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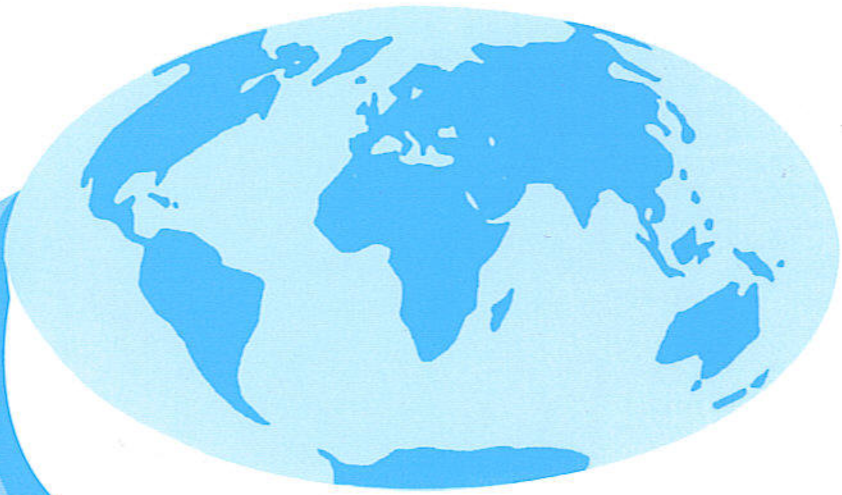

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Editorial

From Unity and Diversity to Consistency in Life

For almost a century, the International Union of Biological Sciences has provided an important service to biology, biologists and societies. Exchanges between scientists and freedom in Science are the founding principles of its activities, and through successive phases of influence and retreat the Union has initiated major scientific developments (Toward a Theoretical Biology, International Biology Programme, The Decade of the Tropics, DIVERSITAS), fostered the growth and independence of specific disciplines (Physiology, Neurosciences,...) and accommodated and welcomed movements born in other "cenacles" (molecular biology or molecular genetics). From its establishment, the role of biology within society is an issue that has been fully recognised and consistently addressed by the Union and this in turn has led to strong positions, suggestions, and actions in the field of education. This aspect of IUBS activity is presently the object of renewed interest. The pressing calls and needs of societies for advancing knowledge and prospective management of the living world revitalize the efforts placed on education. They also open new fields of research and negotiation with biotechnology and bioethics.

In the last fifteen years the reputation of IUBS, from a scientific and social perspective, has grown considerably through its leading involvement in the creation and development of the Decade of the Tropics and Biological Diversity Programs. Through the foregoing programs, IUBS was the forerunner in recognising the importance of the relationship between living organisms and their environment. Then, in light of social developments, the growing awareness in public and government attitudes, and in spite of many controversies and assessment differences, the recognition that more "science" was needed in the future has progressed, and this in turn has led to the establishment and evolution of DIVERSITAS- An International Program of Biodiversity Science.

Challenges for biology and biologists are greater than ever. Societies ask precise questions and expect rapid responses in return. Because of increasing costs of modern technologies and a general scale-up of research, public and private institutions try to control costly investments and to develop pressing scientific policies. In doing so they select specific objectives and refrain from the traditional academic freedom in initiatives. In brief, the role of IUBS is rapidly evolving and the Union is now entering a new period of its history.

IUBS has many strengths, however I believe its most important is twofold: On the one hand, it provides a forum for scientific exchange between members which allows the development of bottom up initiatives within an environment free from institutional restraints and on the other hand, it has at its disposal a large pool of scientists of different intellectual interests and expertise.

Questions are addressed at all levels of biological organizations (from molecules to communities), time scales (from catalysis to evolution) and spacescales (from micro environment to the biosphere). In brief IUBS science has been and continues to be concerned with biological unity (the fundamental laws of life) and diversity (the results of evolution), both of which are inextricably linked. Nevertheless, because of opportunities available to the Union over the past fifteen years, focus has been placed on environmental and diversity issues. Science advances from patterns to processes and ultimately ends in a coherent and synthetic knowledge that allows progress in societies through engineering innovations and prospective managements. With new intellectual tools, the time has come for IUBS scientists, carrying out research on unity and diversity, to engage in an effort towards a renewed understanding of consistency in life and in the relationships between living organisms and societies.

