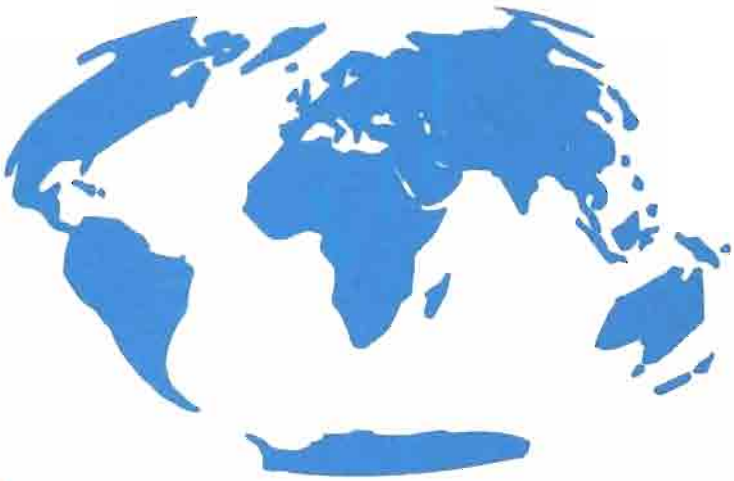
BIOLOGY INTERNATIONAL

The News Magazine of the International Union of Biological Sciences (IUBS)



1995 January N° 30

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ISSN 02532069

Biology International N° 30 (January 1995)

Editorial

Revolutions Impacting on Contemporary Biology

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"Biology is the most complex of the sciences, as it is the science of most immediate and direct importance"
(Huxley, 1924: 241)

The 1990s are witnessing unprecedented demands on the biological sciences. These demands arise from both revolutions within the science and the changing perceptions and priorities of humanity. The confluence of these tides is placing unprecedented challenges on the science of biology and also on individual biologists. As biologists we should expect change rather than stasis, but the self-generated and externally-imposed upheavals now in train are such that they can only be defined as "revolutions".

It is difficult to constrain or terminate a revolution which has a substantial constituency. However, it may not be impossible to ensure that the outcome of a revolution is increased fitness -- provided that the revolution is recognized at a sufficiently embryonic or juvenile stage. The early and accurate identification of a disease is the key to its control. Similarly, to recognize openly the revolutionary forces at work in contemporary biology is the initial step towards ensuring that: (a) any potentially deleterious effects of those forces are minimized; and (b) where possible measures are taken to harness those forces to the benefit of our subject. In introducing this issue of *Biology International,* I wish to draw attention to revolutions I feel we need to be aware of in our thinking at the personal, national, international association, and union levels.

The topics identified here are a personal selection, and certainly not exhaustive. If there are other revolutions in progress which are affecting, or potentially could affect, the practice of biologists in general, the Editor would welcome a communication from you.

External Revolutions

Accountability

The freedom of scientists to devote their energies and obtain resources for curiosity-driven research is subject to increasing constraints in universities as well as specialist research institutions. Peer review groups assess not only the quality of research, but its relevance.
The relevance of research can be judged by a variety of criteria depending on the topic, with pertinence to wealth creation and the quality of life increasingly to the fore -- as exemplified in the UK Government's white-paper *Realizing Our Potential* (UK Government, 1993). The ability of programmes to attract outside funding to support them is another potential measure of relevance which, as citation indices, has to be used with care. "Big science" does not necessarily equate with "good science" or "relevant science".

The use of the number of papers in peer-reviewed journals, and of citation indices as indicators of performance has to be cautious; these "measures" can all too easily become goals in themselves -- inhibiting certain types of publications and to the detriment of science. The objective assessment of the relative significance of particular publications is an almost impossible task and cannot be based on, for example, citation numbers alone. Consider three papers: (a) a 10 page molecular techniques paper with 500 citations repeatedly cited over 1-2 years and then eclipsed (total 500); (b) a 700 page systematic monograph with only 10 citations each year but the standard work cited at this level for 50 years (total 500); and (c) a two page paper with a novel hypothesis for testing attracting 2 citations per year for 10 years, and then a surge to 480 over the years 11-15 following its experimental proof and recognition as a classic insight (total 500). Each is clearly significant and received the same citation total but over different time scales. What is their relative scientific contribution ? How would each have scored one year after publication ? Is it equitable for the author of (a) to be singled out for particular reward ?

Accountability can extend to the recording of the amount of time, consumables and other expenses are used for particular research topics, and upward assessments of performance by students, more junior scientists, or support staff. Programmes are increasingly presented as fixed-term externally funded projects and undertaken by scientists contracted for the duration; these have defined objectives, requirements for regular reports, and may be accompanied by evaluation criteria. In order to secure the finances for projects from outside funding sources, the scientific agendas have to mesh with the agendas and priorities of research councils, foundations, and agencies.

In addressing this revolution, we must endeavour to contribute to the discussions that shape the agendas of both governmental and non-governmental funding agencies, accept that "good science" is not the antithesis of "relevant science", be able to interpret and justify research in those terms, and contribute to the development of appropriate evaluation criteria.

Biodiversity

Biodiversity suddenly entered the political agendas of many countries at the UN Conference on Environment and Development in Rio de Janeiro in 1992. The Convention on Biological Diversity prepared at that Conference came into force in December 1993, and by December 1994 it had been ratified by the governments of 106 countries. As countries start to develop national plans for the conservation and sustainable use of their indigenous biodiversity, the extent of our ignorance of the species that comprise that biodiversity, and further, how they interact to maintain particular ecosystems, is being exposed. Fundamental questions remain unanswered. How can the extent of the biodiversity at different sites be measured (Harper and Hawksworth, 1994). How many species occur on Earth, and how many have so far been described ? What species have become extinct in recent decades ? What effect will the loss from, or introduction of species into a site have on the overall diversity ? How many species are necessary to perform crucial processes necessary for the maintenance of a particular ecosystem ? What potential applications do particular species have ? What is the economic value of the species present ?

Such topics had not previously been a focus for biological research. But the perceived relevance of biodiversity research has changed. In order to maintain the reputation of biology (organismal and ecological), it is crucial that the explosion of recent biodiversity research activity continues on an exponential trajectory, but one directed towards the concerns and questions of governments -- and where appropriate, coordinated internationally (see below). The Conference of the Parties is establishing a Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), which is to meet at UNESCO in Paris in September 1995. Biologists should take the opportunity to brief their national delegations as to the issues of concern to them, both with respect to scientific questions and issues that could impact on the way they work (*see below*).

The conceptual framework of *Diversitas*, the IUBS-SCOPE-UNESCO programme on Biological Diversity (di Castri and Younès, 1994), is pertinent here; it is a means of optimizing the opportunity afforded by the biodiversity revolution for progress in the biological sciences.

Bioethics

The question as to how and to what degree scientists should "interfere" with or direct life is nothing new. Indeed, issues related to eugenics were a subject of active debate through the 1920s into the 1940s in particular (Allen, 1992; Bennett, 1983). The tools now becoming available through the combination of advances in molecular biology and genetic engineering, together with technological advances, mean than *Homo sapiens* is becoming increasingly empowered to intervene in his own destiny.

Interventions which result in the cure of a genetically based disease could hardly not be welcomed, but topics even as basic as sex-selection, let alone the distant spectre of "designer-babies", understandably generate heated debates. An "anti-interference" lobby is developing in some countries which in some instances could lead to violent revolution on occasion.

Bioethical concerns are not confined to humans. To what extent is it ethically acceptable to undertake the genetic engineering of other organisms ? Does *Homo sapiens* have a right to render other species extinct ? How should animals destined to be used for food be reared and treated ?

As biologists we have to be wary of becoming ideologists (Lewontin, 1993), and to stress that it is not science *per se*, but rather its application which may be beneficial, benign, or harmful. A common stance amongst biologists on bioethical issues is probably an

unattainable goal, but it is crucial that issues are debated objectively, and where appropriate, that recommendations and guidelines are prepared by and for use within the global biological community. For this reason, the decision of the 25th General Assembly of IUBS to examine the desirability of establishing a Commission on Bioethics is welcome. Such a Commission could also contribute to ethical issues related to other matters, such as the intellectual property rights to organisms and genes (*see below*).

Biosafety

Biosafety with respect to the handling and containment of organisms hazardous to humans, or of quarantine importance as agents of diseases in crops and livestock, is increasingly becoming regulated. While it is prudent to err on the side of safety, and to install appropriate documentation and procedures, the last decade has witnessed an often almost revolutionary fervour in the desire to eliminate risks. The result has been major changes in the working practices and design of laboratories handling fungi and other microorganisms.

The practice of introducing one organism to control another, biological control, first came to the fore in 1886. Since that time an international trade in beneficial insects, and to a lesser extent fungi, nematodes, viruses, and bacteria, has been taking place. The techniques are especially attractive as alternatives to chemical pesticides as the introduced organisms have restricted host ranges and so do not eliminate naturally occurring beneficial organisms and are environmentally friendly. Biocontrol is also an important weapon for the conservation of biodiversity, for example by the control of invasive weeds (International Institute of Biological Control, 1994). Caution is, however, clearly necessary and moves in progress to establish a Code of Conduct for the release of organisms for biocontrol purposes by FAO are therefore welcome.

However, it is genetic engineering that generates the most concern. Indeed, this proved to be one of the most emotive issues voiced by delegations to the First Conference of the Parties to the Convention on Biological Diversity in The Bahamas last December. While in the case of food crops any potential risk to human health requires evaluation, as does the possibility of possible effects of the transfer of genetic material from the engineered organism to others, could an overall ban as campaigned for by some non-governmental delegates be justified ?

For those without appropriate scientific knowledge, spectres such as those in the popular films *The Fly* (1986) and *Jurassic Park* (1993) may seem all too feasible.

Nevertheless, the revolutionary desire to regulate and contain can be seen as an opportunity and not only a constraint. An opportunity for new research to evaluate potential risks, and also to educate the regulators. In this way, decisions could be made objectively rather than emotively, so that unnecessary constraints to the detriment of humankind are not introduced.

Information technology

The pace of revolution in information technology can only be described as staggering. *Internet*, scarcely heard of in 1992, now connects some 23 million PCs, and the *World Wide Web* is also destined for exponential growth. The potential for rapid exchange of and access to biological data of all kinds is phenomenal, and there is an increasing prospect of electronic scientific journals being established in biology as in physics. While it would be premature to forecast the demise of traditional scientific publications, circulations will be affected by easier access to journal contents pages, abstracts, and photocopy services.

In the US in particular, the freedom of access to information at no cost to the individual is increasingly expected. Where the income from the sale of hard-copy publications is necessary to cover the costs associated with data collection, if databases are to be updated and maintained, some reimbursement mechanism is essential.

Revolutions in information technology are also providing new possibilities for the analysis and delivery of biological information, the production of interactive identification systems, production of compendia, and communications. These enable new approaches to be made to tasks which were hitherto inconceivable. For example, IUBS launched a programme to develop a world master species database approved at the 25th General Assembly in 1994 (SPECIES 2000: World Species Enumeration). The potential for linking biologists world-wide so that they can collaborate in such major programmes is enormous; a vision of what could be realized for the world's taxonomic support system is provided by Janzen (1993).

