examine community samples is to reveal underlying processes of community organization. Various shapes of relative abundance plots have been observed in different communities, inspiring models of community structure that predict particular shapes (May, 1975; Magurran, 1988). In these community models, total species richness is not the characteristic of interest. The models differ in the relative abundance of species. Emphasis is placed on measuring goodness-of-fit of observed samples to the various models.

The model distribution most commonly used to fit observed data is the lognormal (Magurran, 1988). With this distribution, the frequency-abundance plot, with abundance on a log scale, is a normal curve (Fig. 3).
Figure 3. Lognormal distribution of species abundance. As sampling intensity increases, veil line shifts to left, revealing more of distribution.

Most species exhibit intermediate abundance, and fewer species are either very rare or very common. Samples from such a community are presumed to reveal only a portion of the curve, that portion to the right of the "veil line". As sample size increases, the veil line shifts to the left. An advantage of the lognormal distribution is that it allows an estimate of total species richness. Total species richness is the area under the lognormal curve, which can be estimated by examining the shape of the "revealed" portion of the curve, and statistically extrapolating the "unseen" part of the curve. To be effective, the sample size has to be large enough to reveal the mode, the highest point of the "true" distribution. Unfortunately, many samples of arthropod communities fail to reveal the mode. In these cases, the most frequent abundance category is the lowest: those species represented by one individual. One assumes in such a situation that the veil line is to the right of the mode, or that some other model applies. For example, we cannot use a lognormal to estimate species richness from our beetle data, because we clearly have not revealed a mode (Fig. 2).

A second method of estimating species richness is with species accumulation curves (Clench, 1979; Coddington et al., 1992). Cumulative number of species is plotted against some measure of sampling effort: number of traps, time, or some other measure of sampling intensity. For example, cumulative species over time in the beetle project rises quickly and then appears to approach an asymptote (Fig. 4). Any equation with an asymptote can be fit to the data, and the one with the best fit chosen. However, this is an exercise in pure curve fitting. There is no underlying biological or statistical model that produces a particular equation (J. Coddington, pers. comm.).

Figure 4. Species accumulation curve for carabid beetles sampled in pitfall traps, with least squares fit using equation \( C = S - \left( \frac{(S*B)}{(B+T)} \right) \), where \( C \) = cumulative number of species, \( T \) = time in weeks, \( S \) = total number of species in community (estimated parameter), and \( B \) = curve-fitting parameter. \( r^2 \) = 0.998. Solid line = estimate, dotted line = observed.
The Arthropods of the La Selva Project

The arthropods of La Selva project (ALAS) is an attempt to integrate "get them all" methods with "sample and estimate" methods. It is a collaboration between the disciplines of systematics and community ecology, at all levels: institutional, individual investigator, and project design.

Institutions

The project is jointly sponsored by two institutions: the Instituto Nacional de Biodiversidad (INBio) and the Organization for Tropical Studies (OTS). INBio is a novel Costa Rican organization whose goal is a complete national inventory (Gamez, 1991; Janzen, 1991). Its objective is to make biodiversity valuable to society by (1) making it known for educational purposes; and (2) making it commercially available for chemical prospecting (Holden, 1991). It has a "get them all" philosophy, and relies on a network of trained field collectors, called parataxonomists. Parataxonomists are individuals from rural communities - former park guards, hunters, housewives, agricultural workers - who, during interviews, exhibit a penchant for natural history and a willingness to try a non-traditional profession. They attend a 6-month "crash course" in entomology and botany, and then return to their communities, where they establish a biodiversity office. They begin a regular schedule of collecting, sending prepared specimens to the central facility near San José, the capitol city. A team of curators tackle the material, sorting it as far as they can and incorporating the collection data into a computer database. International taxonomists are invited to work with collections, both identifying the collected material and teaching the Costa Rican curators about particular taxa. INBio has pioneered the use of micro-barcode labels for insect specimens, allowing rapid entry and retrieval of collection data.

OTS is a consortium of North American and Costa Rican universities that coordinates and fosters biological research and teaching in Costa Rica. OTS owns and maintains several field stations, the flagship being La Selva Biological Station. This biological station, a complex of dormitories and laboratories nestled in 1500 ha of rainforest, is one of the world's most important loci for studies of tropical ecology, and has a 30-year record of continuous research. The institution has a strong "sample and estimate" orientation, attracting an international clientele of research ecologists. An air-conditioned laboratory has been remodelled for the ALAS project, and contains dissecting microscopes, insect cabinets, and computer equipment for a large specimen database.

Individual Investigators

The principal coordinators of the project are Robert Colwell and myself. Colwell is a community ecologist, well known for his work on hummingbird flowermite communities. I am an ant taxonomist with former training in community ecology. The two of us, representatives from the scientific traditions of ecology and systematics, have been largely responsible for the design of the project. The core research team at La Selva is composed of a resident curator, who has a masters degree in entomology from the University of Costa Rica, two INBio-trained parataxonomists, and a laboratory assistant trained as a specimen preparator. Finally, a cadre of 13 collaborators, taxonomic specialists in particular taxa, is associated with the project (Table 1).
Table 1. Survey Taxa, Focal Taxa, and Collaborators in the ALAS Project.

<table>
<thead>
<tr>
<th>Survey Taxon</th>
<th>Focal Taxon</th>
<th>Collaborator(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oribatida</td>
<td>Ceratozetida</td>
<td>Valerie Behan-Pelletier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Biosystematics Inst., Canada)</td>
</tr>
<tr>
<td>Heterostigmata</td>
<td>Tarsonemida</td>
<td>Ronald Ochoa (Brigham Young Univ.)</td>
</tr>
<tr>
<td></td>
<td>Pyemotida</td>
<td></td>
</tr>
<tr>
<td>Ascidae</td>
<td>Melicharini</td>
<td>Evert Lindquist (Biosystematics Inst., Canada)</td>
</tr>
<tr>
<td>Araneae</td>
<td>Araneida</td>
<td>Jonathan Coddington (USNM)</td>
</tr>
<tr>
<td></td>
<td>Theraphosida</td>
<td>Carlos Valerio (Univ. Costa Rica)</td>
</tr>
<tr>
<td>Curculionidae</td>
<td>Zygopinace</td>
<td>Henry Hespenheide (UCLA)</td>
</tr>
<tr>
<td>Scarabaeoidea</td>
<td>Scarabaeinae</td>
<td>Angel Solis (INBio)</td>
</tr>
<tr>
<td>Gelechioidae, Tortricoidae, Tineoidea</td>
<td>Tortricidae</td>
<td>Jerry Powell (Berkeley)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eugene Phillips (INBio)</td>
</tr>
<tr>
<td>Brachycera</td>
<td>Drosophilida</td>
<td>Dave Grimaldi (AMNH)</td>
</tr>
<tr>
<td>Ichneumonidae</td>
<td>Banchiinae, Pimplinae, Ophioninae</td>
<td>Paul Hanson (Univ. Costa Rica)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jesus Ugalde (INBio)</td>
</tr>
<tr>
<td>Vespoidea</td>
<td>Formicidae</td>
<td>John Longino (Evergreen State College)</td>
</tr>
</tbody>
</table>

The Design

The general design is to (1) use "get them all" methods to produce complete species lists for selected "Focal Taxa"; (2) use quantitative methods to obtain community samples for much larger "Survey Taxa"; and (3) use the Focal Taxa results to calibrate or evaluate the quantitative procedures and estimates (Table 1). The project has three phases, the first of which has been completed.

Phase 1. Selection and Training of Project Staff

Notices were posted in the communities around La Selva, interviews were held, and two candidates selected to be parataxonomists. The two candidates attended INBio's parataxonomist course, and then began work at La Selva. The Resident Curator was selected, and began work at La Selva at the same time as the parataxonomists. Once this research team was established, the taxonomic collaborators subsequently gave intensive, 10-day courses on the Survey Taxa (Table 1). The parataxonomists and the resident curator were trained to recognize, prepare, and identify species of each Survey Taxon. Teaching was greatly facilitated with a small CDC camera which mounted on both a dissecting and compound microscope. Instructors positioned specimens under the microscope, and then pointed out key characters on a monitor.

Phase 2. Quantitative Sampling

For a period of 18 months, the resident team will carry out an intensive, rigorously quantified
programme of sampling for the Survey Taxa. This quantitative sampling will use five methods traditionally and not-so-traditionally used by entomologists: blacklights, malaise traps, Berlese funnels, pitfall traps, and canopy fogging.