This perspective was developed by the 26th General Assembly. Prolonged and thorough efforts on unity and diversity within IUBS's ongoing activities are necessary and simultaneous integration of these capacities and contributions of external partners should be sought and encouraged so as to promote knowledge on consistency in life. The Reproductive Biology and Aquaculture program is a specific example of such future opportunities. The 26th General Assembly asks to go one step further and to implement a full-scale new programme: Towards an Integrative Biology.

Towards an Integrative Biology offers a framework to develop biological science over frontiers or structures and to initiate collaborations with other unions of the ICSU family or any national or international institutions. It provides an opportunity to place biology within society by integrating science within the areas of education, policy, management and production.

The IUBS community is entering an exciting phase of debates to elaborate this future. Debates are never better than when they are nourished by experiments and data of diverse origins. Before IUBS celebrates its centenary we should be able to take up the challenge set by the 26th General Assembly.

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A Strategy For Measuring Landscape Biodiversity

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Abstract

Biological diversity can be quantitatively expressed from different perspectives depending on the aspect (or function) of biodiversity under study and on the spatial and temporal scales at which the study is carried out. In this article I propose that the study of species diversity be done at the landscape or mesoscale level. I feel that the consequences of human activities (community modification and fragmentation) are most evident at this level. These consequences may appear disproportionate in analyses carried out from an ecological perspective (α diversity).

I propose concrete actions to achieve the defined objectives; that is, a strategy that seeks to generate results that are comparable and that permits one to draw general conclusions. The goal of this strategy is to express alpha, beta and gamma diversity together on the scale of landscape through the use of indicator groups. I specify the requirements that the implementation of the strategy must meet and some of the applications of the latter.

Introduction

The numerous proposals for measuring biodiversity is in itself proof of the complexity of the problem and of the difficulties in designing strategies that can be carried out in a reasonable amount of time and with a sensible investment in resources (for a recent synthesis of proposals and associated difficulties see Hawksworth, 1995; Humphries *et al.*, 1995). Reflecting on whether the study of biodiversity is something new, or just a new way of presenting old ideas, Harper and Hawksworth (1995) indicate « ... most especially, it seems sensible to ask whether biodiversity is a property that can be measured and if so what is the most appropriate form that such measurement should take ».

If the conservation of biodiversity has a cost, and this cost should be covered by society, it is difficult to convince the decision-makers of any proposed measure if we are not capable of quantitatively expressing the values of biodiversity in such a way that they can be compared and the relative importance of these data evaluated. As such, I feel that one of the most urgent tasks for the scientific community is that of formulating a group of strategies for measuring the most relevant aspects of biodiversity. My position on this matter concurs with the objectives of the international DIVERSITAS program.

The quantitative expression of biological diversity can be carried out from varying perspectives according to which aspect or function of biodiversity we wish to study, in addition to the spatial and temporal scales at which the study is carried out. Working with species is as logical as working with more basic phylogenetic levels or at the molecular-genetic level, but is much more practical. In working with species, that is, with the « organismal diversity » of Harper and Hawksworth (1995), the focus for approaching the complex problem of measuring biodiversity depends on the location of the study area on two scales: one that is structured in terms of space and the other in terms of time. So, studies carried out from an *ecological perspective* are done within limited areas, with local samples of the community and on a time scale of days or years. Studies that follow this type of perspective, in which one seeks to determine the degree of dominance, equity or the number of rare species, provide an estimate of the structure and function of these communities. At the other extreme of the spatial and temporal scales, also using species as the study unit, research carried out from the *biogeographical perspective* deals with regions or continents over periods of time that stretch to millenia. At the intermediate scales, the *mesoscale perspective*, as it is called by Ricklefs and Schluter (1993) or the *landscape scale*, research deals with a type of study unit that varies in size between the local and regional spatial scales and on a time scales that ranges from decades to centuries (for a review of the concept of scale in ecology, see Schneider, 1994).