Intellectual property

Concern over intellectual property, especially the rights of a country over the use of its indigenous genetic resources, especially outside the country, has come to the fore in relation to the Convention on Biological Diversity (*see above*).

While few would dispute the spirit of concerns over ownership, the practical difficulties in implementing and policing an equitable system of benefit-sharing are immense. These issues will be addressed by the governments that are parties to the convention, but it is crucial for biologists to take an active part in this debate to ensure that this revolution does not render key areas of relevant research impractical.

This is particularly so with respect to the collection and distribution of both living and dead material of organisms in all groups for systematic and other non-exploitive research purposes. Concern extends not only to newly collected material, but to possible implications for the usage and exchange of collections already in existence. The issue has recently been highlighted by proposals of the US Fish and Wildlife Service that museum collections being loaned for systematic research purposes be subject to extensive documentation and in some cases import duties and taxes by invocation of the "Lacey Act" designed to prevent commercial dealings in illegally collected wildlife (Stone, 1995). If such interceptions became the norm, the implications for taxonomy would be enormous. In the case of type material, that is the collections to which scientific names are permanently attached to fix the application of those names, a pivotal component of the communication system of biology would be at risk if these were not held to be in the public domain.

Many of the pertinent issues with respect to the collection of biotic materials for screening by pharmaceutical companies, "biodiversity prospecting", have been aired (Reid *et al.*, 1993), and matters relevant to the world's collections of microbial cultures analyzed (Sands, 1994). In the case of the seed banks held by the various institutes established under the Consultative Group for International Agricultural Research (CGIAR), ownership was transferred to FAO in 1994 so that they are now in international and not national ownership. As in the case of other issues stemming from or related to the Convention on Biological Diversity (see above), in order to ensure that the revolution in progress on the ownership of intellectual property of organisms takes note of the impacts on science, it is essential that national delegates to key policy-making meetings are appropriately briefed. An internationally agreed Code of Conduct on *Ex-Situ* Collections could be of considerable benefit to practising biologists.

Popularization

Natural history aspects of biology have always attracted the interest of the public. However, perhaps partly triggered by the high-profile of biodiversity as "green" issues, and further by a fitter and increasing retired population, this has become a revolution in

the developed world. The public now has a voracious appetite for illustrated natural history books, guides, television, adult courses, and field-orientated societies. At 860 000, the membership of the UK Royal Society for the Protection of Birds (RSPB) exceeds that of the Conservative, Labour and Liberal Democrat parties together. Widespread popularity is also exemplified by David Attenborough's *The Private Life of Plants* the first programme of which was aired on 11 January 1995: six hour-long prime-time programmes on the principle BBC channel (repeated later the same week on a second channel).

Further, "ecotourism" entered our vocabulary in the last few years, and is already becoming a significant part of the tourist industry, itself one of the world's top businesses. In diversity-rich tropical countries particularly, ecotourism is attracting investment and government grants.

"Amateur" naturalists are also becoming more "professional". They demand more comprehensive and critical keys and monographs, purchase quality microscopes, binoculars, and photographic equipment, and some also contribute to local and main-stream scientific journals.

This revolution creates both a potentially valuable "lobby" and a human resource which we should not feel intimidated from utilizing, for example in inventorying and monitoring programmes. Increased interaction with this constituency could also help erode the barriers between "natural history" and the public perception of "science" (*see below*).

Public perception

Di Castri (1994) has eloquently highlighted problems of the public perception of science as portrayed through the media. Results are too often presented in a biased, slanted or sensationalist manner by "scientific" or "investigative" journalists without adequate scientific backgrounds. As in all news, the emphasis is on the dramatic, lurid, shocking, catastrophic, and scandalous. Unsubstantiated claims, statements taken out of context, or conclusions presented as "facts" with qualifying words or caveats omitted, are disseminated to audiences of an inconceivable magnitude compared with the peer-reviewed channels of science.

The situation is exacerbated by the publicity given to apparent cases of scientific fraud, even in the quality scientific press (Anon, 1994), and to enthusiastic scientists making claims that cannot be substantiated by evidence yet available (Simon & Wildavsky, 1993).

The eccentric images of scientists in cartoons, and the portrayal of scientists in books, films, and television, impact on the public from childhood days. Consider, for example, the escapades of Hunter's Professor Branestawm as illustrated by W. Heath Robinson (1872-1944; Hunter, 1990).

The revolution in perception from the respectable, revered and beneficial, towards the irrelevant, irreverent and dangerous, is insidious and pervades all science. This revolution will not be any easy one to stop or redirect, but as individual scientists each one of us can take care not to exacerbate the situation by our own actions, and to grasp opportunities to contribute to improving the public perception of our science. I have exhorted mycologists world-wide to devote two hours each week to explaining the relevance of their work to the public and policy-makers (Hawksworth, 1995); if this were extended to each biologist, imagine the scale of the lobby. If we assume a particularly conservative figure of 200 000 for the number of biologists world-wide, that would amount to about 215 full-time equivalents - not an insignificant "PR" force !

Internal Revolutions

Organization and unification

The organizational structure within biology arose on the assumption that all organisms could be classified either as "plants" or as "animals". This extended from teaching in schools and universities, through national societies, and to international organizations and congresses.

It is now clear that the number of kingdoms of organisms which should be accepted is at least five, and that particular organisms can be classified in more than one "kingdom" depending on individual interpretation (so-called "ambiregnal organisms"). At the same time, recognition of the importance of cross-cutting subjects such as biochemistry, ecology, genetics and molecular biology has contributed to a unified approach to the teaching of biology -- and the incorporation of departments, and examinations, of "botany", "microbiology" and "zoology" into ones of "biology".

Molecular biology has had particularly deep-reaching impacts on almost all areas of biology. By its nature it is interdisciplinary, asking questions and developing technologies cross-cutting and with applications in different groups. This in itself is a major revolutionary force, necessitating the most fundamental revision of working practices in biology since the advent of the light microscope, and also a driving force for more unified approaches to the subject.

These forces necessitate a reconsideration of the remit of often long-established organizations and subject divisions. For example, should the International Mycological Association (IMA; IUBS Section for General Mycology) restrict itself to organisms belonging to the kingdom *Fungi*, or to those studied by mycologists (i.e. including groups referred to the protozoa and stramenopiles) ? Similarly, should cyanobacteria and slime moulds continue to be treated under the International Code of Botanical Nomenclature ?

To continue to reflect outdated concepts in structures can imbue them with an image of being obsolete and irrelevant. The continued recognition of departments and chairs of "Cryptogamic Botany" is particularly unfortunate as it devalues the spectrum of organisms they cover (Hawksworth, 1995) -- especially in contradiction to the situation in zoology where entomology, icythyology, malacology, ornithology, etc., are regularly separated.

IUBS abandoned its divisions of botany and zoology at the General Assembly in 1982, following the cessation of some "microbiological" societies in 1980. But is that sufficient ? Organizational structures that will receive the strongest support will inevitably be those that most closely reflect current priorities and working patterns. This matter will need to be considered by the committee established at the 25th General Assembly of IUBS to review its structure; nomenclatural aspects, particularly the need for increased harmonization and unification of practices across all groups, are also being tackled in earnest (Hawksworth *et al.*, 1994).

Internationalization

The International Biological Programme (IBP), "the first serious effort to develop an international programme in the life sciences" (Younès, 1991), was initiated by IUBS in 1961, and later taken over and co-ordinated by ICSU. During the last thirty years, international co-operation has come increasingly to the fore as a method of realizing major biological research activities. In Europe, this has also been stimulated by the programmes of the European Economic Community (EEC).

The most costly biological research project to date, that to sequence the human genome by the Human Genome Organisation (HUGO) was initiated in 1988, caught the imagination, and by emphasizing its potential importance attracted the necessary funding (Bodmer and McKie, 1994).

The need to approach major scientific questions as team-players on a pitch of global dimensions, and not only as doyans in isolated laboratories, is a significant revolution which needs to be used to advantage. This is starting to take place with respect to initiatives related to the Convention on Biological Diversity, notably the Global Biodiversity Assessment (GBA), funded through the GEF and UNEP, initiated in 1993 and due for completion later this year. Elements of the IUBS/SCOPE/UNESCO *Diversitas* programme also need major international collaboration and funding and we should not be reluctant to stress utility as well as science (*see above*; Janzen, 1993).

Benefiting From Revolutions

Change is rarely welcome. Scientific organizations, just as individuals in all walks of life, develop "comfort zones" outside of which they fear to tread. In my inaugural remarks to the 25th General Assembly of IUBS in UNESCO Headquarters in Paris last September, I recalled Huxley's essay "On living in a revolution" written in 1942 (Huxley, 1944). He stressed the need to enter a revolution consciously, with a set purpose, with the proclamation of comprehensive aims held in common, and the determination not to be thrown off course by minor battles or other diversions. That is how I feel we biologists must tackle the challenges before us. We have to develop a vision of where we wish go, and ensure that the revolutions of which we are a part are directed in the way we wish them to proceed.

In developing his philosophy for UNESCO, Huxley (1946), its first Director General, was particularly concerned with the integration of science, especially biology, with human aspirations. While it would be surprising if some of the philosophy of the 1930s and 1940s did not require reinterpretation for the 1990s, the underlying theme is one which IUBS cannot ignore if it is to realize its potential. In this connection, I was particularly pleased to see the report of the workshop on understanding the interdependencies of man, culture and biodiversity held in Denver last year (Hauser, Little and Roberts, 1994).

My first contact with IUBS was as Secretary-General of the International Mycological Association (IUBS Section for General Mycology) in 1977. I was excited at the prospect of mycologists learning from the global biological community, and contributing to the international scientific programmes of the Union. Eighteen years later, I am even more enthusiastic about the potential of IUBS to make significant contributions to the progress and standing of biological science, to assist its scientific members in achieving their objectives, and to harness and benefit from the revolutions now confronting our science.

The IUBS Scientific Programme for 1994-97, described elsewhere in this issue of *Biology International*, is particularly challenging -- and embraces a significant number of the topics related to the revolutions identified here. That IUBS is fit and eager to embark on ambitious programmes of global relevance is a particular tribute to the persistence and vision of its Executive Director, Dr Talal Younès, during the period of the Union's "renaissance" from 1979 (Younès, 1991), as well as to a succession of distinguished and dedicated Presidents, other Officers, and Executive Committee members.

However, IUBS is not some ethereal body, but comprises every biologist within its scientific purview -- linked through their national specialist societies to particular international scientific members. IUBS has the potential, as an organization, to take advantage from, respond to, or where appropriate help direct, the revolutions now in progress.

Realization of this vision of IUBS as not only a coordinating but increasingly also a proactive force, furthering both the interests of science and humanity, will ultimately depend on the commitment of each one of us. I will count on, and look forward to, your support for, and inputs into, IUBS policies and programmes during my period of stewardship.