Many night-flying insects are attracted to ultraviolet light. A common insect sampling method is to string white sheets up in the forest, and use a car battery to run blacklights (filtered, so that protective eye gear is not necessary) in front of the sheets. Many moths and other insects come to the sheets, where they can be collected.

Malaise traps are used to collect day-flying insects. Malaise trap sampling is based on a phenomenon familiar to any camper who has left a tent door open. Insects will collect inside, concentrating in the uppermost corner. A malaise trap is simply a screen tent with open sides, and a bottle at the upper corner into which insects are funnelled and trapped.

Berlese funnels are used to extract small arthropods (mites, ants) from soil and leaf litter. A funnel is placed over a cup of alcohol, a soil or litter sample is placed over the funnel, and a light bulb is placed over the sample. The heat gradient created by the light bulb drives the small arthropods out of the sample, into the funnel, and down into the alcohol.

Pitfall traps are used to sample arthropods that run over the ground surface, and arthropods that are attracted to certain kinds of baits. They are simply plastic cups or other smooth, straight-sided containers buried to the rim in the ground. Ants, beetles, spiders, and other arthropods walking over the surface drop into the cups and cannot escape the steep sides. By placing odoriferous baits, such as feces or carrion, over the cups, a large community of otherwise rarely seen arthropods is sampled.

Canopy fogging is a relatively new technique used to sample the arthropods of the forest canopy (Erwin, 1983; Adis et al., 1984; Adis & Schubart, 1985; Stork, 1987; Stork & Brendell, 1990). We climb to the canopy using mountain-climbing gear, and from there disperse an insecticidal fog. The falling arthropods are collected in an array of large funnels on the ground below. Many people are horrified at the thought of using insecticides in the rainforest, but the insecticides that are used are short-lived pyrethrins. Pyrethrins are derived from plant products, and break down within a few hours in sunlight. They are specific to arthropods, and have no affects on vertebrates. They are used commercially to control pests in food warehouses, institutional kitchens, and other situations where insecticide residues are prohibited. Data on recovery rates of arthropods in trees are few, but in one study a re-fogging ten days after the first one yielded 20% as many arthropods (Stork, 1991).

The quantitative samples will be taken on a regular monthly schedule, with samples stratified with respect to primary vs. secondary forest, two soil types, and, in the case of canopy fogging, species of tree. All the specimens collected and prepared by the resident team will be labelled with INBio-compatible micro-barcodes and entered in a database. Computers capable of storing and manipulating this large body of data are essential. Colwell has designed a fully relational database which, through the barcode label, allows linking of abundance, collection, and identification data (Fig. 5).

Rapid identification of specimens is necessary for this project, and an innovation intended to facilitate identification is the use of digitized images of species. The CDC camera we used for teaching also connects to a "grabber board" in a computer, which allows us to capture digitized images of specimens. These digitized images are then used as values in picture fields in the species database. We expect this to be a great aid in identification of species, allowing one to select a set of potential species and view them on the screen, before having to pull a drawer and put specimens under a microscope.

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Figure 5. Structure for ALAS database, designed by R. Colwell.

While the quantitative survey is underway, each of the collaborators will use "get them all" methods to provide a complete La Selva species list for their Focal Taxon. Collaborators may use everything at their disposal: previous museum collections, taxonomic literature, and their own targeted collecting at La Selva. They will apply all their specialized, non-quantitative knowledge to produce as complete a list as possible. One of the products of the project will be identification guides for these Focal Taxa.

**Phase 3: Analysis**

First, the taxonomic collaborators will return to La Selva to identify the material prepared during the quantitative survey. All the traditional methods of estimating species richness (species accumulation curves, lognormal distribution, etc.), and potential new estimation procedures, can then be applied. In addition, because we will have complete species lists for the Focal Taxa (a "known universe" for statistical purposes), we will be able to examine the efficiency of various sampling methods, and the accuracy of various estimation procedures.

We can also use Focal Taxon results for a direct estimate of Survey Taxon richness. If we assume that Focal Taxon species and the remaining Survey Taxon species have equal probabilities of capture in the quantitative samples, then we can estimate the total Survey Taxon richness by:

\[
\frac{Q_{\text{(focal)}}}{S_{\text{(focal)}}} = \frac{Q_{\text{(survey)}}}{S_{\text{(survey)}}}
\]

Where \(Q\) = number of species in the quantitative samples, and \(S\) = total number of species in the community. Both terms are known for the Focal Taxon, \(Q\) is known for the Survey Taxon, allowing \(S\) (survey) to be calculated. In effect, \(Q\) (focal) / \(S\) (focal) is a measure of the efficiency of the quantitative samples. We will have ten replicates of this measure, giving us some ideas of the variance between taxa.
Conclusion

The ALAS project, by combining the approaches of systematics and community ecology, will improve our understanding of tropical arthropod diversity. For those interested in the traditional systematics approach, it will provide identified specimens, identification guides, and natural history data. For those interested in community ecology and ecosystem function, it will provide needed data on tropical arthropod communities, and on methods of estimating species richness. Above all, it should augment the conservationists’ toolbox, allowing the largest component of biodiversity, the arthropods, to be used for the conservation of tropical habitats.

Acknowledgements

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Biodiversity and Groundwater/Surfacewater Ecotones

A Report of the Round Table Session No3 held on 7 July 1993 in Lyon, France

by P. Marmonier¹, J.V. Ward², and D.L. Danielopol³

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Biodiversity is the object of a large international programme of the IUBS/SCOPE/UNESCO and is important for many scientific, economic, and ethical reasons (Solbrig, 1992). In groundwater, the study of biodiversity can be considered as a promising research field (Marmonier et al., in press). During the international conference on Groundwater/Surfacewater ecotones in Lyon, a round table was devoted to biodiversity. Five major topics were discussed: 1) the importance of Groundwater/Surfacewater ecotone fauna in the estimation of global biodiversity; 2) the local and regional biodiversity; 3) factors promoting biodiversity; 4) biodiversity in gradients and impact of disturbances; 5) how to preserve biodiversity.

Importance of Groundwater/Surfacewater ecotone fauna in the estimation of global biodiversity

Groundwater fauna is largely ignored in the calculation of global biodiversity. The number of species of tropical rain forests is estimated to be 10 or 20 times higher than those known to science (Cairns, 1988). Groundwater diversity is less well known than the diversity of surficial species in tropical forests globally: the total biodiversity of groundwater fauna is certainly higher than current estimations (in the Stygofauna Mundi for example - Botosaneanu, 1986) and these organisms may represent an important part of global biodiversity.

This is greatly important if groundwater fauna play an active role in groundwater system functioning. It is especially true for microbes (microfauna, bacteria, fungi) which are still more or less unknown and may play an important role in the bank filtration of large rivers (the Rhine River for example, is rather well-studied from this point of view).

Macrophytes and microphytes which occur in groundwater/surfacewater systems (both aquatic and terrestrial ones) should also be included in groundwater/surfacewater ecotone biodiversity. For example, in the Netherlands, wetland macrophyte biodiversity decreased during the past centuries mostly because of the exploitation of Groundwater. There is a strong need for such studies which can be grouped as "Ecohydrology".

In the same way, the state of knowledge is not equal for all countries. The groundwater organisms of Africa, Latin America, Eastern Asia, and Australia are still poorly or not at all known. There is also a need for methodological progress: for instance, standardized quantitative methods which can be exported from one region to another. Two other types of biodiversity are still poorly known and need research: (1) the great "phylogenetic biodiversity" in groundwater, many rare taxa are represented in the underground environment, they are sometimes representatives of very old phylogenetic lineages (considered as "living fossils"), and (2) the phenotypic biodiversity, between connected populations or between isolated ones is also still poorly known.
The local and regional biodiversity

Groundwater fauna is characterized by the high number of species with a high degree of endemism. Most of them are limited to one catchment area or one karstic system. *Phreatocandona motasi*, for example, is only known from a single well in Romania (Danielopol, 1978) and *Antrocampius catherinae* was described from a single population of a karstic stream in Southern France (Rouch, 1988).

Many factors may influence the biodiversity in alluvial aquifers. Ward, Stanford & Palmer (in press) proposed a list of factors that influence spatial distribution patterns of interstitial animals in alluvial aquifers (Table 1). Although not directly addressing biodiversity, the factors in Table 1 are responsible for structuring local and regional faunal assemblages which ultimately determine biodiversity patterns. The protection of groundwater fauna should consider these and other factors.

Table 1. Some factors that influence spatial distribution patterns of interstitial animals in river aquifer systems (modified from Ward & Palmer, in press).