In ecology, the term landscape refers to a unit of space with geographic limits and climatic and geomorphological characteristics. Internally, the landscape might be more or less heterogeneous since it is comprised of different communities. The landscape, just like its geographic and biological components, has a history. This cannot be ignored as is the usual practice in the ecological analysis of local diversity (see Forman and Godron, 1986). Both the composition of the fauna and flora of a landscape and the number of species therein are affected by the random events that have occurred in that landscape=s biogeographical history. This history (as for all biological phenomena that occur in time) does not follow a linear progression, but rather is a choppy tide of events, the importance of each moderated by the ecological circumstances of the moment. Ecological effects that are dominant at the local level and historical effects (biogeographical and evolutionary) that are dominant on broader scales, register at the landscape scale. Furthermore, it is in landscapes where the consequences of human activities such as deterioration, ecosystem modification and fragmentation as well as pollution are most dramatic; and these consequences often escape the scrutiny of local ecological analyses. It is from the landscape perspective that we can best analyze the diversity of species not only as a function of the heterogeneity of the physical and biological environment, but also as a function of human activity (see Noss, 1983; Franklin, 1993). On the landscape scale, a series of heterogeneity characteristics such as patch size and shape, connections between them and ecotone extension best show their relationships to the diversity of species (for an analysis of the relationships between diversity at the local and landscape levels, see Caley and Schluter, 1997).

The study of biodiversity at the landscape level is situated between ecology and historical biogeography. It is the study of biodiversity *per se*, identified by other authors as Aspecies richness per se@ or Aspecies richness assay@.

For several years I have been working with a group of collaborators at the Instituto de Ecología that includes Mario Enrique Favila, Lucrecia Arellano, Claudia Moreno and Rafael Sánchez, in addition to Edith García Real of the University of Guadalajara, on the application of several of the existing biodiversity indices in order to solve clearly defined problems and to design strategies for measuring biodiversity and addressing different objectives. In this paper I present what, in some aspects, is a synthesis of previous studies (see, for example, Favila & Halffter, 1997) and possible strategy for the analysis of biodiversity at the landscape level.

Why do we need a strategy?

A strategy is required to address concrete issues and achieve defined objectives. In order for the strategy to be useful for the objectives outlined below, it must produce results that are comparable; results that allow us to draw general conclusions and to generate models.
In spite of the notable increase in the number of publications on biodiversity, beyond indicating its role in the structure and functioning of the community it is difficult to proceed with comparative analyses. For example, in the recent and excellent book edited by Ilkka Hanski and Ives Cambefort (1991), « Dung Beetles Ecology », Appendix B presents the most complete list of copro-necrophagous Scarabaeoidea from different locations that I know of. Nevertheless, this and other information available in the literature are only comparable in a general way, since it is not clear when a given author is referring to local or alpha diversity and when the focus is on landscape or gamma diversity. It is even more difficult to determine whether the richness of the species lists is a direct reflection of a high degree of diversity or whether it results from landscape heterogeneity and its consequent effect of

increasing beta diversity. The problem does not lie with Hanski and Cambefort, nor does it originate with the authors whose data they have compiled. The reality is that we are very imprecise when we refer to biological diversity and this lack of precision often makes the rigorous comparison of data from different publications impossible.

A Mesoscale Strategy

There are two ways to estimate species diversity on the landscape level. The first is to try to take an inventory of all the species of extant organisms. This allows us the possibility of generalizing about the total diversity based on the inventories of the most studied groups and to consider concepts such as megadiversity. The departure point for the second approach is accepting that it is impossible to completely inventory the vast majority of landscapes, and so it is necessary to estimate total richness based on a series of samples or to compare different situations and monitor changes in the biological diversity over time.
For this second approach, we will have to sample one or several indicator groups (taxonomic or functional). The use of indicator groups is both the tremendous advantage and disadvantage of this method. The positive side is that we can plan studies with concrete objectives, and that these can be attained over reasonable periods of time and with a modest investment in materials. The disadvantage is that, even though our deductions will be solid, they will only refer to those indicator groups that have been selected for the study. In order to generalize about other organisms we must keep in mind that the relationship between different hierarchical units (for example, Subfamily Scarabaeinae, Order Coleoptera, all insects) can vary markedly from one site to another.

With this second strategy we can use parametric or nonparametric models to estimate biodiversity (see Colwell & Coddington, 1994, 1995). Parametric models require that, when sampling, not only do we determine the identity of species in samples, but that we also determine the frequency of occurrence of each species. This requirement, which implies additional costs and time for our study, is not necessary when we intend to work with nonparametric models or if we adopt the strategy which I propose in this paper.