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Biology International N° 30 (January 1995)

Geographic Information System and Database Management at a Tropical Rainforest Research Station

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Introduction

Biological research stations are growing in numbers and becoming more sophisticated in the services they provide. It is not uncommon for researchers to have access to full meal services, air conditioned laboratories, libraries, and computers (NSF, 1992). More comfortable living combined with access to research equipment allows researchers the opportunity to stay longer at the site thereby becoming part of an atmosphere that promotes the integration of data, information, and knowledge. One of the mechanisms available for this integration is access to computer-based tools such as Geographic Information Systems (GIS) and Database Management Systems (DBMS).

Techniques associated with GIS and DBMS are not new to research and government agencies. Their popularity also extends into various disciplines including geography, ecology, and biology (Cromley, 1987; Michelmore *et al,* 1991; Roughgarden, 1991; Wright, 1991; Moreno, 1992). In these fields, GIS allow for the combination of diverse, geographically referenced data in a computer environment for storage, query, and analysis. Additionally, they provide users with a structured environment in which data from various sources can be integrated and analyzed. For example, it becomes possible to examine impacts of socio-economic development on biological conservation (Scott *et. al* 1993; Sader *et al.*, 1990). Prior to the availability of such tools, combining data from multiple sources was difficult and often not attempted. Tools such as a GIS/DBMS in the data collection environment makes this possible.

This paper shows how the installation of a GIS/DBMS at one field station, La Selva Biological Station in Costa Rica, is bringing tools for multi-disciplinary research directly into the research environment. The important aspects addressed are the differing needs of the station administrators and the researchers, the integration of station-managed databases with researcher data sets, and the techniques used to provide data, computer access, and training. These concepts will be described by discussing the design study, the actual implementation, and the impact the system has on administration and research at the station.

The La Selva Biological Station

The Organization for Tropical Studies (OTS), founded in 1963, is an international consortium of about 50 universities, colleges, museums, and research institutions with the common goals of education, research, and conservation in the tropics. OTS promotes and

supports a wide variety of basic and applied research at three field stations in Costa Rica. The largest of these is the La Selva Biological Station located in north-eastern Costa Rica.

As a result of improvements in roads, public transportation, and dedicated OTS staff, La Selva has grown from a small isolated field station to an easily accessible research facility. This growth can be seen by the increase in the number of researchers that have visited the station: from 57 researchers in 1982 to 240 in 1992. In 1992 alone, La Selva hosted over 100 undergraduate and graduate courses and a variety of conferences and workshops in such diverse fields as agroforestry, biology, botany, ecology, herpetology, mammalogy, and ornithology (Clark, 1993). In addition to growth in research and education, the physical plant has been expanded to include a library, air conditioned laboratories, conference rooms, and housing for up to 70 people per night. Even the actual size of the station has grown to include approximately 1500 hectares of lowland tropical rainforest. The property consists of primary and secondary forest, abandoned pastures and plantations, managed habitats, and a 45 kilometer trail system (Figure 1).

The administrative activities at La Selva are also expanding at an increasing rate. In 1985, as part of the La Selva Master Plan, OTS implemented a database policy (OTS, 1992). This policy requires researchers to submit key data for archive when requested by the station administrators. Prior to this policy, researchers would collect data and return with them to their home institutions thus restricting the data access of other researchers.

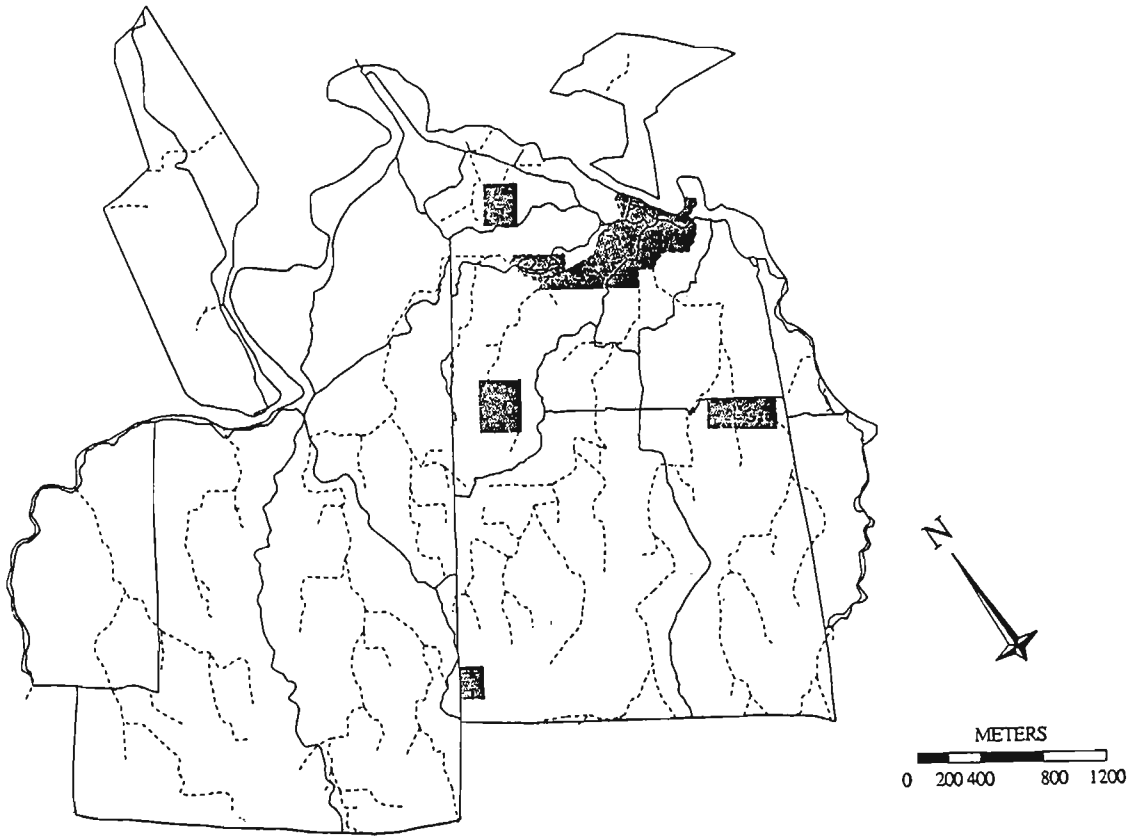


Figure 1

The station growth, coupled with the need to examine data historically and across disciplines, demanded a new environment to manage station and researcher data; simply archiving was not enough. This need forced the station administrators to investigate new computer tools, including a GIS and DBMS, as a means to support the increased growth.

The Design Study

Before an integrated GIS/DBMS system can be successfully implemented, a design study should take place to identify the needs of all potential users. Systems implemented without designs often fail, not from technological limitations, but because the system has not met the needs of the users (Marble, 1989). Design studies are either undertaken from within the organization or outside consultants are hired. In the case of La Selva, the study was conducted through a graduate level geography course offered at The Ohio State University.

The Ohio State Design Study

Following the design approach recommended by Dr. Duane Marble, twenty Ohio State University (OSU) graduate students divided into groups and formed questions for the La Selva administrators and researchers (Marble and Wilcox, 1991; Marble, 1983). The researchers were selected based on their potential interest in GIS applications as indicated by the station co-directors, Drs. Deborah A. Clark and David B. Clark. Questions focused on the database design and expected outcome:

1. what data do you expect to be included (e.g., soils, topography)? what scale?
2. what data would you provide?; what is the original format of the data?
3. do you have any previous GIS experience? and
4. what products/analyses do you expect?

In brief, the goal of the La Selva GIS is to be a tool shared by students, administrators and researchers so that the combined use of the system generates cross-disciplinary research and data integration. To meet these goals, the geographic database was fashioned in a hierarchical form, beginning with a detailed station survey, and then expanding the database to the surrounding region. The hierarchical database allows for expansion so that researchers can contribute to the system at all geographic scales. Another result of the study was identifying the need for a full-time person to work at La Selva for user support. This would allow the system to support the on-site needs of the station administrators and the researchers. A final result focused on the physical components of La Selva's infrastructure that are necessary to support a sophisticated computer system. To clarify these design results, a more thorough discussion of each follows.

Design Results

As a result of the design study, the following system goals were identified:

1) build a geographically referenced database to facilitate new approaches to research at La Selva;

2) assist the station administrators to make the decisions that directly affect the quality and type of research that takes place at the research station. For example, it is possible to use the GIS to analyze existing plot locations, trail locations, and forest cover to identify the locations of new research plots (Wentz and Castro, 1993);

3) design methods to help researchers use the database for project planning and spatial analysis;

4) provide the flexibility to include regionally based projects so researchers can take advantage of the system's ability to manage large data sets; and

5) develop on-line demonstrations and training documents to help provide the means for everyone to use the facility.

It became apparent that the La Selva system needed to include a non-geographic database management system (DBMS) in addition to the GIS. Tabular lists of flora and fauna, published and unpublished documents, and other information were in various forms at La Selva. To develop an integrated system effectively, these data needed to be included but were clearly not part of the geographic database. The DBMS portion of the database thus contains two types of data: those collected by researchers to be made publicly available, and the data maintained by the La Selva staff. Researchers provide digital data in a predetermined format with limited constraints to their accessibility as described in the database policy document. The core database maintained by OTS contains data representing general interests of the researchers and administrators such as researcher biographies, lists of flora and fauna, weather data, and herbarium records. The DBMS operates with the GIS so that relationships between the spatial distribution of certain features are associated with their non-geographic counterparts. For example, one of the geographic data layers is the distribution of researcher study plots. The user is able to link this geographic data layer with the lists of researchers involved in a particular study, resulting publications, keywords, and collected data. The researcher data and the station-supported data all contribute to data archived at the station in both geographic and tabular forms.

Geographic database development started for the La Selva region independent of OTS, but, coincidentally, was concurrent with the design study. This database included topography, roads, hydrography, park boundaries, and political boundaries obtained from maps published by the Instituto Geográfico Nacional (IGN) (Wilcox, 1989). During the interviews and with the aid of these data, it became apparent that a detailed survey of the research station was necessary. The interviews revealed that research scales vary from smaller than one hectare plots where individual plants are mapped to the entire station (approximately 1500 hectares). Even in the research projects involving the entire station, the maps published by IGN at 1:50,000 scale would not contain the detail necessary to identify spatial patterns for analysis. OTS decided to fund the development of a database with sufficient detail at the station level. Maintaining the plan for a hierarchical database, the database has grown to a larger and more regionally defined database including data from the adjacent national park as well as the initial data from the IGN maps.

In addition to the GIS based data, remote sensing data are also incorporated in the La Selva GIS and are being used by the researchers. These include images from airborne scanners, aerial photographs, and readings from radio telemetry (Luvall *et al.*, 1990). Uses of remote sensing in the tropics can include: examination of forest-land cover types to estimate deforestation rates and land use patterns, animal tracking through radio telemetry, and monitoring biodiversity (Sader and Joyce, 1988; Stoms and Estes, 1993; Campbell, 1993).