<table>
<thead>
<tr>
<th>1. Characteristics of the Alluvium</th>
<th>Particle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Particle Size Heterogeneity</td>
</tr>
<tr>
<td></td>
<td>Pore Size</td>
</tr>
<tr>
<td>2. Exchange Characteristics</td>
<td>Hydraulic Conductivity</td>
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<tr>
<td></td>
<td>Clogging</td>
</tr>
<tr>
<td></td>
<td>Water Movement</td>
</tr>
<tr>
<td></td>
<td>Oxygen Concentration</td>
</tr>
<tr>
<td>3. Food Resource Patterns</td>
<td>PPOM</td>
</tr>
<tr>
<td></td>
<td>Biofilm</td>
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<tr>
<td></td>
<td>Prey Species</td>
</tr>
<tr>
<td>4. Competition</td>
<td></td>
</tr>
<tr>
<td>5. Predation</td>
<td></td>
</tr>
</tbody>
</table>

After all, there is a great need for articles on local measurements of biodiversity; data have to be published to be used and compared. These publications may also have a great importance for local managers who may directly use them for the protection of groundwater fauna.

Promoting biodiversity studies

Because of this high degree of endemism, the need for specialists on the systematics of each group of animals is increasing as the number of studies increases. The need is not supported by universities which have more and more problems finding students who want to invest their efforts in such a poorly promising topic from the employment point of view. In a few years, who will identify the animals collected by stream and groundwater ecologists? There is also a need for taxonomic institutes, because this type of permanent structure may formalize training and pass that knowledge to successive generations.

In the same way, there is also a great need for taxonomic books and keys to identify groundwater animals. These books may detail taxa at the species level (those intended for ecologists) or just consider the major groundwater high-level taxa (those to be used by managers). The need for specialists and taxonomic books is not the only way to promote studies of groundwater faunal biodiversity; lay people have to be made aware of the problem. For this, two main strategies are required: 1) development of academic education of students, by
Background: The protection of groundwater biodiversity has become increasingly important due to the recognition of its unique ecological and evolutionary significance. It is crucial to preserve these habitats as they provide ecosystem services that are essential for human well-being. Effective management of groundwater depends on understanding the ecological processes that sustain this biodiversity. This paper discusses the challenges and strategies for preserving groundwater biodiversity.

How to Preserve Groundwater Biodiversity

Ecosystems: The unique features of groundwater ecosystems include their structural complexity, which creates diverse habitats for various organisms. These habitats support a wide range of species that are adapted to the specific environmental conditions found in groundwater systems.

Impacts of Human Activities: Human activities, such as agriculture, urban development, and industrial activities, can negatively impact groundwater biodiversity. These impacts include changes in water quality and quantity, alterations to natural hydrological processes, and habitat destruction.

Management Strategies: To preserve groundwater biodiversity, it is essential to implement effective management strategies. These strategies should focus on protecting key ecological processes, such as groundwater recharge, and creating habitats that support biodiversity. Additionally, monitoring and research are crucial to understanding the dynamics of groundwater ecosystems and identifying the specific threats they face.

Another important aspect is the need for conservation policies that consider the importance of groundwater biodiversity. This includes the development of protected areas and the implementation of regulations that limit activities that negatively impact groundwater systems.

References:


group, represent a multifacacious topic where the utilitarian aspects can or should not be separated from cultural aspects. Similar arguments were addressed recently by one of the leading contemporary evolutionary biologists, L. Stebbins (1992).

**Conclusion: gaps in knowledge and guidelines for future research**

During this round table seven main gaps in knowledge have been underlined and can be considered as recommendations for future studies:

1) The total number of groundwater species is far from being known, especially in poorly studied continents (Africa, Australia, etc.).
2) There is a need for international standardized sampling methods which could facilitate valuable inter-sites comparisons.
3) Available data on groundwater biodiversity have to be published.
4) There is also a need for taxonomists and books for identification of groundwater animals.
5) Education at both academic and popular levels have to be developed.
6) Ecological and ecotoxicological tolerance of groundwater fauna, acute and long-term, have to be studied for widely distributed taxa.
7) Finally, it would be efficient to define "biodiversity hot spots" for groundwater/surfacewater ecotones, at both local and global scales.

UNESCO can bring important help to the understanding and protection of groundwater/surfacewater ecotone biodiversity by supporting book publication (point 2 and 4) and promoting the integration of Groundwater Ecology in education (point 5).

**References**


WARD, J.V. & PALMER, M.A. In Press. Distribution patterns of interstitial freshwater meiofauna over a range of spatial scales, with emphasis on alluvial river-aquifer systems. *Stygologia*.

Biodiversity Dynamics and Environment
Diversitas-France: a Research Programme for the Rio Challenges

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Introduction

Within the conceptual framework of DIVERSITAS, the IUBS-SCOPE-UNESCO International Programme on Biological Diversity, and following the recommendations of the Convention on Biological Diversity, a national DIVERSITAS programme has been launched in France with the support of a number of major national scientific bodies.

This national programme has three goals: (1) to study the factors that determine biodiversity levels and changes; (2) to evaluate, model and forecast the direct and indirect effects of human societies on biodiversity; and (3) to understand the economic, ethical and cultural dimensions of biodiversity issues.

This programme is coordinated by a scientific committee chaired by Professor Jean-Claude Mounolou. Taking into account the broadness of the field and the need for an interdisciplinary approach, the programme will address the following themes:

- origins, maintenance and loss of biodiversity;
- environmental changes and community dynamics: effects upon biodiversity;
- role of the biological diversity in ecosystem function;
- perceptions and uses of biodiversity; and
- censusing and monitoring biodiversity.

The scientific projects are coordinated within national networks (in order to favour international groupings in the future).

Origins, Maintenance and Loss of Biodiversity

Processes involved in the establishment of present faunas and floras of Western Europe.

Much of the picture given by present biodiversity, particularly in temperate regions, is due to the impacts of the quaternary glaciation cycle and of human populations. The formation of most present continental ecosystems has occurred, to some extent, in the last 10,000 years. We do not know the relative roles played in this process by factors as different as climate warming, anthropisation, biological evolution in the changes.

The first phase aims at collecting the available data on faunas and floras and their changes. Highlighting the chronology of extinctions, regressions, recolonisations, and their relationships with abiotic and biotic changes of the habitats as well as with the genetic or phylogenetic constraints within particular taxons, should constitute a unique opportunity to explain biodiversity in a biogeographical perspective. With a clear view of the processes involved, it will be possible to predict the impact of future changes on biodiversity.
Dynamics of Biological Diversity: Mechanisms of Evolution and Maintenance

The purpose of this theme is to promote research on the evolutionary mechanisms that produce and maintain biological diversity within and between species, in order to optimize the management of natural biodiversity. Experiments performed under these lines of research should be applicable to the field of conservation biology.

There are two scientific networks in this field. The first one, dealing with persistent interactions between organisms (host-parasite, mutualistic associations, symbiosis), emphasizes the role of this kind of interaction in the dynamics of biodiversity. The second one is presented in the second area of research, below.

Environmental Changes and Community Dynamics: Effects on Biodiversity

Habitat fragmentation, metapopulations and assessment of extinction risks: a network in conservation biology

This network is crucial to the growth of a modern conservation biology in France. Analysing and modelling dynamics and genetics of fragmented populations is a reasonable first step toward this goal. It is well known that the fragmentation of habitats tends to reduce species diversity and increase risks of population extinction. Thus it is essential to understand the dynamics of fragmented populations and communities - and to study immigration and emigration processes with an evolutionary perspective.

Biodiversity dynamics and habitat management

Recently launched by the French Ministry of Environment, this programme is an extension of a previous one - with the same goal of contributing to the emergence of a strong conservation biology in France. It aims to forecast what spatial configuration could optimize biodiversity in the current situation of natural and man-made perturbations. It relies on a historical perspective as well as on a good knowledge of life history traits of species and on the role of interactions between species.

Role of Biodiversity in Ecosystem Dynamics

Role of microbial biodiversity in ecosystem function

Many functions in ecosystems involve microorganisms: nitrification, denitrification, nitrogen fixation, cellulolyse, detoxication, etc. Therefore, some issues linked with microbial biodiversity deserve further research:

- Some functions are played by a unique taxon (for instance, nitrification in soils is due only to Nitrobacter), while others can be accomplished by several, apparently equivalent taxa (for instance: non-symbiotic nitrogen fixation); is there any reason for such a difference (lateral transfers)?
- Are these apparently equivalent taxa really redundant? If one disappears could it be replaced by another?
- In agrosystems is there any relationship between microbial biodiversity and damage due to phytopathogenic microorganisms?
- Are there some functions for which uncultivable microorganisms could play an
important role? We know at ca. 10% of microorganisms of natural habitats, mainly because, until now, identifying a microorganism means knowing how to culture it.