It is reasonable to suppose that, within a few years, inventories will be available from most countries - even at the landscape level - for vertebrate species, and perhaps for flowering plants and some of the other well studied groups such as diurnal butterflies. Presentely, however, for many groups and regions this information is incomplete, especially for the tropics and the subtropics. It is important to remember that the species which we can inventory with relative ease do not include hyperdiverse groups such as insects, especially

Coleoptera, or microorganisms. The available information does not allow us to assume that the geographic variation of diversity in these hyperdiverse groups follows the same patterns as it does in vertebrates. For these reasons, we will have to resort to the study of indicator groups. It is for these pivotal and urgent reasons that I believe it is essential to develop a strategy for expressing alpha, beta and gamma diversity together, using indicator groups at the landscape level. Whittaker (1972), in a truly seminal article, was the first to deal with the importance of the interactions between alpha, beta and gamma diversities.

In order for the proposed strategy to provide results, it is necessary to meet four requirements. First, the limits of the geographic unit being analyzed must be determined. These limits may be very obvious, however this is not so in all cases. When the limits are not known, prior studies are necessary in order to ensure that what we are calling a landscape does indeed share the same biogeographic history and a certain ecological homogeneity. Second, the indicator group (or groups) must be selected. This selection is very important, requiring not only knowledge about the group and previous experience with it, but also knowledge about sampling techniques that are appropriate for the group. Third, the results must be expressed in terms of alpha or local diversity, gamma or total diversity for the landscape unit and beta diversity (i.e. a measure of the species substitution between different communities). Only the joint expression of these three values will allow us to find out how much of the observed diversity is a result of the intrinsic complexity of the dominant ecosystems and how much results from landscape heterogeneity, that is, to re-exchange. Finally, the strategy must be designed to produce comparable data.

As indicated, when geographic limits are not evident, the spatial limits that correspond to the landscape under study must be determined. For example, using Scarabaeinae, Geotrupinae and Silphidae (Insecta: Coleoptera) my colleagues and I are working along an altitudinal transect in the state of Veracruz on the Gulf slope from sea level to the highest point the mountain range at 4,250 masl. Under these conditions, where are the limits of the landscape unit? The matter is further complicated because we are in a biogeographical transition zone where marked altitudinal bands correspond to different biogeographical historical affinities. As such, at low altitudes only elements of tropical affinity are found and in the high range northern elements predominate, and there is an intermediate transition zone where overlap occurs. Considering the entire range as a single landscape ignores historical and geographical information. We have used an indirect method of ordenation (principal components analysis) with which species-site ordenation is carried out and, independently, environmental variables-site ordenation. Both are integrated in the next level of interpretation. Groups obtained in this way have been compared to their phylogenetic affinities (Halffter *et al*., 1995) and these studies have led us to believe that there are three distinct landscapes within the study area. These landscapes correlate very well to the physiognomy of the vegetation and the distribution of environmental variables.

When we began our work in Veracruz, Colwell and Coddington (1994, 1995) had not yet published their ideas on the concept of complementarity. This concept is very useful for solving the problem of limits as described above. Not only because of its statistical simplicity, but also because the concept itself is an eloquent estimate of reality. In a case such as the one I have described, by considering the species richness of the entire altitudinal range and that of each of the supposed altitudinal bands on their own, we can easily determine the complementarity (difference or lack of similarity) between them. The greater the complementarity, the more reason to consider each part as a distinct landscape.

No all groups of organisms can be used as indicator groups. A group that is useful for a given type of landscape, is not necessarily appropriate for other types. The required characteristics of the indicator group are presented in the next section.

Characteristics of the Indicator Group

In collaboration with M.E. Favila I have presented the characteristics of the indicator groups in detail, using the Scarabaeinae (Insecta: Coleoptera) as an example of an appropriate group for the study of tropical forests and derived ecosystems (see Favila & Halffter, 1997; Halffter & Favila, 1997; Halffter & Favila, 1993; Halffter *et al*., 1992). Citing characteristics very similar to those we have proposed for indicator groups, Hammond proposes the use of Afocal groups@ (see Hammond, 1995) and several authors speak of Aindicator groups or assemblages@ (Brown, 1991; di Castri *et al*., 1992; Pearson & Cassola, 1992; Kremen, 1992; Prendergast *et al*., 1993; Kremen *et al*., 1993; Pearson, 1994, 1995; Margules *et al*., 1994; Faith & Walker, 1993, 1996).