During the design study, the computer resources in Costa Rica were found to be extremely limited, including technical support and personnel to run the machines. This was especially true in the more remote regions of the country, which is where the research station is located. As a result, a system was designed to best support the users in a way that limited down-time would occur should problems arise with either the hardware, software, or databases. A second system running at the research station provides the first backup. A third system was donated by OTS to the School of Geographic Sciences in the Universidad Nacional Antonoma de Costa Rica to help maintain and establish further links with the Costa Rican universities and provide La Selva researchers with a system near

San José. A fourth system plus technical support is provided through the Department of Geography at Ohio State University. This system is accessible to authorized La Selva users through *Internet*. Providing multiple systems in several locations supports researchers while they are at the research station and when they are at their home institutions.

The users of the GIS/DBMS are mostly biologists, and therefore not trained and often not wishing to take the time to be trained in the technical aspects of GIS. In fact, many are not aware of the hours necessary to design applications, enter data, perform analyses, and output the products typical to basic GIS projects. The users want quick results to sometimes fairly complex questions. To resolve some of these issues, the GIS at La Selva is designed to have these components:

1) a database manager to assist researchers with the design of projects that involve a GIS component;

2) menu-driven programs to aid in the development of geographically referenced databases;

3) programs to assist with the output of these data either in the form of maps or digitally transferable files; and

4) general recommendations on where to look for additional information about GIS and methods for analysis upon their return to home institutions.

With the system objectives in mind, these components consist of databases and programs that are transportable to other systems, thus providing options and flexibility to the administrators and researchers. Details regarding these databases and programs will be discussed in the implementation section of this paper.

During the design study a few potential problems were identified that would determine whether or not the computers required for the system would function at the research station. La Selva is a tropical research station where high temperatures and humidity are normal. Also, rural areas in Costa Rica do not always have consistent electric power. Power fluctuations and shortages occur frequently that could damage the computers. OTS addressed most of these problems long before the design study. The two laboratories, as well as the library, are air conditioned and an electric generator capable of supplying power to the entire research station was in place for several years prior to the GIS/DBMS installation. In addition, surge protectors and uninterruptable power supplies (UPS) were purchased for the GIS/DBMS. These are designed to help guard against electric surges and to maintain consistent power during the ten seconds it takes the generator to provide electricity.

Implementation

Critical to the development of an integrated database was the construction of a precise geographic database. As indicated by the design study, the publicly available maps would not contain the necessary detail for mapping and analysis. OTS needed to construct a grid detailed enough to provide practical and accurate locations by researchers in the field. To meet these objectives, it was decided to construct a 50 by 100 meter topographic survey of the station. The accuracy of the grid is +/- 20 cm in the x-y direction and +/- 10 cm in the z direction. Also included in the survey were the trails, streams, station boundaries, building locations and primary research plot boundaries. These data form the foundation from which the remainder of the geographic data are constructed.

To assist researchers in the field with the collection of geographically based data, a steel tube was placed at the intersection of each 50 by 100 meter grid line and labelled with a unique identification number. By using the fixed tubes, researchers can now map the location of trees, plants, animal sightings, study plots, etc. based on the survey with a compass and a tape measure. Although no protocols regarding quality control on data collection are established, the grid provides a better system for recording study locations. Previously, researchers would estimate their location based on approximate distances from unsurveyed positions on the trail. With the survey, data collected from the grid can be entered directly into the GIS and combined with the existing information in the hierarchical database.

To complement the hierarchical database design, remote sensing data were collected for the region. Sets of black and white aerial photographs from 1960, 1971, 1976, 1981 and 1983 were purchased from IGN. Each of these sets, at minimum, covers the research station property and most include significant portions of the surrounding area. The Canada Centre for Remote Sensing tested RADAR sensors in Costa Rica on two occasions and both included La Selva. Data from the first project conducted in 1977 are not available. Data from the second RADAR project were collected in 1992 and are in place at La Selva. These include the RADAR data and a set of low level color aerial photographs.

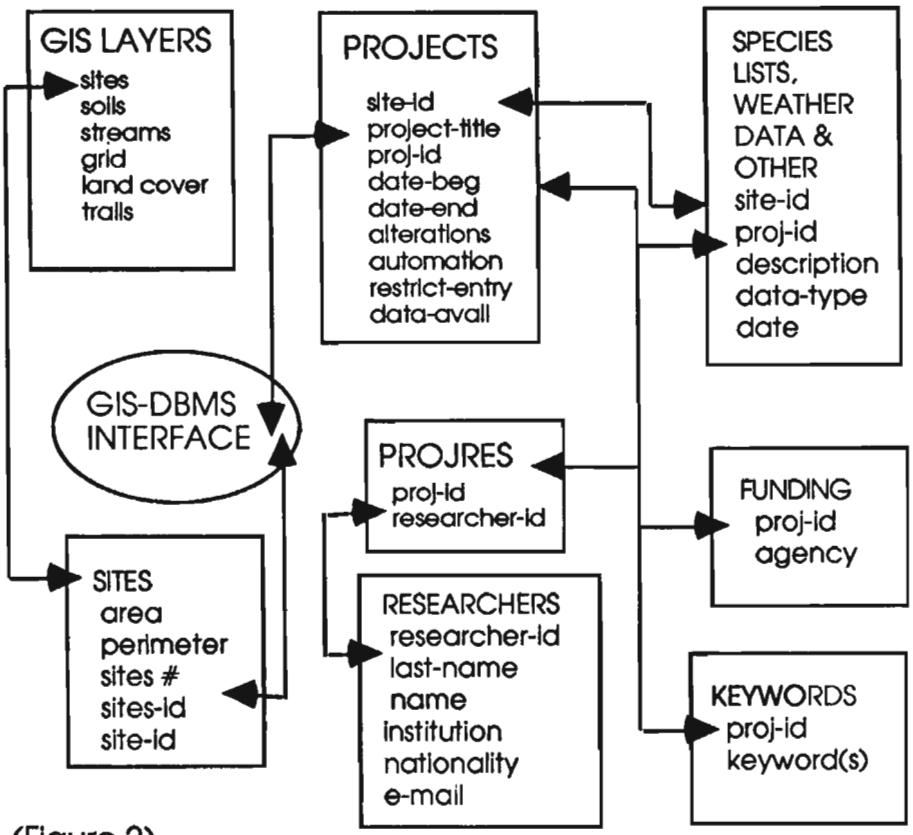
The National Aeronautics and Space Administration (NASA) also collected data from the area around La Selva. In 1988 NASA conducted a project to test two airborne multispectral scanners, as reported in Luvall *et al.* (1990). The two sensors, a Thermal Infrared Multispectral Scanner (TIMS) and a Calibrated Airborne Multispectral Scanner (CAMS), were tested over La Selva and most of the adjacent national park. Copies of aerial photographs taken as part of the project were donated by NASA. They include a natural color set and a false color infrared set for their entire study area. The TIMS and CAMS digital data are on-line at La Selva.

The non-geographic data were more difficult to compile because existing tabular databases were in several unorganized formats. Some data existed only on paper; others were in various software packages; some were in many stages of completeness; and most were maintained by different people, on different computers, and in different countries. To compile these data it was decided to start simple and begin with databases that were already in digital form in Costa Rica. Concurrent with the construction of the tabular database in Costa Rica, a comprehensive structure was designed with the idea that new databases could be added without disrupting the initial design (Figure 2).

An interface was structured to provide a direct connection between the GIS software and the DBMS software as the data were being compiled. Part of this link included the capability to transport the geographic and tabular data in ASCII format or in one of the export formats of the GIS or DBMS software in order to provide researchers a mechanism to take data home.

The GIS software being utilized is ARC/INFO because it provides a high level of programmer and user flexibility. Additionally, many of the OTS member institutions use it, thereby helping researchers apply what they have learned from La Selva to the systems at their home institutions. Sybase was purchased as the DBMS software because it is one of a small group of DBMS software packages with direct integration capabilities to ARC/INFO. The decision was made to use a DBMS software because they provide a Structured Query Language (SQL) interface not available through INFO alone. The hardware at the research facility includes two UNIX-based Sun workstations, two large digitizers, and two 8-color pen plotters. A local area network was installed, which includes three IBM compatible PC's and several Macintosh computers. These were established to facilitate data transfer and to allow for access to the databases from the administrative and public computers. The selections of hardware were made because the functionality of

ARC/INFO increases at the workstation level and workstations have the ability to support multiple users.



(Figure 2)

Examples of Use

There are several potential applications that demonstrate how the GIS is well suited to assist station administrators. The administrators need to maintain physical structures and monitor the research areas. The research use throughout La Selva can be monitored in the GIS to avoid conflicts and maintain the quality of the forest (Wentz and Castro, 1993). This type of site management is challenging because of the many variables to be considered: surface topography, trails and existing research plots. The GIS combines these variables and the output is a composite of the variables that OTS can use to assist researchers locate new study plots based on their specific criteria and existing environmental conditions. For example, a researcher may wish to locate a study area in a region that can be cleared, with alluvial soils, little change in slope, and independent of existing sites. The GIS can combine these variables and display areas fitting these criteria. If the researcher chooses to locate their plot in this location, the new site boundaries and the information about the researcher can then be added to the system.

Station administration was not the first project to utilize the GIS. A pilot project was established to polish the design and identify holes in the implementation. This project was a 16-month comparative ecological study of two of the primate species that coexist at

La Selva: *Ateles geoffroyi* (red spider monkey) and *Cebus capucinus* (white faced capuchin). A major component of the study included a comparison of the feeding patterns of these primates. Research included studies of feeding behavior as well as the spatial and temporal distribution of food resources used by the monkeys. While observing the monkeys, all trees that were used for feeding were marked with flagging. These trees were later mapped to the 50 by 100 meter grid. Prior to the installation of the GIS at La Selva, each tree was plotted by hand on a paper map of the study site. After the installation, all mapped feeding trees used by both primate species were entered as point data into the project database. Associated attribute data (observation date, tree species, monkey species, etc.) were also entered to produce the feeding tree database.

Possibilities for GIS use in primate field research are vast and virtually untapped. Some of the topics being explored in this and future research serve to illustrate how GIS has expanded the possibilities for approaching challenging research questions such as understanding how the animals use forest space. The GIS calculated overall use area by comparing a variety of techniques. For example, area of use can be calculated by counting the number of 100 by 100 meter grid squares that contain feeding trees, a minimum convex polygon, or buffering of the feeding trees. Examining how the use areas vary over time is critical in understanding how seasonal variation of food resources affects their use of the forest. Area size is only one component to analyzing the spatial distribution of the species. Other factors to be considered are tree species density and diversity of habitat.

The specific results of these applications are unpublished and hence are not included in this document. The application of GIS to this study, however, has given the researchers insights into the spatial patterns of the food resources that could not have been obtained using previous methods (e.g., paper maps). As a result, future primate field studies by this investigator will likely expand on results obtained in the current study and include GIS in the initial project design.