Biodiversity and the dynamics of marine ecosystems

The main goal of this programme is to determine the relationships between functional characteristics of ecosystems and the factors structuring species assemblages. Within the theoretical framework developed by DIVERSITAS, two hypotheses are addressed:

- Are the mechanisms of flows of material linked with changes in genetic diversity or perturbations of species assemblages?
- How do changes in diversity - at the genetic level, the species level or the functional level - affect the stability and resilience of pelagic and benthic communities?

Perceptions and Uses of Biodiversity

The themes "Environment" and "Development", widely mediatized throughout the Rio Conference, are presently at the heart of discussions with regard to environment policy. The Convention on Biological Diversity emphasizes the need for its "sustainable" use, so that questions about why and how to save biodiversity are closely linked with the concept of "sustainable development". This means both reducing human impacts and saving or managing menaced populations concerned.

Moreover, most societies have deep cultural relationships with the milieu in which they live. Each society has its own identity with respect to nature. So perceptions and representations of nature, and interactions between "natural" dynamics and "social" dynamics should be considered as basic requirements for proposals of sustainable management of resources in the long term. The ultimate goal of the research should be to make use of the traditional knowledge in order to promote a sustainable management of biodiversity. In this broad area of research a first theme has been identified: "Perception, use and evaluation of biodiversity in the case of fallow".

Biodiversity and fallows

There are many types of fallows. They reflect the history of agricultural systems and their evolution. Their perception by different populations is different, depending on agricultural traditions and technological levels. Fallows appear as reserve of wild and domesticated species or strains. Their role in fertility restoration is well known.

This strongly interdisciplinary topic will develop along three main orientations:

- an approach at the level of systems of production,
- a botanical, zoological and biogeographic approach,
- a functional ecology approach.

Analysis of conservation policies, from local to global

This theme, still in a beginning phase, should allow us:

- to em"ize the representations of biodiversity that scientists and politicians have at different scales of decision, and their changes in time;
to stress the local effects of this new concept of "biodiversity" through its uses within different circuits of decision in biological diversity management;
- to analyse the legitimacy of procedures at work in these processes, particularly through the creation of new types of monetary evaluation of ecosystems and their functions.

Human societies and fermented alimentary goods

Fermented foods and beverages constitute one of the more common uses of microbial diversity in the world. Alimentary fermentation has been used for a long time and still remains at the center of agro-alimentary industries. For beverages, fermentation also plays an important role in religious rituals. The industrial use of microbial diversity results in an impoverishment of genetic and species diversity:

The general question to be tackled by this scientific network can be summarized as follows: how does change, in space, time and technology, affect the relationships between microbial diversity and their uses by the society for alimentary purposes? This question deals with scientific paradigms related to yeasts and fermentation agents, as well as to the evolution of technical processes and alimentary customs.

The Scientific Organisation "Bureau des Ressources Génétiques"

The intense pressure exerted by human activities has led to the reduction of genetic diversity, and sometimes to their loss, while at the same time development demands their maintenance for adapting to long-term changes. The genetic diversity of life constitutes a constantly changing richness, where the biological objects of economic progress can be found, which govern the physical, natural and cultural environments of human beings. Knowledge, mastering and access to genetic resources are strongly disputed at the international level. States, enterprises and individuals are involved in this fray, which mobilizes governments, scientists, farmers and consumers.

For these reasons, there is an agreement between all the scientific bodies and institutions involved in genetic resources to cooperate and coordinate their efforts within a National Scientific Grouping called the "Bureau des Ressources Génétiques".

Analysing, censusing and monitoring biodiversity

Three National Services on Biosystematics have been created in 1992, at Lyon, Montpellier and Paris. Their purpose is to make modern molecular and information retrieval techniques available to taxonomists in order to give a new impetus to systematics in France. Moreover, a national effort will be undertaken in order to promote data and knowledge bases in the field of systematics to coordinate with similar European and overseas initiatives.

Historical biogeography of New Caledonia

On the basis of the amount of data accumulated for many years, the objective of this project is to compile faunistic and floristic inventories with biogeographic, historical and ecological perspectives.

Long-term studies of marine biodiversity and biogeography

Temperate, polar and tropical French sites are ideally situated for allowing the national
scientific community to get involved in ambitious research on the biogeography and long-term monitoring of marine faunas and florae. Stimulated by the concerns about "global changes", national institutions have become aware of the need to engage long term studies, along the coast as well as off-shore. The National Programme on Coastal Oceanography (PNOC) launched this research, but with an emphasis on material flows. Thus, new action dealing specifically with the long-term monitoring of marine biodiversity will be undertaken under the lead of this programme on biodiversity dynamics, in concert with the PNOC.

Fishes of continental waters: a model for studying biodiversity

When speaking about biodiversity it is normal to focus on tropical forests or terrestrial ecosystems, and sometimes on marine ecosystems. But continental waters are more poorly represented. Nevertheless these areas and their species are strongly related to human activities, particularly in tropical areas. Here we are dealing with the problem of sustainable development and patrimonial use of resources, with specific questions resulting from the need of preserving (in situ) the species and their habitat.

The number of specialized scientists involved in these areas is small. Thus, it has been decided to focus efforts on a particular group of animals, the fishes. They represent an economical resource, a diversified biological model, and a group threatened by human activities simultaneously - while having, in many cases, an acknowledged patrimonial value. Moreover the cultural aspects associated with fishes and their exploitation are very important: myths and traditions (totem fishes or sacred fishes); influence in traditional arts; development of diverse fishing techniques; and societies organized around fishing.

Last but not least, fishes are susceptible to the quality of habitats and can be used as bioindicators in management and monitoring projects. Thus, choosing fishes as the target of research will reveal important information about aquatic systems.

Conclusion

The national Diversitas programme in France is only beginning, and will become not larger, but more focussed in the coming years, particularly through the collaboration and interaction with similar projects developed in other countries. Coordinating and adjusting the efforts on the European and international scales should be our common goal.
Biodiversity Study in China

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China has a vast territory with a complex climate, varied geomorphic types, a large river network, and many lakes and coastlines. Such complicated natural conditions inevitably form diversified habitats and ecosystems. In terms of the classification system based on vegetation formations, there are about 600 ecosystem types.

Ecosystem Diversity in China

The terrestrial ecosystem can be divided into several types such as forest, shrub land, meadow, steppe, savanna, desert, tundra, marsh, etc. The aquatic ecosystem can be classified as marine, rivers, and lakes.

Forest

The forested area of China is small with unbalanced distribution and variety of types. In total, it is approximately 11.5 million ha, with an average coverage of approximately 12%. The proportion of forest coverage ranges from 55% to 4% in different provinces.

Forests mainly have 212 formations indicated by the dominant species, co-dominant species or characteristic species in arbor layer. The bamboo forests of China are equally rich, with 36 formations. The coniferous forest in China consists of taiga (44 types), warm temperate coniferous forest (5 types), and subtropical and tropical coniferous forests (27 types). The temperate coniferous and deciduous broad-leaved mixed forest is mainly distributed in northeast China.

There are 42 main types of broad-leaved deciduous forests, which are distributed over hilly areas and mid- or lower-mountainous areas in the temperate zone and the subtropical zone of China. The broad-leaved deciduous forest is the zonal vegetation of the warm temperate zone. The broad-leaved evergreen forest is composed of many broad-leaved evergreen tree species in the subtropical zone, animals inhabiting this forest are in imminent danger of extinction due to habitat destruction. Tropical seasonal rainforest and tropical rainforest cover a small area of Southern China. Tropical forests have been seriously destroyed, especially on Hainan Island.

Meadow

The meadows are those communities which developed under appropriate moisture conditions. The dominant species are mesophytes and perennial plants. They can be divided into several types: typical meadows (27 formations); saline meadows (20 formations); marsh meadows (9 formations); and high cold meadows (21 formations). In total, there are 77 meadow formations.