Briefly, the characteristics of an appropriate indicator group according to Halffter & Favila (*op. cit.*) are:

1. It must be made up of a group of organisms that comprise a rich, well defined guild in the type of landscape in which one wishes to study diversity. The guild should be important to the structure and functioning of the ecosystems of the study area. The selected taxonomical group should also be important in terms of its biogeographical history for the region in which the studied landscape is located. This will allow the

researcher to work with a sufficient number of species and will thus facilitate comparative studies.

2. There must be sufficient information available about the natural history and taxonomy of the proposed indicator group in order to avoid confusion regarding the identification of species and ecological interpretation.

3. The organisms that belong to the indicator group must be easy to capture. Capture methods must be standardizable and it must be possible to make captures according to a preestablished schedule. This will make it possible to compare results obtained from different geographic locations within the same ecosystem, from areas of differing dimensions or degrees of disturbance or from areas that are biogeographically very different. It is important to remember that the value of the indicator group lies in the possibility of being able to compare the data obtained and, as such, making diagnoses and predictions.

4. The group must be such that specimen collection and other activities necessary for the study will not put the conservation of the group at risk.

5. The indicator group should provide information not only about the intact community, but should also be useful for measuring the reduction in its biodiversity as a result of different causes, such as reduction of the area owing to human activities or environmental changes, differing degrees of disturbance, management or other anthropogenic activities.

6. To those cited in previous studies (*op cit.*) I add a sixth feature that must be considered: how quicky one can arrive at the asymptote for the accumulation of species using the indicator group and the capture methods required. Pearson and Cassola (1992) provide an illustrative example. In Tambopata (Madre de Dios, Peru), 50 hours of field work was sufficient to find 93% of the Cicindelidae (Insecta: Coleoptera) fauna, while capturing 90% of the butterfly species required 1,000 hours of work and for birds several years were needed.

Measuring total richness by carrying out a complete census is only possible, for terrestrial studies, for plants and possibly some of the more conspicuous and philopatric mammals. Therefore, it is of the utmost importance to establish a sampling program appropriate to the group of organisms that one wishes to use as an indicator group, and that the program be feasible in the type of community under study. Coddington *et al*. (1991) recommend serious consideration of these points before beginning capture efforts.

A central problem for any sampling based study is that of estimating to what degree the values obtained from sampling represent reality. Colwell & Coddington (1994, 1995) present different types of estimates for real species richness based on values obtained from sampling. Their lucid texts are recommended to the reader. For a strategy such as that which we are proposing for the measurement of biodiversity *per se* in landscapes, it is necessary to use estimates based on presence-absence data for species in the samples collected, with the exception of species represented by only one or two specimens (i.e. singles and doubles). To the contrary, the frequency with which each species is represented will be indispensible for any study of biodiversity with an ecological focus.

The lack of information about species frequency prevents us from using parametric tests for calculating « real » species richness. Nevertheless, we do have the species accumulation curve and several nonparametric tests and these are very useful when we have a good number of samples, as would be expected for a study carried out in a landscape. « ... 'species accumulation curve' or 'collector's curve', is a plot of the cumulative number of species discovered, *s (n)*, within a defined area, as a function of some measure of *n* of the effort expended to find them. » (Colwell & Coddington, 1995: 105).

Colwell & Coddington (1994, 1995) speak of the « species accumulation curve » when referring, in a broad sense, to the data from an area or habitat that is uniform in spatial and temporal terms. They reserve the term « species-area curves » for larger scale patterns that explicitly include heterogeneous areas.

If the species accumulation curve reaches and maintains an obvious asymptote, no statistical treatment of the data is required to obtain an estimate of the real number of species present. In order to avoid unnecessary replications when sampling and to obtain an estimate of species richness with less effort, Colwell & Coddington (1994, 1995) propose the use of nonparametric estimates such as Chao 2 and « second-order jacknife » (also see Palmer, 1990).