Not all research projects at La Selva, however, are based on the movement of animals. Many studies are based on sedentary organisms (e.g., trees). Geographic analysis for these studies may examine tree growth spatially and temporally compared to slope, elevation, and soil type. Using the GIS and the 50 by 100 meter grid, one project examined seven palm species found at La Selva (Clark *et al.*, 1993). When comparing the mapped locations to soil type, topographic position, and accessibility for harvesting, four of the species displayed highly-significant non-random distributions. It would have been difficult to obtain these results without the GIS.

The data collected and entered into the GIS from the primate project were among those used in the development of a poster and an on-line demonstration. The goals of the poster and demonstration were to introduce the concepts associated with GIS and DBMS and to begin to give potential users hands-on experience. Both were designed to illustrate the goals of the GIS at La Selva to appeal to students, administrators and researchers and to aid in the evolution of their ideas for the GIS. Utilizing data collected from the primate project promotes data integration objectives to other researchers. In addition to the poster and demonstration, extensive training manuals were written to document the entry of data, procedures for making maps, and samples of spatial analysis. For more information regarding GIS, users are encouraged to follow the training documents supplied with the ARC/INFO software. Although all projects at La Selva do not require explicit geographic analysis, these researchers benefit through the management of data sets, standard trail maps of the station, and the archive of databases.

Lessons Learned

When establishing a system like the La Selva GIS/DBMS, the primary goal is to create a solid foundation from which the system can continue to grow. This can only happen

through adjusting the initial design and educating the researchers and administrators in the use of the tool. The design continues to be improved through interviews with users as they visit the station and interact with the training and demonstration materials. The user interviews identified and continue to emphasize the need for a common database for administrators and researchers. It is especially valuable to researchers because it is unlikely that an individual researcher would construct a detailed system for personal use or integrate their data with other researchers. An advisory committee is being formed to formulate the future goals of the system. This group will be involved in setting priorities for the purchase of hardware and software, staff training, and database development and integration.

In general, the idea of data integration is supported by researchers but it is rarely practised. It is also true that administrators have little control on data collection techniques and thus data quality. Various protocols can be written by station administrators but they must be implemented and maintained. Despite these difficulties, the growth in research facilities demands better management of station resources, and a GIS/DBMS is one possible solution to these problems. This kind of facility should be maintained because it can be viewed as a centralized data archive for cross-disciplinary data and historical records of the research site.

The main objective for most researchers going to a research station is to collect data. Working at a computer in a laboratory can be viewed as inefficient use of resources during difficult financial times. A major problem with most GIS/DBMS is that the software programs are complex and training is expensive. As a result, many researchers are self-taught and this requires a time commitment that may be impossible in some cases. As the technology becomes integrated into the research environment, researcher resistance to a new mode of working will diminish. Unfortunately the technical staff available on-site to train researchers and construct new databases is a constraint. OTS operates on a limited budget primarily funded through grants and station fees. The problem is being addressed by providing users with portable databases, user oriented programs, documentation, and systems based at home institutions.

Conclusions

There are many similarities between La Selva and other field-based research facilities. On-site facilities provide many benefits by addressing both researcher and administration needs: creating a framework for multi-disciplinary research and providing for easy and uniform data archive. These needs can be met through implementing a software and administrative system that institutionalizes data sharing and standardization by providing a framework for storage and analysis. Researchers can perform preliminary analysis on-site so that more or different data can be collected quickly. Data can also be verified and re-collected if errors are found. These benefits will be more apparent as the technology is incorporated into the normal operating procedures of the researchers at the station.

Acknowledgements

The authors of this paper would like to express their appreciation to Dr. Duane F. Marble, Dr. Donald E. Stone, Dr. Deborah A. Clark, Dr. David B. Clark, Aimee F. Campbell, Marco V. Castro Campos, Dr. Donna J. Peuquet, Dr. Wayne L. Myers and the Organization for Tropical Studies for their participation and assistance with the project. Thanks also go to the National Science Foundation, Andrew W. Mellon Foundation, Sun Microsystems, Inc., and Environmental Systems Research Institute, Inc.

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The Convention on Biological Diversity: First Conference of the Parties (COP1)

Nassau, The Bahamas, 28 November - 9 December, 1994

The first Conference of the Parties (COP1), i.e., delegations from those governments which had ratified the Convention on Biological Diversity, took place in Nassau, The Bahamas, on 28 November - 9 December 1994. COP1 was attended by 722 registered persons in 277 delegations; these included 94 of the 106 nations that had ratified the Convention, 37 observer nations, 13 UN agencies/programmes, 25 other inter-governmental organizations, and 108 non-governmental organizations. Various institutions and companies were also represented at a "Biodiversity Technology Fair". The total number of people involved, including exhibitors, press, reporters, translators, and support staff, must have been around 1000.

Key Decisions of the Conference

The Conference inevitably focused on administrative and financial matters, but topics to be considered in the short- and medium-term work programmes were also considered. Major issues and decisions related to:

1. The financial mechanism to operate the Convention. The Global Environment Facility (GEF) had been operating as the interim financial mechanism, and was restructured in 1994. Developing countries were concerned about how this would operate and modalities to be developed as to how the COP could have inputs into project funding decisions. Details have still to be worked out, but the second phase of the GEF will continue to serve as the financial mechanism at least until COP2.

2. The United Nations Environment Programme (UNEP), which had housed the Interim Secretariat, was selected as the organization to house the Secretariat.

3. The Interim Secretariat has been based in Geneva, and a permanent location for the Secretariat was required. Offers from Kenya (Nairobi), and Spain (Seville), and Switzerland (Geneva) had been received, and COP1 decided on the criteria to be used in making a choice between the three proposed locations.

4. A budget for the Permanent Secretariat of US $ 5.7 million for 1995 was presented, but contributions by the ratifying countries to the fund would be "voluntary".

5. How to establish the Clearing House Mechanism and its scope required by the Convention had already been the subject of considerable discussion, including workshops in Mexico, Nairobi and Bogor, a meeting in Geneva, a published Discussion Paper prepared by the Stockholm Environmental Institute, and a separate meeting on 22-23 November 1994 in Nassau jointly sponsored by the Governments of Sweden and the Bahamas. The COP agreed to mandate the Secretariat "to prepare a comprehensive study .... containing concrete recommendations" which would also "need to draw on all relevant existing institutional structures". A pilot phase of operation is planned for 1996-97.

6. The medium term work programme was discussed at length, with property rights, compensation, and biosafety to the fore. Existing legislation on property rights is to be compiled, and it was decided "to establish an *ad hoc* group of experts with balanced regional representation" to prepare a review of risk assessment and existing guidelines and legislation.

7. The establishment and tasks of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) required by the Convention were discussed and the agenda for 1995 largely agreed. This will be chaired by Mr J Seyani (Malawi) in 1995 and by Dr P. J. Schei (Norway) in 1996. SBSTTA will meet at UNESCO Headquarters in Paris on 4-8 September 1995.

8. The Second Conference of the Parties (COP2) will take place in Nairobi in December 1995.

The last three days of the Conference were a Ministerial Segment in which governments and other bodies could, with the approval of the Chair, make policy statements. A document (Box 1) was approved towards the end of this segment.

The Bahamas Ministerial Declaration on The Convention on Biological Diversity

We, the Ministers participating in the high-level segment of the first meeting of the Conference of the parties to the Convention on Biological Diversity, held in Nassau, Bahamas, from 28 November to 9 December 1994,

Affirm the first meeting of the Conference of the parties to the Convention on Biological Diversity as the culmination of more than two decades of efforts aimed at the development and effective implementation of an international legal instrument to ensure the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources;

Recognize, in view of the rapid rate of species loss, the urgency of the task we face in conserving biological diversity;

Recognize that, as reflected in the Convention, conservation of biological diversity is not only a question of species extinction or ecosystems in need of preservation, but is linked to achieving social, economic and cultural progress, in a sustainable manner, for the benefit of present and future generations;

Regard the Convention as a treaty with a global vision, based on common concern, mutual reliance and fair and equitable sharing of benefits;

Regard the Convention as much more than just a set of rights and obligations: it is a global partnership with new approaches to multilateral cooperation for conservation and development;

Welcome the inauguration on 8 December 1994 of the International Decade of the World's Indigenous People, recognize the vital role that indigenous people have to play in implementing the Convention on Biological Diversity and the need to strengthen international cooperation on the indigenous people's issues under the Convention;

Recognize that the first meeting of the Conference of the Parties to the Convention on Biological Diversity is a significant step in the quest of humankind for the promotion of sustainable development, of which biological diversity and its components are an integral part;

Declare that we will spare no effort in undertaking the obligations embodied in the Convention, for the benefit of life on Earth, for present and future generations.

Biodiversity Assessments: Biosystematic and Information Needs

During the COP, on 6 December 1994 a workshop was arranged to highlight programmes and initiatives related to the constraints affecting biodiversity assessments or pertinent to other aspects of the Convention being undertaken by various bodies coming under the umbrella of the International Council of Scientific Unions (ICSU). These include those of DIVERSITAS (IUBS and SCOPE), Species 2000 (IUBS, in collaboration with CODATA), Microbial Diversity 21 (IUBS/IUMS Committee on Microbial Biodiversity), and the Biodiversity Committee of the World Federation for Culture Collections (WFCC).

The following programmes/issues were introduced for 5-10 minutes and then discussed by about 30 participants at different times. The topics covered were: bionomenclature (D L Hawksworth, Egham), human resources (J L van Goethem, Brussels), *ex-situ* collections (S D Sastrapradja, Jakarta), world species checklist (D L Hawksworth, Egham), wild relatives of domesticated organisms (V H Heywood, Reading), microbial diversity and resources (V Canhos, Campinas), marine biodiversity (P Lasserre, UNESCO), and inventorying and monitoring (D L Hawksworth, Egham).

Several documents were prepared for this occasion and also made available to the delegations. *Biosystematics: an essential component of biodiversity analysis* (prepared by M Wake for IUBS), *Microorganisms: an essential component of biological diversity* (prepared by L Sly for the IUMS/IUBS International Committee on Microbial Diversity), *Species 2000: a world species enumeration* (prepared by F A Bisby for IUBS), and *The Biodiversity of Microorganisms and the Role of Microbial Resource Centres* (edited by B Kirsop and D L Hawksworth for the WFCC). The CAB INTERNATIONAL delegation provided the logistical support required for the workshop.

Future Collaboration with the Conference of the Parties and Secretariat

Many of the issues discussed at the Conference were not of a scientific nature, but required a sound scientific understanding. Considerable progress was made during the Conference in alerting government delegations to the relevance of current ICSU-family programmes and the potential of the international scientific community to assist the Conference and the Secretariat in the execution of its duties. International scientific organizations have a special role to play as a key source of apolitical scientific advice.

In the case of the Clearing House Mechanism in particular, the need to collaborate with IUBS (i.e. in the Species 2000 programme) was indicated in conference papers produced by the Secretariat.