Steppe

Steppes consist of perennial xeric herbs, occurring from temperate to tropical zones. There are 45 formations of steppe, roughly classified as meadow steppes, typical steppes, desert steppes, and high cold steppes. The steppe can be found in temperate semi-arid zones, such
as the Qinghai-Xizang (Tibet) Plateau and the mountainous arid region with dominant species of *Stipa, Festuca, Aneurolepidium, Cleistogenes*, and *Artemisia*, respectively. The total area of temperate steppes in China is 315 million ha. Due to over-exploitation and over-grazing, the steppes have deteriorated over an area estimated at 30% of the total.

**Savanna**

Arid savannas can only be found in the xerothermic valley in the southern Yunnan and some parts of Hainan Island. In addition, some tropical forests felled repeatedly become secondary savannas.

**Desert**

The desert covers a total of 20% of land area and is mainly found in the northwestern region of the country. There are 52 desert formations including small wood desert, shrub desert, small semi-shrub desert and cushion-like small semi-shrub desert.

**Marsh**

There are approximately 19 marsh formations which can be recognized as follows: herbaceous marsh (14), woody marsh (4), and peat bog (1). The Chinese mangrove (a typical marsh forest), has 18 formations. The total area of marsh is about 11.5 million ha. It occurs in the mountainous area of the Northeast, Sanjiang Plain, and Heilongjiang Province, now mostly reclaimed and turned into farmland. The remaining 2.27 million ha are protected to some extent through the establishment of a few reserves. In addition, there are 17 formations of tundra, alpine cushion-like mobile sand vegetation, with small distribution areas.

**Freshwater and Marine Ecosystems**

Among the numerous rivers, streams, and lakes in China, there are 22 rivers longer than 1000 km and 2848 lakes larger than 1 square km. China is one of the largest producers of freshwater fish in the world. The silver carp (*Hypophthalmichthys molitrix*), bighead (*Aristichys nobilis*), and grass carp (*Ctenopharyngodon idellus*) are well-known aquacultures.

China is also rich in marine fish. There are 1694 species recorded from China seas, consisting of 175 chondrichthyes, and 1519 teleosts. From the total of 2804 fish species recorded, 440 are endemic.

**Species Diversity**

The proportion of different taxa are as follows: 12.5% for mammals, 13.1% for birds, 37.8% for gymnosperm, 11.4% for angiosperm, and 17.0% for fungus. A great number of these species are endemic ones. For example, 73 species in mammals, 99 species of birds, 240 genera in seed plants, and approximately 10 000 species of vascular plants, representing 14.6%, 8.3%, 7.6%, and 30% of the total found in China respectively. Economic species are also abundant in China. There are approximately 5000 species of medicinal plants, over which 1700 species are commonly encountered. In addition, numerous species of animals and microorganisms have been widely employed for medicinal purposes and public health, and species of fruit trees, oil-bearing plants and fiber plants are too numerous to mention.

Biogeographically, China is situated in both the Palaearctic and Oriental Realms. During the
late Tertiary period, most regions had not been affected by glaciation, thus the fauna and flora are characterized by having many endemic and relic species. The number of species in China, which is considered as one of the megadiversity countries, make up about one-tenth of the total number of species of the world.

Table 1: Number of Species in China and the World

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Spp. of China (SC)</th>
<th>Spp. of World (SW)</th>
<th>SC/SW (%)</th>
<th>Estimated N° in the World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>499</td>
<td>4,000</td>
<td>12.5</td>
<td>5,000</td>
</tr>
<tr>
<td>Birds</td>
<td>1,186</td>
<td>9,040</td>
<td>13.1</td>
<td>11,000</td>
</tr>
<tr>
<td>Reptiles</td>
<td>376</td>
<td>6,300</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Amphibians</td>
<td>279</td>
<td>4,184</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td>Fishes</td>
<td>1,804</td>
<td>19,056</td>
<td>12.1</td>
<td>28,000</td>
</tr>
<tr>
<td>Insects</td>
<td>40,000</td>
<td>751,000</td>
<td>5.3</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Bryophytes</td>
<td>2,200</td>
<td>16,600</td>
<td>13.3</td>
<td></td>
</tr>
<tr>
<td>Pteridophytes</td>
<td>26,000</td>
<td>10,000</td>
<td>26.0</td>
<td></td>
</tr>
<tr>
<td>Gymnosperm</td>
<td>200</td>
<td>520</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td>Angiosperm</td>
<td>25,000</td>
<td>220,000</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>Fungi</td>
<td>8,000</td>
<td>46,983</td>
<td>17.0</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Bacteria</td>
<td>500</td>
<td>3,060</td>
<td>16.3</td>
<td>30,000</td>
</tr>
<tr>
<td>Algae</td>
<td>5,000</td>
<td>26,900</td>
<td>18.6</td>
<td>60,000</td>
</tr>
</tbody>
</table>

A large number of endemic taxa including higher ones are recognized and main endemic taxa in China are shown in table 2. As examples of endemic species, the monotypic genus of *Cathaya argophylla* which only occurs in southern parts of China, the Yangtze River Dolphin (*Lipotes vexillifer*) only lives in lower reaches of the Yangtze River, and the Giant Panda (*Ailuropoda melanoleuca*) is confined to the S.W. mountainous region, Sichuan, Gansu, and Shaanxi. In addition, some species, e.g., *Cryptomeria* found in China as well as in Japan are regarded endemic taxa to eastern Asia.

Table 2: Number of Endemic Genera or Species in China

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Known genera or spp.</th>
<th>Endemic genera or spp.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>499 spp.</td>
<td>73 spp.</td>
<td>14.6</td>
</tr>
<tr>
<td>Birds</td>
<td>1,186 spp.</td>
<td>99 spp.</td>
<td>8.3</td>
</tr>
<tr>
<td>Reptiles</td>
<td>376 spp.</td>
<td>26 spp.</td>
<td>6.9</td>
</tr>
<tr>
<td>Amphibians</td>
<td>279 spp.</td>
<td>30 spp.</td>
<td>10.8</td>
</tr>
<tr>
<td>Fishes</td>
<td>2,804 spp.</td>
<td>440 spp.</td>
<td>15.7</td>
</tr>
<tr>
<td>Bryophytes</td>
<td>494 gen.</td>
<td>8 gen.</td>
<td>1.6</td>
</tr>
<tr>
<td>Pteridophytes</td>
<td>224 gen.</td>
<td>5 gen.</td>
<td>2.2</td>
</tr>
<tr>
<td>Gymnosperm</td>
<td>32 gen.</td>
<td>8 gen.</td>
<td>2.5</td>
</tr>
<tr>
<td>Angiosperm</td>
<td>3,116 gen.</td>
<td>232 gen.</td>
<td>7.4</td>
</tr>
</tbody>
</table>
Genetic Diversity

Due to human encroachment the habitat for animals and plants is continuously diminishing, which decreases the numbers of animal populations and plant species. The resulting problems such as inbreeding, genetic drift, bottleneck effect, gene flow break, lead to the reduction of genetic diversity or genetic exhaustion.

*Macaca mulatta*, a common primate in China, possesses rich differentiation of subspecies. Different geographical populations and subspecies show different mtDNA polymorphism. This subspecies in north China has a unique type of mtDNA, i.e., unique genetic diversity, and it should be considered as one of the major primates to be protected.

In 1988, a new species of deer (*Muntiacus gangshanensis*) was discovered in northwestern Yunnan. Its chromosomes (2n=8 female, 9 male) are large and easy to distinguish.

China has also a wide variety of domestic animal breeds and crops which are an important component of the global genetic resources. In addition, many important crops originated in China, such as soybean, rice, barley, tea, apples, etc. Besides these, there are many wild-related species and ancestral forms of domestic animals and cultivated plants, such as red junglefowl, wild ox, wild quail, wild soybean, wild barley and rice. Only in the Xishuangbanna area, more than one hundred wild species of cultivated large cattle are found in the Dulong River area. This species is well adapted to local harsh conditions and can be easily reared in tropical and subtropical mountainous regions as a potential and valuable animal resource.

The varieties of wild rice discovered in Southern China are abundant (*Oryza sativa, O. mayeriana, O. officinalis*, etc.). These plant germplasm resources are valuable in modern plant cultivation and gene transfer biotechnology.

Major Research Programmes and Activities in China

Conservation of genetic diversity of animals and plants has been initiated recently mainly in collection, preservation and utilization of genetic resources as well by using modern biotechnology. The Institute of Crop Germplasm Resources of the Chinese Academy of Agricultural Sciences has collected and preserved a large number of seeds of cultivated crops and their allied wild forms. The Institute of Cell Biology and Kunming Institute of Zoology of the Chinese Academy of Sciences (CAS-KIZ) have established cell and gene banks. This "frozen zoo" contains cell and tissue cultures of more than 200 species of animals including sperm and ova of some rare and endangered animals.