Alpha Diversity

« The most generally appropriate measure of diversity is simply s, the number of species per unit area as represented in some kind of standard sample ». Whittaker, 1972: 222 (see the discussion on the expression of alpha in the cited text).
For the comparison of different locations we must take into account that the value of alpha expressed as the number of species is not independent of sample size, or, put another way, is dependent on the time dedicated to collecting. It is not possible to carry out a rarefaction exercise since we are not considering the frequencies of different species in our indicator group. A species accumulation curve should be established (or the corresponding nonparametric estimates that require species for which there are only one or two specimens per sample to be counted) for each particular location type that corresponds to a precise class of community in a given geographic area. Once we know the capture effort necessary to arrive at the asymptote value for the real diversity, we can apply this same effort to all similar locations within our landscape.

The alpha diversity of any location is a balance between the actions of local biotic and abiotic elements (among the former, competition and predation) and immigration from other locations. We cannot expect absolutely stable values. From this arises the interest in working with average alpha values that correspond to different captures withing the same type of community in a given landscape.

Gamma Diversity

AThe total or gamma diversity of a landscape, or geographic area, is a product of the alpha diversity of its communities and the degree of beta differentiation among them.@ Whittaker, 1972: 214.

While the number of species in a given place depends mainly on ecological conditions, the species richness of a large area (landscape or region) depends primarily on historical processes. This was established by McArthur in 1969. A landscape has more or less species as a result of its history, its isolation in relation to new colonizers and extinction processes. For this reason, the expression of alpha diversities in relation to a landscape tells us little if it is not accompanied by information about gamma diversity and, in order to explain the latter, by beta diversity. Only in this way will the relationships between and relative importance of regional and local diversity, and between historical and ecological phenomena be combined and highlighted.

Gamma diversity corresponds to the species richness of an extensive and heterogenous spatial unit - in principle, a landscape. Gamma diversity can be expressed by the number of species found in a landscape. If we use the formula presented below, the value obtained will depend on the landscape=s heterogeneity and on the number of sampling points that have been established to estimate alpha diversity. It is fine to express simple gamma diversity as the total number of species found in the landscape and also as dependent on the values of alpha and beta diversity. In fact, the values will be very close. We remain however, with the the doubt as to how closely these values represent reality. Just as in the case with alpha diversity, in order to obtain an estimate of the real value from sampling, we can use the species accumulation curve or nonparametric estimators (see Colwell & Coddington, 1994, 1995).

Landscape units each have their history and this manifests as the taxa found within the landscape. This history includes the unique events and geographic circumstances that occurred during the formation of the landscape. Historical occurrences also influence diversity at the local level, however their effect is much more important in landscapes. In principle, alpha diversities are directly related to the structure and availability of community resources even though, for historical reasons, the organisms that can take advantage of those resources may not be found in the landscape. In addition, gamma diversity is determined by the spatial configuration of the different communities that make up the landscape and this configuration depends on the geographical and geological topology of the landscape, and on the vagility and dispersal properties of the organisms found.

According to Schluter & Ricklefs (1993), gamma can be calculated as follows:

$$\gamma = \alpha \text{ x } \beta \text{ x the total number of habitats or sample sites}$$

α and β are average values for a landscape unit

It is evident in this equation that γ diversity can increase while α diversity remains constant if species exchange increases or, in other words, as the total habitats shared by a given species decreases.

Beta Diversity

Beta diversity is a measure of the replacement of species between different types of community or habitat. As such, it corresponds to the spatial contiguity of different communities or habitats (Halffter & Ezcurra, 1992; Cody, 1993).

Beta is expressed as:

$$\beta = 1/ \text{ mean number of habitats occupied by a given species}$$

For the comparison of two habitats or contiguous communities the following formula can be used (Cody, 1993):

$$\beta = 1 - C\,(T_1 + T_2) / T_1T_2$$

where T_1 and T_2 correspond the the number of species in sampling sites 1 and 2, respectively; C is the number of species that are shared by locales 1 and 2.

Beta diversity can be determined for different habitats, but also as an element dependent on the distance between sampling sites within formations that are apparently uniform. Under these circumstances, beta reflects the allopatric distribution of equivalent taxa.