An increased appreciation of the agendas of governments by scientists, and conversely of the capabilities of the international scientific community by politicians and civil servants, can only be beneficial to the realization of the objectives on both sides. Continuing dialogue and representation of ICSU-family organizations in activities related to the Convention and its implementation, especially the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) and the Clearing House Mechanism, is therefore important.

by D L Hawksworth
President, IUBS

Highlights of the IUBS 25th General Assembly

5-9 September, 1994, UNESCO Headquarters, Paris, France

The IUBS Scientific Programmes 1994-97

The 25th General Assembly of IUBS adopted the recommendations of the Scientific Programme Committee *(Resolution 1)*, related to the IUBS scientific programmes for the period 1994-97. They include the continuation of the current programmes --*Diversitas*, Reproductive Biology in Aquaculture, and Bio-nomenclature and Taxonomy, and the adoption of two new initiatives related to "Taxonomic Databases and Biodiversity", and "Bioethics". The following represents the specific recommendations for each one of the programmes.

Diversitas

1. The Scientific Programme Committee reaffirms the appropriateness of IUBS' lead role in *Diversitas*, given its mandate to facilitate research interactions in all areas of the hierarchy of biology, especially in biodiversity studies. The *Diversitas* programme must be further implemented; it has a unique role to play in international communication about and coordination of regional, national, and international activities, research and otherwise, that consider issues in the investigation of the nature of biodiversity. However, the Scientific Programme Committee recommends several structural and functional changes.

2. The Executive Committee should re-consider the goals and the structure of *Diversitas*. A reorganisation that broadens the scope of *Diversitas* and assures its interaction with national groups, other international organisations, and funding agencies should be considered. The unique identity of IUBS should be emphasized as its role is more clearly defined. In addition, the effectiveness of the partnership with SCOPE and UNESCO should be assessed in the light of the conclusion of the Ecosystem Function theme.

3. The role of the Coordinating Committee for *Diversitas* should be more clearly defined. The structure of the Committee should be assessed in terms of its numbers, representation, and internal communication. Provision should be made for rotation of members at regular intervals.

4. The Steering Committees for each of the three continuing themes and the interest groups should establish clear goals for their programmes, elucidate mechanisms for their implementation, and establish a timetable for their accomplishment during the next triennium. These should be presented to the Executive Committee as soon as possible, certainly within one year.

5. We concur with the President and the Secretary General that the Executive Committee should establish a new Steering Committee for the Monitoring and Inventorying theme, and give it a clear charge.

6. Each programme of IUBS (*Diversitas* components, RBA, etc.) should have yearly, external, peer review. At a minimum, each programme should have a thorough external review every three years that is reported confidentially to the Executive Committee.

7. The Scientific Programme Committee enthusiastically recommends continuation and implementation of the joint efforts of IUBS and IUMS (International Union of Microbiological Societies) in research and coordination of activities in microbial biodiversity, and that this inter-union effort be a significant part of the *Diversitas* programme.

8. We strongly recommend that the activities of the special interest group for marine biodiversity continue, especially the integration of networks of marine laboratories with networks of terrestrial

and freshwater sites. Given that the goals of *Diversitas* are the central theme of the effort, these activities might be integrated with other parts of the *Diversitas* programme as appropriate.

9. The Scientific Programme Committee recommends that IUBS continue to encourage the training and hiring of taxonomists. Many of the tasks of the *Diversitas* programme cannot be solved without an international community of taxonomists working on all groups of organisms. In particular, Monitoring and Inventorying require taxonomic expertise if the dynamics of biodiversity are to be understood. We commend the Commission on Biological Education of IUBS for its publication and dissemination of information about training in taxonomy to "precollegiate" school students.

10. We recommend that the working group on Human Contributions to Biodiversity continue its activity, specifically the follow-up workshop that it proposes for consolidation and extension of its considerations.

11. The Scientific Programme Committee recommends that an e-mail network for the dissemination of IUBS materials be established, as well as a feasibility study of an overall communications network.

Reproductive Biology in Aquaculture

12. The Scientific Programme Committee recommends that the programme focus on a) providing research training and organizing workshops for young RBA scientists from developing countries, and b) organizing one or two symposia for discussing RBA research to which young scientists from developing countries should be invited.

13. The RBA Steering Committee should strengthen contacts with ICLARM and its INGA programme to aid in realisation of RBA objectives.

14. The RBA Steering Committee and the IUBS Executive Committee should work together to find appropriate funding for the programme from international agencies and local or regional sponsors.

Bionomenclature and Taxonomy

15. The Scientific Programme Committee endorses the action items agreed to by the IUBS/IUMS Exploratory meeting on harmonisation among the codes of nomenclature. These include:

a. establishment of an inter-union IUBS/IUMS International Commission on Bionomenclature (ICB);
b. seeking of resources to enable the ICB to produce a harmonised nomenclatural Code;
c. sponsorship of a session to review progress on aspects of bionomenclature at the next International Congress of Systematic and Evolutionary Biology (ICSEB V);
d. the completion of the Glossary of Terms Used in Bionomenclature;
e. promotion of awareness of the importance of bionomenclature and biosystematics to biodiversity and other aspects of pure and applied biology through meetings and publications. (The preparation of lists of names in current use, etc., will be facilitated by the activities of the new programme on Global Master Databases.)

We also recommend that they continue their efforts to support initiatives to provide training programmes to provide taxonomic skills, and to improve the resource base for systematics through collaboration in networks now being developed for various groups. Where appropriate; steps should be taken to address the relevance of bionomenclature and taxonomy to conservation and the sustainable use of biodiversity.

Global Master Databases

16. The Scientific Programme Committee recommends the establishment of a programme on Global Master Databases. Because time is of the essence, it should be structured as an independent Commission of IUBS, but explore collaboration with CODATA.

The Committee endorses its proposed task force, with the suggestion that it might be expanded. It urges that communication with the Monitoring and Inventorying group of *Diversitas*, the Bionomenclature and Taxonomy programme, and the joint IUBS/IUMS working group, as well as the agencies involved in database generation, be established.

IUBS Bioethics Commission

17. The Committee recommends the establishment of an IUBS Bioethics Commission as described above. This will provide IUBS representation to advise on bioethical issues in research and its application to the appropriate international bodies. The Executive Committee is requested to establish a Steering Committee to determine and direct the activities of the Commission.

18. Finally, the Committee notes the comment on the need for an arid lands programme, and looks forward to the presentation of a formal proposal before the next Assembly.

These 25th General Assembly of IUBS unanimously adopted the recommendations of the *Ad Hoc* Committee on Scientific Programmes.

The General Assembly also recommends that National Committees for IUBS consider generating specific activities related to IUBS programmes in their home countries to increase the effectiveness of these programmes and the awareness of scientists of IUBS and its efforts.

The IUBS 25th General Assembly Resolutions

The following resolutions were adopted by the IUBS 25th General Assembly:

Resolution No. 1 : IUBS Endorsement of the Scientific Programme
The 25th IUBS General Assembly
ENDORSES the report of the Scientific Programme Committee,
ADOPTS the programmes recognized within it, and
THANKS all those who led and participated in the scientific programmes approved by the 24th General Assembly.

Resolution No. 2 : IUBS Endorsement of the Principle of Free Movement of Scientists
The 25th IUBS General Assembly
ENDORSES the ICSU principle that demands that no ICSU Union will hold or support a meeting from which scientists are excluded on the grounds of national, political, or religious affiliation, and URGES all scientific members of IUBS to implement this principle in their own scientific meetings.

Resolution No. 3 : Stability in and Harmonization of Bionomenclature
The 25th IUBS General Assembly
NOTES with pleasure the actions taken by the XV International Botanical Congress 1993 to reduce the number of changes in scientific names and to avoid any for non-scientific reasons,
ENCOURAGES current moves towards harmonisation of nomenclatural codes, and in particular
ENDORSES the establishment of a new joint IUBS/IUMS Commission on Bionomenclature as proposed by the joint Exploratory Meeting on Harmonisation Between Codes of Nomenclature 1994 and
URGES the new Commission to expedite work towards a unified system of bionomenclature.

Resolution No. 4 : IUBS/IUMS Committee on Microbial Diversity
The 25th IUBS General Assembly, recognizing the fact that microorganisms are an important, albeit often unseen, part of biological diversity,

ENDORSES the establishment of an Inter-Union Committee on Microbial Biodiversity between IUBS and IUMS whose programmes will be a major component of all the *Diversitas* themes as they become elaborated in the future.

Resolution No. 5 : Collaboration between the ICSU Bio-unions
The 25th IUBS General Assembly
NOTES the common issues that currently concern biologists, particularly the understanding of biodiversity from the biochemical and genetic to the ecosystem and global and to the human and cultural dimensions,
WELCOMES the increased collaboration between IUBS and IUMS on microbial biodiversity and bionomenclature, and
ENCOURAGES the IUBS Executive to seek actively ways of facilitating enhanced collaboration between the various bio-unions of ICSU wherever appropriate.

Resolution No. 6 : The Maintenance of Biosystematic Reference Collections
The 25th IUBS General Assembly
NOTES that the assembling of documentation and data concerning biodiversity is central to our understanding of ecosystems and a major factor in the formulation of future efforts to utilize sustainably the natural resources of this planet, and further that our current knowledge is based solely upon the materials preserved in biosystematic reference collections. It therefore
INSTRUCTS the IUBS Executive to bring to the attention of all governments the vital importance of the continuous curation of biosystematic collections as a component of their biodiversity action plans.

Resolution No. 7 : International Collaboration on Terrestrial Invertebrates
The 25th IUBS General Assembly
RECOGNIZES the immense diversity and ecological significance of terrestrial invertebrates, NOTES with concern that, although there are International Congresses affiliated to IUBS, there is no international association representing workers on the vast majority of these organisms, and
MANDATES the IUBS Executive to investigate ways in which the diverse scientific community studying these organisms can be brought closer together and become more involved in all the scientific programmes of IUBS.

Resolution No. 8 : Global Species List
The 25th IUBS General Assembly
WELCOMES the progress made by a large number of institutions and organisations in the compilation of the scientific names of organisms,
RECOGNIZES that such lists are the crucial component of the communication system of biodiversity, and
ENCOURAGES the IUBS Executive to explore mechanisms through its Scientific Programme by which a Master Global Species List can be produced, as well as the nature of such a list in order to maximize its utility to biodiversity scientists, policy-makers and other users.

Resolution No. 9 : Motion of Thanks
The 25th IUBS General Assembly, greatly appreciating the opportunity to meet in the dynamic and beautiful city of Paris, to have available the excellent facilities of the UNESCO Headquarters, to visit other institutes such as the Muséum National d'Histoire Naturelle, and recognizing the high quality of the programme and organisation of the International Forum, Biodiversity, Science & Development, RECORDS its gratitude to all those who have made these events possible, and, in particular :

The co-sponsors, the French Government, the United Nations Educational, Scientific and Cultural Organisation (UNESCO), and the International Council of Scientific Unions (ICSU);

The organisations that provided financial support, including TOTAL, The European Commission (Directorate XII), and the French institutions, Ministry of Higher Education & Research, Ministry of Environment, Centre National de la Recherche Scientifique (CNRS), Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Institut National de la Recherche Agronomique (INRA), Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTOM), and Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER); the host organisation, Comité National des Sciences Biologiques- Académie des Sciences;

The President of IUBS, Professor Francesco di Castri, the panellists, discussants and other speakers, and all others whose participation ensured the success of the Assembly and Forum, most especially, in view of the very extensive role of the IUBS Secretariat in this achievement, Dr. Talal Younès, Executive Director and Mme. Colleen Adam, Executive Assistant.