The major research activities on biodiversity in China at present are the following:

The Biological Basis of the Conservation and Sustainable Use of Biodiversity in China

This is a five-year (1991-95) major programme of CAS and consists of 7 components. The total funding for the five year programme is 5 million RMB yuan.

- Establishment of a Biodiversity Databank
- The Effect of Human Activities on the Ecosystem's Diversity
- Studies on the "Island Effect" in the Fragmented Tropical Rain Forests and on the Rules of the Fluctuating Species Diversity
- Studies on the Genetic Diversity of Wild Animals and Plants
- Studies on the Conservation of Biology and Population Viability Analysis (PVA) of Endemic Animal and Plant Species in China
- Studies on the Off-Site Conservation of Endangered Plants
- The Biological and Ecological Studies on the Sustainable Use and Scientific Management of Major Resource Animal Species.

Basic Studies on the Conservation Ecology of Biodiversity in China

This is a five-year key major programme supported by the State Sciences and Technology Commission (SSTC). The total funds equal 2.5 million RMB yuan. The programme is consists of three components.

- The Expansion and Modification of Biodiversity Information
- Studies on the Assessment, Prediction, Zonation, Sustainable Management and Policy-Making
- Case Studies of Biodiversity in Major Ecosystem Types and Zones

The Preliminary Studies on Biodiversity Conservation Techniques

This is a project of a five-year key programme of the SSTC, for breakthroughs in science and technology entitled "Studies on Techniques for Comprehensive Harness and Rehabilitation of the Ecological Environment". The total funds for this project are 1.5 million RMB yuan.

Studies on Conservation Biology of Major Endangered Plants in China

This is another five-year programme supported by the National Natural Sciences Foundation (NNSF) and is composed of 3 projects. Total funds equal 2 million RMB yuan.

- Studies on the Population Structure and Dynamic Models Endangered Plant Species
- Studies on the Reproductive Biology of Endangered Plant Species
- Studies on the Genetic Diversity of Endangered Plant Species at the Morphological, Cellular, and Alloenzymic Analysis.

The Biodiversity Research and Information Management Project

The Biodiversity Research and Information Management Project (BRIM) is supported by the World Bank grant (US$5.5 million) under "Chinese Environmental Assistance" from 1993-1997. The objectives are to (1) generate necessary information for management of endangered flora and fauna, conservation of genetic diversity, and sustainable management of natural ecosystems; and (2) provide information on biodiversity and bioresources to key policy-makers, planners, and the public in formats appropriate for incorporating biodiversity conservation into land management programmes and policies at local, regional, and national levels.

1. The Chinese Biodiversity Information System (CBIS):
   - to establish a national network for management and exchange of biodiversity data among major institutes and field research stations;
   - to strengthen the research capability of CAS in key areas relevant to biodiversity conservation sustainable natural resource management, and restoration of degraded ecosystems and natural communities; provide the
decision-makers with both primary and derived scientific information.

2. Species Diversity Conservation and Sustainable Use:
   - studies in conservation biology on rare and endangered species;
   - studies on conservation of endangered species and their sustainable use;
   - off-site conservation of endangered plants.

3. Ecosystem Research, Monitoring and Management:
   - to assess the status of ecosystem diversity within the major climate zones of China;
   - to identify the major impacts of human activities on natural communities within selected ecosystems representative of major bio-regions in China;
   - to undertake long-term studies on sustainable use of natural resources;
   - to undertake pilot studies on restoration of degraded natural landscapes.

4. Genetic Diversity Research and Conservation
   - to improve capabilities for research and survey of genetic diversity in natural populations of animals and plants;
   - to develop and enhance the capacity of research centers of genetic diversity to store and maintain genetic materials.

5. Information Dissemination and Training
   - to help the BC/CAS organize specialized scientists periodically to write reports on status and strategy of biodiversity in China, and assist the government in finalizing a standard policy.
   - to publish *Biodiversity Magazine* (quarterly in Chinese and English, in addition to a *Biodiversity Newsletter* periodically);
   - to enhance awareness of issues on biodiversity conservation and the sustainable use of wild animal and plant resources for policy-makers, planners, and the public; to facilitate the access and use of equipment for training programmes related to biodiversity conservation;
   - to coordinate the above three points in designing and implementing related training programmes.

**Acknowledgements**

This paper is based on the proposal submitted to the World Bank entitled “Biodiversity Research Information Management Project” and “Biodiversity in China: Status and Conservation Needs” compiled by the Biodiversity Committee of the Chinese Academy of Sciences (CAS). The author would like to express his appreciation to Professors Qian Yingqian, Cheng Linzhi, Wang Song, Ma Keping, and other authors.

**References**


Russian National Biodiversity Conservation Programme

by V.E. Sokolov, B.R. Striganova, Y.S. Reshetnikov, Y.I. Chernov and M.I. Shatunovsky

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Introduction

Biodiversity, a modern concept covering the entire multitude of life forms and communities on Earth, is essential for maintaining the balance and the functioning of the biosphere. Public awareness of the importance of biodiversity and the need for its conservation resulted in the adoption of the Convention on Biological Diversity at the United Nations Conference on Environment and Development (UNCED), held in 1992 in Rio de Janeiro, which has been signed by more than 160 countries, including Russia.

During the recent decades, the loss of plant and animal biodiversity and the degradation of a number of valuable resource communities has been primarily associated with heavy anthropogenic pressure and the manifestation of such distant consequences of technogenesis, which could have hardly been foreseen when new technologies were introduced.

However, the development of policies aiming at the conservation of biodiversity and the management of biological resources calls for the investigation of a number of problems related to the current status and dynamics of biodiversity on a global scale and in particular regions of the world. The solution of these problems at the regional level determines the need to develop national programmes for the assessment and conservation of biodiversity.

There is a major need to promote biodiversity inventorying and monitoring due to the unsatisfactory level of investigation of numerous groups of organisms. According to some assessments, the number of known species, currently estimated at 1.4 million species, accounts for no more than 15% of the possible total richness of living organisms. Only 10% of insects and only 5% of fungi have been studies (Raven & Wilson, 1992). The difference between the number of known species of microorganisms and their actual diversity appears to be still greater.

Even the diversity of superspecies taxa, including higher ranking taxa, calls for further study. This is indicated by the fact that as early as the 1980s, two new orders of marine invertebrates and two new families of flower plants were described, and this list can be continued. A new type of deuterostomatic invertebrates, Cephalorhyncha, was discovered, and a number of new species and a new class - Loricifera - were described within it (Malakhov, 1980; Adrianov et al., 1989). This fact itself demonstrates the incompleteness of our knowledge of the biodiversity of the surrounding world. One needs to primarily expand the regional floristic and faunistic studies, and to develop quantitative approaches to the assessment of the spatial distribution of biodiversity on different scales - from the landscape to the microtopological level (MacArthur, 1982; Ricklefs, 1987). Other aspects to be addressed by national biodiversity programmes should include the analysis of the causes and...
sequences of the waves of mass extinction during the past epochs, when there were no anthropogenic pressure (Raup, 1991), and investigating the impact of climate change on biodiversity.

**Biodiversity Research in Russia**

Recently, Biodiversity research programmes have been developed in Russia, focusing on ecological transects. Prediction models of the shifts of separate natural zones on the territory of Russia at the elevation of the mean yearly temperatures at 1.4 and 2 degrees respectively, were developed.

The investigation of the effects of anthropogenic factors on biodiversity comprises both direct and indirect impacts. For example, anthropogenic changes in the landscapes (ploughing up of farmland, urbanization, recreation pressure, etc.) leading to the reduction and patchiness of natural habitats, affects the diversity of the gene pool and the structure of populations and communities, as well as the host-parasite and plant-pollinator relationships.

In Russia, active studies of the floras and faunas of particular regions and the diversity of natural communities in different zonal and landscape communities as well as the dynamics of natural populations have been studied for many years. The extensive territory and the great landscape diversity of Russia and adjacent countries that were previously parts of the Russian Empire, and subsequently, of the U.S.S.R., have been determining the traditional trends of Russian academic studies in biology, biogeography, soil science, and ecology, as well as comparative research into the floras, faunas, soil and plant cover and wild life in particular regions.