If we compare two contiguous areas, the value of beta can be very sensitive to the inclusion or exclusion of rare species when sampling; especially that of Atourist@ species, those for which a single individual is captured in one of the samples, but does not appear in any of the other samples. This occurs in more cases than we might suppose *a priori* and the problem is reduced by working with mean values.

Harrison *et al.* (1992) indicate that, unlike alpha diversity and those studies derived from it (e.g. the comparison of the number of species on islands or the number of species on altitudinal gradients), there are few studies that specifically focus on beta diversity. These authors measure beta diversity in Great Britain along two gradients (north-south and east-west) using eight groups of animals and seven groups of plants. The principle hypotheses are: beta values should be greater for those taxa with very restricted areas of distribution; within each group beta should increase with increasing ecological differences between sites; beta diversity should be greater in groups with organisms of limited vagility; and finally, within each taxonomic group, beta diversity will increase with increasing distance between the sites being compared. The results obtained were not those expected. The most sessile groups had lower beta values than the vagile groups. Species exchange as a function of distance turned out to be of little importance in terms of regional diversity. The authors conclude that in Great Britain it is difficult to demonstrate the degree of influence that beta diversity has as a determinant of regional diversity. I know of no similar study done under tropical conditions (see comments in Whittaker, 1972: 243), however studies currently underway (such as our study of Coleoptera in Veracruz) lead me to think that the proposals of Harrison *et al*. would be true under tropical conditions. However, even though beta diversity is a very important component of regional biodiversity for Scarabaeidae, it does not appear that the same is true for Chiroptera, for example (Claudia Moreno, pers. com.).

Ways to use the Strategy

What problems can this strategy be used to solve?

1. The most notable use of the strategy proposed is related to the possibily of measuring and predicting the effects of alterations resulting from human activity in landscapes; whether these are modifications resulting in the fragmentation of ecosystems or from changes to them. The usual analyses of biodiversity in ecology do not provide a good estimate for measuring the effects of fragmentation in landscapes. Several authors have warned against the risk of automatically applying conclusions obtained for a particular scale to another. That is, from the local scale to landscapes. An example: according to the conventional perspective: all anthropogenic modifications to pristine communities results in a loss of species richness. This can occur at the local level (alpha diversity), but may produce the opposite effect over a landscape (gamma diversity). This is particularly true under tropical conditions where it appears that a certain degree of fragmentation results in an increase in the total diversity on the landscape scale (but see also Murphy, 1989 and Santos Filho, 1995; doubtless, the observed effects of fragmentation in landscapes will vary depending on the type of organism used for the analysis of the consequences of said fragmentation). Schluter and Ricklefs (1993: 2) note « . . . Thus, the entire mosaic, which is part of a larger regional equilibrium, contains more species than any individual patch. This observation is the basis of the 'intermediate disturbance hypothesis' (Connell, 1975), in which disturbance is regarded as a stress that precludes species at high levels and fails to prevent competitive exclusion by a few superior competitors at low levels (Paine, 1966; Connell, 1978; Huston, 1979; Keough, 1984), resulting in the greatest species diversity at an intermediate level of disturbance ».

   Several interesting questions arise with respect to the effects of human activities in landscapes. At which level of fragmentation does the greatest gamma diversity occur? How do different types of changes affect this diversity? It is to be expected that, on the landscape scale, anthropogenic modifications that are followed by abandonment and the development of secondary formations will not have the same effect as tranformations that tend to be permanent. These questions can be answered by comparing the values for different types of diversity in landscapes that originally had the same types of communities, but which have different degrees of fragmentation.

   It is important to note that the few studies that have been carried out with the intent of measuring biodiversity in tropical and subtropical fragmented landscapes have focussed on the resulting reduction in alpha diversity as a function of decreasing fragment size (for studies of arthropods, see Klein 1989; Shure & Phillips, 1991;

Brown, 1991; Holloway & Stork, 1991; Holloway *et al*., 1992; Majer & Beeston, 1996). The possible enrichment of diversity in landscapes resulting from the introduction of new conditions (including those caused by human activity) has not been examined, nor on which spatial and temporal scales of the fragmentation process this enrichment occurs; or whether the contrary is true and diversity is reduced, relative to continuous natural landscapes (see Halffter *et al*., 1992; on the fragmentation of Brazilian rainforest and the possible species extinction see Brown & Brown, 1992).