The IUBS Executive Committee Members (1994-97)

The 25th General Assembly of IUBS unanimously adopted the proposal of the Nominations Committee related to the new Executive Committee the period 1994-97.

The IUBS Officers are:

President :
HAWKSWORTH, David L. (U.K.)
Past-President:
Francesco di Castri (Italy)

Vice Presidents:
OKADA, Tokindo (Japan) and
SOKOLOV, Vladimir (Russia)
Secretary General :
WAKE, Marvalee (U.S.A)
Treasurer :
SCHULZE, Ernst-Detlef (Germany)

Voting Members
CHOU, Chang-Hung (China-Taipei)
HALFFTER, Gonzalo (Mexico)
HAUSER, Gertrude (Austria)
HUNTLEY, Brian J. (South Africa)
MOUNOLOU, Jean-Claude (France)
RAMAKRISHNAN, P.S. (India)
VAN OORDT, P. G.W.J. (Netherlands)

Alternate Members
BIRO, Peter (Hungary)
CASTILLA, Juan Carlos (Chile)
DONE, Terence John (Australia)
HÄNNINEN, Osmo O.P. (Finland)
KAVANAGH, James A. (Ireland)
UCHMANSKI, Janusz (Poland)
YAN, Shaoyi (China-Beijing)

New Scientific Members

The 25th General Assembly of IUBS admitted the following new scientific members:

1. *Asociacion Europea de Coleopterologia*
2. International Association of Plant Sexual Reproduction Research
3. International Congress of Vertebrate Morphology
4. International Association for Lichenology
5. International Commission on the Taxonomy of Fungi
6. International Society for Tropical Root Crops
7. International Organization for Plant Information.

The IUBS 26th General Assembly

The 25th General Assembly of IUBS unanimously accepted the invitation by *Academia Sinica*, Taipei, to host the IUBS' 26th General Assembly in Taipei, in September, 1997.

International Forum
Biodiversity, Science and Development
Towards a New Partnership

Jointly organized with the 25th General Assembly of the IUBS, the International Forum "Biodiversity, Science and Development- towards a new partnership" took place on 5-9 September, 1994 at the UNESCO Headquarters in Paris.

The principal objectives of the Forum were to bring about a better understanding of biodiversity, which is a necessary ingredient for its efficient and rational use. The main scientific issues addressed by the Forum were derived from the conceptual framework of *Diversitas*, the IUBS-SCOPE-UNESCO programme on Biological Diversity.

Timely organized-less than two months before the First Conference of the Parties of the Convention on Biological Diversity in the Bahamas- the Forum was very successful in stressing the need for integrating scientific knowledge, research and training in the implementation processes of the Convention.

An important feature of the Forum has been the strong advocacy for establsishing a new partnership among scientists, politicians, decision-makers and users. Although, the initiation and organisation were the prime responsibility of the IUBS, the Forum provided the opportunity to establish a fruitful collaboration between a wide range of partners. Co-sponsored by UNESCO, ICSU and the French government, the Forum received support from the European Commission, the 'Fondation d'Entreprise Total'; the French Ministry of Higher Education and Research, Ministry of Environment, CNRS, CIRAD, ORSTOM, INRA, and IFREMER, as well as by the *Diversitas* Programme component in Japan.

More than six hundred participants attended the Forum, representing 50 countries and the major international organisations concerned with the problems of environment and development. Representatives of the UNEP, UNDP, FAO, the World Bank, the Interim Secretariat of the Convention on Biological Diversity, the Global Environmental Facility (GEF), the OECD, and the IUCN all participated in the Forum.

Nine panels were presented in a logical hierarchical approach. The first three were devoted to the study of biodiversity at different levels of organisation from the molecular, cellular, organismic and populations up to ecosystems and landscapes. The Forum panel followed dealing with the various aspects related to biodiversity conservation, and the remaining other panels dealt with terrestrial resources (agriculture, pastures and forestry); aquatic resources (aquaculture and fisheries; pharmaceutical industry and biotechnology; and biodiversity in urban and peri-urban environments respectively. Finally, the last panel addressed the cultural and ethical aspects related to biodiversity.

In his opening address, Prof. Federico Mayor, Director General of UNESCO, stressed the importance of *...taking stock of the knowledge we have, confronting the often diverging viewpoints, and viewing this complex issue from different angles to facilitate the dialogue with decision-makers and find practical applications for scientific results.*

HRH Princess Chulaborn of Thailand provided numerous examples of how to conserve and use biodiversity for the improving human health. Also, the address by Mr. Michel Barnier, the French Minister of Environment, together with the messages received from Mr. Carlos Menem, President of the Republic of Argentina, Mr. M. Soeharto, President of the Republic of Indonesia, and Mr. N. S. Rao, Prime Minister of India, all stressed that...*biodiversity is the essential source of the socio-economic development of nations, and that ... efforts to transform the potential of these resources certainly require both science and technology.*

The 5th European Workshop on Insect Parasitoids

The 5th European Workshop on Insect Parasitoids was held on 24-28 May, 1994, in Biri, Norway. The meeting was organized after those of Leiden (1981), London (1985), Lyon (1987), Perugia (1991), under the responsability of Eline B. Hågvar (Agricultural University of As, Norway) and Trond Hofsvang (Norwegian Plant Protection Institute).

Eighty participants from 16 countries attended the workshop. The delegations with the greatest number came from UK (12 participants), France (11), Spain (9), Switzerland (9), Italy (7), The Netherlands (6), and Norway (5). Belgium, Denmark, Germany, Greece, Poland, Sweden were also represented, in addition to the USA (4), Canada(2) and Israel (2). Sixty-eight contributions were given : 44 oral communications and 24 posters. All these works have been published in a special issue of the *Norwegian Journal of Agricultural Sciences* (Suppl. 16 : 1-413, 1994). The next meeting will be held in Valencia (Spain) in 1997 or 1998.

A number of European research teams are currently dealing with insect parasitoids, with somewhat different goals (either ecological, genetical, or agricultural). These periodical international conferences have enhanced or created strong links between all these researchers (staff and students), and have been the origin of a number of collaborative projects, and are of the greatest importance for the whole community.

These studies are important for two main reasons. First, at the ecological and evolutionary level, these insects are among the main factors responsible for the limitation of other insect species that they use as hosts. Thus they actively contribute to the equilibrium of natural ecosystems and to their demography, genetics, species richness and diversity. In applied biology, it is worth keeping in mind that most agricultural pests are of insect origin, responsible for 5 to 30% loss of crops. Forestry and medicine are concerned also very much as many insect species act as vectors of microbial and parasitic diseases. Entomophagous insects, including predator and parasitoid species, represent natural enemies of insects, and therefore, can be considered as the most powerful natural allies of Man.

Two introductory lectures developed these two general directions. The first, entitled *"How can parasitoids regulate the population densities of their hosts?"* by C. Godfray and M. Hassel (GB), dealt with the mechanisms of the persistence (i.e., the non-extinction) of host-parasitoid systems. Simple theoretical models are not intrinsically stable, and the natural stabilising mechanisms are not yet fully understood. The decrease in the efficiency of parasitoids with the increase of their relative density (interference and pseudo-interference) probably plays a major role. Other stabilising factors are :

i the heterogeneity of the individual probability of hosts being parasitized, corresponding to the existence of refuges (either spatial, phenological, or immunological) ;
ii the heterogeneity in the spatial distribution of hosts and;
iii to a lesser extent, the density-dependent aggregation of parasitoids on host patches.

Another prospect is to develop a population-based community ecology of parasitoids considering the diversity of species -both hosts and parasitoids- which actually interact in the field.

The second lecture by M. Hoy (USA), *"Transgenic arthropod natural enemies for pest management programs"* focused on the improvement of the "quality" of biological agents including parasitoid insects through genetic manipulation. He addressed such questions as which traits to enhance? Which genes to transfer? How to get stable transformation? How to obtain effective expression of the inserted genes? What are the risks associated with massive releases of transgenic arthropods?

Substantial results have been obtained with pesticide-resistant natural enemies, allowing top better combine chemical and biological

strategies of pest management. However the genetic manipulation of other traits (physiological, behavioural, etc.) will require a lot of further additional research, and will need the coordinated efforts between molecular and population geneticisists, ecologists, and pest management specialists.

The workshop was comprised of 5 scientific sessions.

Biological control and life history (9 papers)

Contributors focused on the taxonomical problems and the reliability of published host-parasitoid records ; the life history parameters of parasitoids (longevity, fecundity, development, nutrition, diapause, the role of their own enemies, etc.) and their geographical variations; the role of symbiotic rickettsia in the sex-determination and the fitness of some hymenopteran species.

Evolution and Genetics (9 papers)

This session dealt with the relation between clutch size and fitness of parasitoid females, the differential susceptibility of parasitized hosts to predation, the amount of genetic variability within and between parasitoid populations : molecular markers, physiological traits (fecundity), behavioural traits (locomotion, biological rhythms).

Behaviour and host infestation (14 papers)

All the behavioural steps that the adult females perform while searching and infesting their hosts are essential for their infestation efficiency. Most of them are elicited or oriented by chemicals emanating either from the trophic substrate of the host (e.g., plants), or from the hosts themselves (e.g., aggregation pheromones). The behavioural response to these stimuli can be modulated by learning or by experience, thus enabling the females to better exploit various ecological situations. Other features of the hosts (size, species, etc.) are involved in host acceptance, and the spatial distribution of infestation among the host population is another important trait.

Physiology, host suitability and host regulation (5 papers)

The immunological compatibility and the physiological suitability between parsitoids and their hosts determine the success of the parasite's development. Imbedment of the parasite's egg in the host tissue could allow some parasitoids to evade encapsulation, and parasitoids can actively regulate the hormonal metabolism of their host by using special cells. Finally, the physiological suitability of a given host species to a parasite is not a fixed trait, but can vary according to its nutritional condition or external factors such as temperature.

Parasitoid webs, complexes and communities (4 papers)

In the wild, many host and parasitoid species do interact, leading to complex competitive relationships which are as yet poorly understood. They affect the species richness and diversity of communities, their demographic evolution, and the effectiveness of biocontrol agents.

This congress was very successful, thanks to the excellent scientific and social organization, and to the high quality of papers and of discussions. All the current scientific orientations were represented. However, experimental approaches were predominant, thus allowing appreciation of the technological progress in such fields as biochemistry, molecular polymorphism analysis, quantitative behavioural studies, and computerized databases in taxonomy. The more theoretical approaches based on mathematical modelisation, as well as the more pragmatic ones based on field studies or agricultural experiments, were a little less well represented, despite their development in Europe. Clearly, this was only a matter of coincidence, as the organizers did not favour *a priori* any specific field.