The Russian territory includes virtually all landscape formations of the extratropical zone from polar deserts to wet subtropics and arid communities of the Central-Asian type. There are some unique communities which are unprecedented in other continents or in other parts of Eurasia. For instance, in northern Siberia are inland polar deserts, which are absent in the Western Hemisphere. Throughout the entire length of Eurasian coast of the Arctic Ocean stretches a well-defined zone of tundras and forest-tundra, covering all the modern diversity of subarctic ecosystems from those that develop under the effect of marine climate to extracontinental formations, developing on perennial permafrost. In the East-European Plain there is a well-defined zone of sandur plains with coniferous-broad-leaved forests, which are unique for the Euro-Asiatic continent and stretches from the western borders of Russia to the Ural. This zone is a huge depot of moisture in boggy areas, and it contains diversified forest formations with respective plant communities and wildlife. Russia alone has retained forest-steppe landscapes that were never developed or cultivated. It also includes a number of mountain systems in the European and Asian parts, which are regarded as centers of taxonomic diversity and speciation of many groups or organisms, due to their rich flora and fauna and high level of endemism.

The diverse and largely unique nature of Russia has also determined the traditional trends in the investigation of biological resources, which started in the middle of the last century. Numerous studies have focused on zonal and regional regularities of the distribution of living organisms and the structure of biological communities. It is not accidental that in Russia the patterns of natural zonality and genetic series of soils were described (Dokuchaev, 1983; Berg, 1934). Today, the Russian science has accumulated a large body of data, which can lay the foundation for the goal-oriented investigation of biodiversity on a modern conceptual and methodological basis, including both the theoretical and applied aspects.
The Russian National Programme for the Conservation of Biodiversity

The Russian Academy of Science has developed a proposal for the Russian National Programme for the Conservation of Biodiversity. This programme aims at developing biodiversity research and studies orientated towards the conservation and management of biological resources.

The assessment of biodiversity in the draft programme is limited by such levels of organization as the organism - population - community. The investigation of molecular and cellular levels of biodiversity is envisaged in other biological programmes, including the problems of the development of cyrobanks, cell cultures and collection of microorganisms. The main problem of the Biodiversity Programme of Russia is assessment of the recent biodiversity status and development of methods for the conservation of this status in situ and ex situ, and also the restoration of biodiversity in territories where it was disturbed by anthropogenic impacts, as well as development of the methods for management of bio-resources potential of Russia.

The draft programme is comprised of the eight following units:

1. methodology and methods of the investigation of biodiversity;
2. assessment of the status of biodiversity of Russia;
3. monitoring and dynamics of biodiversity;
4. biospheric and ecosystem functions of biodiversity;
5. conservation of biodiversity;
6. restoration of biodiversity;
7. sustainable use of biodiversity components;
8. legislative support of biodiversity conservation.

This programme, which is to be implemented by the year 2000, envisages the development of computerized databases on particular taxonomic groups of plants and animals, and the flora and fauna of particular regions of Russia, as well as the diversity of communities and ecosystems. Of great importance in this case in increasing publication of checklists, keys, etc., development of databases on zoos, botanical gardens, herbaria, zoological museums, systematization of collection funds, including the collections of living cultures. An important aspect of the investigation of biodiversity is the development of methods for isolating and assessing of biodiversity parameters, and also creating monitoring system of the diversity of communities and ecosystems, and isolation of zones with a maximal level of diversity for the designation of protected areas, including biosphere reserves.

A retrospective assessment of the nature and rates of biodiversity decline over the last 50 years is proposed with special reference to different regions of Russia and publication of checklists of plant and animal species, with abundance indices over each decade during that period. In this case the dynamics and of anthropogenic pressure in some individual regions (chemical pollution, eutrophication of waterbodies and development of lands, etc.) will be considered.

The Programme includes assessment of biodiversity decline as a factor modifying the functional links in the ecosystem and reducing the rates of the biological cycle, the energy flow along the food chains. The system of the assessment of the level of ecosystem disturbance will be developed with special reference to the tolerance and plasticity of the ecosystems as determined by natural mechanisms. Particular attention is given to the
investigation into the status of the gene pool of animals and plants in different regions of the country. An assessment will also be made of the gene pool reduction over 50 years.

On the basis of the materials obtained recommendations will be developed on the restoration of genetic diversity of populations and particular species and also on the restoration of biodiversity of the ecosystems. These studies will be closely related to sustainable methods of the use of biological resources with special reference of differences of particular populations and communities determined by natural factors, and also the degree of their degradation under anthropogenic pressure. Hence, a special unit of the Programme is the development of scientific fundamentals of the conservation of biodiversity, including the juridical aspect, and bringing the legal basis of Russia in conformity with the International Convention for Biodiversity.

It is proposed that the Biodiversity Programme will be approved by the Supreme Council and the Government of Russia as a federal science and technology programme under the auspices of the Ministry of Science and Technological Policy with the participation of the Ministry of the Conservation of the Environment and Natural Resources and the Russian Academy of Sciences. The implementation of this Programme will involve the Federal Service for Forestry and also the country's universities. The participation of roughly 40 academic institutes and those involved in developing applied problems. The Biodiversity Programme, as well as other federal science and technology programmes will be funded by the Government of Russia. The volume of research under this Programme will be determined by the level of funding. In addition, some particular executives of the Programme may be included in the projects, which are financially supported by an international foundation.

The approval of the National Russian Programme for Biodiversity and its implementation will make possible a joint action of scientists from many countries in the assessment and conservation of recent biodiversity in Russia. In this case, a great importance is attached to the development of international cooperation and inclusion of the results of the assessment of biodiversity of Russia into the international system of database for the development of a global strategy of biodiversity conservation, which is currently conducted under the auspices of the UNEP.

References


Towards the Development of a National Strategy of Biodiversity Conservation in Hungary

A framework for a National Strategy of Biodiversity Conservation in Hungary was developed by a working group of Hungarian ecologists and approved, in January 1993, by the Ecologicai Committee (chaired by Dr. Gabor Fekete) of the Biology Department of the Hungarian Academy of Sciences.

This "Strategy" is aimed to fulfill different tasks, among which the status of nature conservation in Hungary - from the scientist's point of view - is described and some of the critical problems are pinpointed. Symptoms and causes of biodiversity erosion of Hungarian habitats are specified, the effectiveness of different methods in conserving biodiversity is compared, and neglected and new research areas of biological conservation in this region are identified, as well as assigning the relevant tasks among responsible authorities (management, legislation, etc.). The study also discusses the methodology of the traditional nature conservation (nature reserves and in situ wildlife conservation), together with ex situ conservation approaches, and deals with some of the specific problems of biodiversity conservation related to agriculture.

Furthermore, the principles of the survey methods to be used in searching for endangering factors of Hungarian habitat types are determined, and procedures of building adequate databases for the diversity of flora, fauna and habitats are worked out. It is to be noted here that Hungarian ecologists and conservationists have already made the first steps to join the unified data systems of the Commission of the European Communities (CEC), e.g., CORINE Biotopes Project.

A special emphasis has been put on innovative ways of designing nature reserves. For example, to determine the size and location of a reserve, the scaling properties of the vegetation, the area requirements of different animal communities (birds, insects and others), and the scale of habitat diversity necessary to preserve these animal communities will be considered as well. However, a serious problem of biodiversity conservation consist, in many cases, of the shortage of specialists needed to inventory biodiversity, especially in some animal groups. The study also outlines the principles of improvement and further development of red lists reminding that even our moderately rare species are more and more threatened.

The study emphasizes the importance and responsibility of Hungarian botanical gardens in ex situ conservation (e.g., propagation and maintenance of nearly extinct populations). Four types of diversity are to be preserved here: diversity of traditional cultivated animals and plants, diversity of spontaneous species, diversity of land use types and diversity of agricultural systems (cooperatives, farmers; traditional and organic agriculture). The urgent need for establishing gene banks (live and meristem collections) of cultivated plants (e.g., fruit tree and vegetable variants) and of ecotypes of wild grasses and peaflowers which are potentially suitable for agriculture use is also stressed.