Finally, it is worth noting that a number of young scientists and students attended the congress, and were easily able to discuss and exchange viewpoints with seniors scientists. This demonstrates the vitality and energy prevalent in the field, and showed the awareness of, and sensitivity to modern environmental problems.

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XIth Ecdysone Workshop

The XIth Ecdysone Workshop was held on 29 June-2 July, 1994 in Ceské Budejovice, Czech Republic. There were 131 participants from 20 countries (Germany, France, United Kingdom, Spain, Belgium, Italy, Czech Republic, Hungary, Poland, Slovakia, Switzerland, Russia, Uzbekistan, USA, Canada, Japan, People's Republic of China, Australia, Israel, and Korea). Seven sessions were organized, each starting with an introductory lecture followed by 5-10 oral communications corresponding to the particular theme. There were 53 oral communications, two round-table discussions and 54 posters.

The following provides a brief account of each one of the workshop sessions.

Session 1- Ecdysteroid chemistry and metabolism

Knowledge of the biosynthetic pathway from cholesterol to ecdysone still remains limited. Jim Warren (Chapel Hill) provided evidence for the intermediacy of cholesterol 5α,6α-epoxide.

The development of plant cell cultures in several laboratories (Josefina Casas *et al.*, Barcelona; Marie-France Corio-Costet *et al.*, Bordeaux; Vladimir Volodin, Syktyvkar) will probably provide new biological tools for biosynthetic studies. The structures of several new ecdysteroids have been reported by the groups of Josep Coll (Barcelona), I. Máthé (Szeged) and Juraj Harmatha (Prague).

Session 2- Ecdysteroid hormones: sources, production control, endocrine interactions

Jean-Paul Delbecque (Dijon) reviewed ecdysteroid-producing tissues in arthropods. It is now generally accepted that epidermis can represent an alternative source, and Klaus Hoffmann (Ulm) has shown that this production can be enhanced in a cricket by an ecdysiotropic factor (TE = testis ecdysiotropin) from *Lymantria dispar*. More generally, work on regulatory factors is in progress. Thus, Jan Koolman (Marburg) has shown that an hexapeptide known as TMOF (i.e., "trypsin-modulating oostatic factor") inhibits ecdysteroid biosynthesis by the ring glands of *Sarcophaga*. Interestingly, this inhibitory effect proceeds through an increase of cAMP levels, as is the case for the MIH of Crustaceans. Dale Gelman (Beltsville) has characterized low molecular weight (0,5-1,5 kDa) ecdysiotropins form *Manduca sexta proctodeum*. Wei-Wei Li (Ceske Budejovice) has investigated the presence of *Bombyx* PTTH analogs in *Drosophila* by screening a cDNA library with monoclonal antiobodies. Peter Harvie (Irvine) characterized key genes involved in the regulation ring gland activity by using the enhancer trap method, and has found genes coding for calmodulin and protein kinase A.

Session 3- Control of development and reproduction by ecdysteroids

Klaus Richter (Jena) described the correlation between ecdysteroid titers and molting gland activity in a cockroach, together with the ecdysiotropic activity of brain and hindgut extracts. Klaus Hartfelder (Tübingen) gave arguments for an involvement of ecdysteroids in queen/worker differentiation in bees. Mei-xun Cao (Shanghai) isolated two hemolymph proteins associated with larval diapause (DAPs) in *Ostrinia nubilalis* and he will prepare antibodies in order to develop a convenient tool for the characterization of the diapausing status. Yoshiaki Tanaka (Tsukuba) analysed the different effects of ecdysone and 20-hydroxyecdysone added to the diet of silkworm larvae. Karl-Heinz Tomaschko (Ulm) works on primitive arthropods (Pycnogonids) which contain the highest amounts of ecdysteroids ever found in animals. He has shown that these molecules are stored in specialized areas of the epidermis and are used as repellents against Crustacean predators.

New immuno-assays were described by Corinne Royer *et al.* (Lyon and Paris) and by Ulla von Gliscynski *et al.* (Bonn, Dijon and Paris). No doubt they will be helpful for many physiologists.

Session 4- Ecdysteroid effects at tissue and cell levels

Linda Restifo (Tucson) reviewed key ecdysteroid-controlled genes involved in the metamorphosis of the central nervous system of *Drosophila*.

Many communications dealt with the control of specific proteins by ecdysteroids. Bernhardt Koch (Ulm) analyzed how a drop of 20-hydroxyecdysone allows dopa-decarboxylase to appear in pharate adult wings of *Precis coenia*. Thorsten Burmeister (Würzburg) has studied the control of arylphorin uptake by the fat body of *Calliphora*. Dieter Sedlmeier (Bonn) showed the stimulation of protease secretion by 20-hydroxyecdysone in crayfish epidermis. Madeleine Morinière *et al.* (Paris) analyzed the regulation of chitinoprotein production by epidermal cell lines of *Plodia*. Ch. Yang (Ceske Budejovice) has shown that in silk glands of *Galleria mellonella* the effects of 20-hydroxyecdysone vary according with the physiological stage of animals.

Sergey Chernysh and A. Akimov (St Petersburg) noted that ecdysteroids inhibit both humoral and cellular immune responses in *Calliphora*. Therefore dia-pausing larvae will produce constitutively antibacterian peptides. Claude Wicker (Orsay) analyzed the hormonal regulation of sexual pheromone production in *Drosophila* with thermo-sensitive mutants.

Session 5- Control of gene expression

Jean-Antoine Lepesant (Paris) presented a review of the mechanisms regulating stage and tissue-specificity of gene expression based on an updated version of Ashburner's model (early and late genes).

Many authors considered the regulation of specific genes by ecdysteroids in relation with the presence of ecdysone-response elements (EcREs) of various types.

Alexander Raikhel (East Lansing) shown interest in the regulation of gene expression in adult mosquito fat body, and Krishna Kumaran (Milwaukee) in the arylphorin gene in *Galleria* (its expression is inhibited by 20-hydroxyecdysone). Michael Lehmann (Berlin) works on Sgs-4 (a gene coding for a glue protein) which is expressed in salivary glands at a specific time during the last larval instar. M. Furia (Naples) is interested in intermolt genes which are expressed when hormone levels undergo a subtle increase. Christophe Antoniewski (Paris) and Helen Benes (Little Rock) gave a detailed analysis of the EcREs of drosophila genes.

Isabelle Rondot *et al.* (Dijon) analyzed the regulation of cuticular proteins which are expressed at specific stages or in specific epidermis areas in *Tenebrio molitor*. Similarly, Peter Wolbert (Würzburg) considered the regulation of a cuticular protein in *Galleria*. Kiyoshi Hiruma (Seattle) has addressed the question of structure-activity relationship of ecdysteroids in *Manduca sexta*. Ronald Hill (North Ryde) has transfected mammalian cells with a gene coding for ecdysteroid receptor and a reporter gene. Such constructs are designed as a basis for a human gene therapy strategy.

Session 6- Ecdysteroid receptors

Markus Lezzi (Zürich) was reviewed our present knowledge on ecdysteroid receptors (EcRs), focusing especially on the mechanisms that are involved in their nuclear location, and on their possible interactions with heat-shock proteins.

Starting from sequences of EcRs of *Drosophila*, several authors have cloned homologous proteins in various species. K. Iatrou (Calgary) cloned *Bombyx* EcR. Alexander Raikhel (East Lansing) cloned both EcR and a usp homolog from *Aedes aegypti*. Jean-François Mouillet (Dijon) cloned *Tenebrio* EcR together with several proteins belonging to the same superfamily. Penny Hopkins (Norman) sequenced a PCR fragment from the crab *Uca pugilator* that could represent the EcR in this species, although its homology with *Drosophila* EcR seems rather low. Lynn Riddiford (Seattle) has shown that *Manduca* EcR can be induced by low concentrations of 20-hydroxyecdysone. Peter Deak (Szeged) characterized an EcR in *Chironomus thumni* and measured its variations during development, which suggest again that receptor levels could be controlled by those of their ligands.

Session 7- Non-steroidal agonists and antagonists

Glenn Carlson (Spring House) reviewed available data on the non-steroidal ecdysone agonists from Rohm & Haas (RH 5849 & RH 5992). Clearly these molecules share very different activities on various insect species. Many subsequent communications were concerned with these compounds, especially RH 5992. Arthur Retnakaran (Sault Ste Marie) showned that this compound induces ecdysone-dependent genes in *Choristoneura fumiferana*. Guy Smagghe (Gent) compared the biological activity of these molecules and their affinity for the EcR. Similar data have been reported by Klaus-Dieter Spindler (Düsseldorf) with *Chironomus* cell lines. Michael Friedländer

(Beer Sheva) showed that RH 5992 induces the resumption of spermatogenesis in diapausing animals. Laurence Dinan (Exeter) illustrated the usefulness of his bioassay using micro-titerplates for ecdysteroid agonist and antagonist studies. He has used this bioassay for a screening of many plant species for agonist properties, and has also described the isolation of new ecdysone antagonists that have been identified as cucurbitacins (steroidal compounds from plants). This will certainly deserve further studying of the compounds previously known for their antifeedent properties.

The Proceedings of the XIth Ecdysone Workshop will be published as a special issue of the "*European Journal of Entomology*", at the end of 1994. Abstracts of lectures and posters together with a set of full-length articles will be included. The XIIth Ecdysone Workshop is planned to take place in Barcelona (Spain) in July 1996 and will be organized by Xavier Belles and Josep Coll.

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New Learning Models

Consequences for the teaching and the mediation of biology, health and environment

An international workshop "*New Learning Models, Consequences for Teaching of Biology, Health and Environment to Pupils, Students and the General Public*" was held together with the annual meeting of the IUBS Commission for Biological Education (CBE), from 19 to 26 September, 1994, in Geneva, Switzerland, and Chamonix, France. Both meetings were organised by the LDES (Laboratoire de Didactique et Epistémologie des Sciences, Prof. André Giordan, Director) in collaboration with the *European Association of Biology Education*, and the *Communication, Education, Scientific and Industrial Culture (CECSI) Network.*

The principal aim of the workshop was to discuss the use and application of new learning models in biological education. That there is a great need to change their ideas on the approaches to education is becoming more and more apparant to both biologists and biology educators. The meeting found that it would be particularly helpful to begin with the rejection of the antiquated "only one model or method available" philisophy. There are far too many learning approaches today as well as the disparity of subject material for there to be any kind of unanimity of procedure. There is little in common with learning the number of sepals and petals of a flower, something which requires simple memorisation, and learning population genetics, which relies mainly on very abstract mathematical deduction, or learning about photosynthesis and the concept of regulation which requires paradigm change.

Participants were very interested in developing new learning models, such as the zig-zag, and the allosteric models. They stressed the need for more research in the field of biology education. Priority should be given to data collection and the establishment of a database to help address the following questions: what are the mechanisms of knowledge treatment? What combination of situations, strategies and didactic is best to help change the conception of the learner? What are the mechanisms which engender new knowledge, particularly, what is the role of categorisation, analogue transfer, induction, deduction, or hypotheses development and testing? What are the memory mechanisms and that of mobilisation?

For more information and proceedings

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