Emphasis has been put on the problems of biodiversity conservation related to agriculture, and the need to promote changes in the forest manager's attitude to conservation since 45 per cent of the Hungarian plant species and many more animals live in our forests.

by Janos Salanki and Peter Biro, based on Nemzeti biodiversitas-megorzési stratégia, published in Hungarian in the journal Magyar Tudomány, August 1993.
Resolutions of
the 24th General Assembly of ICSU

The 24th General Assembly of the International Council of Scientific Unions (ICSU) took place on 2-8 October, in Santiago de Chile. Among the Assembly's resolutions, the following are either related directly to the IUBS programmes and activities or have relevance to overall biological sciences community:

**Biodiversity and Taxonomy**

Considering the global importance of biodiversity and the many activities underway in countries world-wide, directed toward assessment, inventories, monitoring, conservation and management of biodiversity;

Recognizing the development of the important DIVERSITAS programme launched by IUBS, SCOPE and UNESCO in collaboration with IUMS;

The 24th General Assembly of ICSU

Resolves that the DIVERSITAS programme be commended and supported as a joint initiative;

Requests that the Executive Board give due consideration to the sponsorship of the international forum "Biodiversity: Science and Development - Towards a New Partnership" to be held in September 1994;

Endorses initiatives to develop biological taxonomic research (including molecular biological techniques) and training as essential components of programmes such as DIVERSITAS.

**Animal Research**

Whereas research involving animals has proved indispensable in a range of high priority research problems across the biological and biomedical disciplines;

Whereas such research must meet progressively higher standards of methodology and research ethics;

Whereas ICSU has been requested to formulate guidance about some of the problems now confronting researchers whose work involves use of animals;

The 24th General Assembly of ICSU

Resolves to establish an Inter-Union Working Group involving the Bio-Unions and ICLAS with the following objectives:

- to draw up an international data base on the present methods of regulating research involving living animals;
- to investigate the optimum means of sustaining the delicate balance between the requirements of essential research and the welfare and protection of animals;
- to formulate an outline code of conduct for research involving animals, taking into consideration the ethical implications;
- to consider how best to foster public awareness and understanding of the need for animal experiments in scientific research; and

Requests the Working Group to submit an interim report for discussion at the 1994 meeting of the General Committee.

**Brain Research**

Whereas basic research on brain structure and function may provide essential understanding of normal mechanisms underlying mind and behaviour and of disease-related brain dysfunctions;

Whereas the admission of IBRO as a new Scientific Union member of ICSU has highlighted the importance and interdisciplinarity of the area of brain research;

Whereas the importance of this field has been recognized by the declaration of the "Decade of the Brain" initiated by the U.S. Senate;

The 24th General Assembly of ICSU

Refers to the consideration of the Executive Board whether "brain" should be set as a priority area for ICSU through the establishment of an Inter-Union Working Group that would formulate a proposal to create a priority programme on brain research which would ensure the participation of all interested ICSU Members, and report on its conclusions and recommendations at the next meeting of the General Committee.

**Patenting of Naturally Occurring Partial Human DNA Sequences**

The 24th ICSU General Assembly of ICSU

Fully endorses the declaration on the patenting of naturally occurring partial human DNA sequences made public by the ICSU Executive Board in 1992; and

Entrusts the Executive Board to follow the development of this issue and to strive for an international agreement that deals with this subject and which can preserve human dignity and can safeguard the widespread access of information on human genes to scientists from all latitudes.

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The International Commission on Zoological Nomenclature (ICZN) proposes to publish a new edition of the Code, taking into account the large number of possible amendments submitted, many of them in response to a widely circulated invitation published in volume 46, part 1 of the *Bulletin of Zoological Nomenclature*. It is planned that the Fourth Edition will be published during 1995 and that on 1 January 1996, its provisions will supersede

The Commission's Editorial Committee met in Hamburg from 12-16 October to prepare a discussion draft for the new edition of the Code. This draft will be available for distribution in February 1994. Copies will be sent without charge to all subscribers to the Bulletin and to members of the American and European Associations for Zoological Nomenclature. Any other institution or individual may order a copy from the Executive Secretary, at the address listed above. The cost of printing and postage is about £3 or US$5. Bank charges on currency exchange make it uneconomic to charge the cost of printing and postage (£3 or US$5) except for payment in sterling or US dollars. The draft of the Code will therefore be sent free of charge, but those able to pay in sterling or US dollars are asked to enclose a cheque for £3 or US$5 to cover the cost.

Before completing the definitive text of the Fourth Edition, the Commission will (in accordance with Article 16 of its Constitution) carefully consider all comments and suggestions on the draft submitted within one year from February 1994.

By Philip K. Tubbs, Executive Secretary of ICZN, British Museum (Natural History), Cromwell Road, London SW7 5BD, U.K.

Call for Nominations for New Members of the International Commission on Zoological Nomenclature

The following members of the Commission reach the end of their terms of service at the close of the XXVth General Assembly of the International Union of Biological Sciences to be held in Paris in September 1994: Dr. F.M. Bayer (U.S.A., Corallia); Prof. J.O. Corliss (U.S.A., Protoista); Prof. Dr. G. Hahn (Germany, Trilobita); Prof. Dr. O. Halvorsen (Norway, Parasitology); Dr. Ya. I. Starobogatov (Russia, Mollusca); Dr. V.A. Trjapitzin (Russia, Hymenoptera).

The addresses and specialist fields of the present members of the Commission may be found in the Bulletin of Zoological Nomenclature, 50 (1) (March 1993). Under Article 3b of the Commission's Constitution a member whose term of service has ended is not eligible for immediate re-election unless the Council of the Commission has decided to the contrary.

The Commission invites nominations, by any person or institution, of candidates for membership. Article 2b of the Constitution prescribes that:

"The members of the Commission shall be eminent scientists, irrespective of nationality, with a distinguished record in any branch of zoology who are known to have an interest in zoological nomenclature".

(It should be noted that "zoology" here includes the applied biological sciences (medicine, agriculture, etc.) which use zoological names).

Nominations made since June 1990 will be reconsidered automatically and need not be repeated. Additional nominations, giving the date of birth, nationality and qualifications (by the criteria mentioned above) of each candidate should be sent by 1 June 1994 to: The Executive Secretary, International Commission on Zoological Nomenclature, c/o the Natural History Museum, Cromwell Road, London SW7 5BD, U.K.
10th International Symposium on Carotenoids

Sponsored by IUPAC, the 10th International Symposium on Carotenoids was organized on 20-25 June 1993, in Trondheim. This symposium was devoted to discuss and disseminate research results concerning chemical, biological, biotechnological and functional aspects of carotenoids and retinoids. As many as 222 active participants coming from 28 different countries attended this meeting which offered 7 invited plenary lectures, 12 invited session lectures, 48 oral contributions, and 133 posters.

The molecular analysis of carotenoid synthesis appears to made much progress. The gene coding for the enzymes catalyzing the specific steps in the carotenoid biosynthetic pathway have been cloned. The use of recombinant DNA techniques has been shown to affect carotenoid productivity in bacteria, yeast and higher plants, and offers exciting prospects.

The absorption, transport and metabolism of carotenoids in humans has been extensively covered and the triggering process of visual transduction was exposed. The function of carotenoids in photobiology were reviewed as well as recent advances in clinical research involving carotenoids.

One session concerned the function of carotenoids in photosynthesis with special interest to their excited states and their fluorescence properties. Several posters were devoted to the xanthophyll cycle and to the localization of carotenoids in pigment-protein complexes.

The developments in world aquaculture, feed formulations and the role of carotenoids including those as antioxidants and activity in reproduction and growth processes and immunological functions were noted. Many posters concerned the necessary use of dietary carotenoids, i.e., astaxanthin, canthaxanthin in the salmonid diet.

By Y. Lemoine, Université des Sciences et Technologies de Lille, 59655 Villeneuve d'Ascq Cedex, France

Four Million Years of Hominid Evolution in Africa

In honour of Dr. Mary Douglas Leakey's Outstanding Contribution in Paleoanthropology, an international congress "Four Million Years of Hominid Evolution in Africa" was held on 8-14 August, 1993 in Arusha, Tanzania.

Two main themes were considered: Archaeology and Paleontology (mainly palaeoanthropology and paleoecology). Over 130 participants from 16 countries were present, and about 90 lectures were given, focusing on various aspects of archeological, paleoanthropological, and paleontological fields in Tanzania and Kenya.

The first part featured new results from recent field work excavations, as new Tanzanian sites were presented, bringing important contributions to the understanding of hominin evolution. The anthropological session presented the opportunity to observe the remains of the most recently discovered hominids, including the well-preserved skeleton of the "West Turkana Boy" and the mandible of the Chiwondo Beds in Malawi.

Tanzania is very famous for its yield of important hominid remains as well for the oldest footprint traces of Australopithecines.

By Christiane Denys Ura, 327 CNRS Laboratorie de Paléontologie, Institut des Sciences de l’Evolution, Case Courrier 064 USTL, Place E. Bataillon, 34095 Montpellier Cedex 05, France