2. A second line of research that can benefit from this strategy is related to fragment size and shape rather than the degree of fragmentation of the entire landscape addressed in the previous point. One can ask: What is the relationship between the alpha, beta and gamma values and the size and shape of the patches that remain after a landscape has been fragmented?

   Answering this question leads us to express the existing relationship between the landscape=s topology and biodiversity. These relationships can serve as the basis for monitoring programs or can even be used for the creation of predictive models.
   In this line of research, as in the first, the results will produce a much closer estimate of reality when repeated with different indicator groups. Given the current state of knowledge in this field it is reasonable to suppose, although not without some doubt, that the diversity of different groups of organisms might vary in a similar way.

   Under tropical conditions we do not really know whether this happens or not. Therefore, working with different indicator groups is a good way to obtain results with a certain degree of general validity.

3. A third line of research or questioning, addresses the conservation of biodiversity in protected areas. The majority of the analyses carried out on the shape and dimension of protected areas treat these areas as Aislands@, that is, with an alpha focus on biodiversity. Precisely now, when the insular image of protected areas is emphasized as the area surrounding it is transformed, an interesting series of questions can be answered by following the proposed strategy: If in a given landscape there is a strong occurrence of species replacement (a high beta value) as a function of distance, what proportion of the global diversity of that landscape can be conserved by a protected area?

According to the proposals of Colwell and Coddington (1994, 1995), this same question can be formulated in the following way: Considering the diversity of a landscape as total (gamma diversity) how complementary is the diversity that resides in the protected area in relation to the distinct diversities that occur outside of the area under protection? Without a doubt, as complementarity increases, the possibilities that the protected area on its own can ensure the conservation of the landscape=s diversity decrease.
If the answer is that the complementarity is high (which does not appear to occur in temperate conditions, although it possibly occurs in the tropics) then an entire policy based on ensuring the long term conservation of biodiversity with protected areas for landscape types (or even biogeographical provinces), is faced with serious shortcomings. Not because the conservation of protected areas is in itself a bad strategy, but because from the start such efforts fall short of their defined objective.

There are several possible ways of dealing with the dilemma that a protected area is not a sufficient sample of a landscape, and is even less so for a biotic province. Among these is that of increasing the corridors between areas. However, what is required is essentially a dual policy that, in addition to maintaining large protected areas, also favors conservation efforts outside of these areas.

For the same line of research, experiments that apply the strategy that we suggest would shed new light on the discussion of what is preferable for the conservation of landscape biodiversity: a single large protected area or several smaller interconnected areas. Once again, traditionally this discussion has centered around an exclusively ecological (alpha) perspective of biodiversity. What is still lacking is what an analysis of biodiversity *per se* at the landscape scale can tell us. This is the scale that truly counts, since in the majority of cases the objective is not to describe and protect local diversity, but rather to obtain the richest and most representative sample possible for the global diversity of the landscape or biogeographical province under study.

In order to design a conservation policy with a solid scientific base we must be able to answer the following question for different ecological and biogeographical conditions: What is the principle component of gamma diversity: a high alpha diversity in the dominant community or a high degree of exchage as revealed by high beta values?

A preliminary examination of the literature would appear to indicate that under temperate conditions the relationship between alpha and gamma diversity is not the same as in the tropics. There may be high local alpha diversity in temperate zones, but the same species are found throughout the landscape if general conditions remain constant. On the other hand, species exchange in the tropics, even in the absence of serious modifications in the type of community, appears to be much higher (for a study of diversity within apparently homogeneous units see Erwin, 1988).

4. Interesting information can be obtained using the same indicator group for the comparison of ecologically similar landscapes from areas that are biogeografically different. This comparison will tell us much about the importance of historical elements in the shaping of biodiversity at the landscape scale (see Ricklefs, 1987; Ricklefs & Schluter, 1993b; for a proposal based on Scarabaeinae see Halffter, 1991).

   If on the other hand, we use the same indicator group for two landscapes that are ecologically different but occur within the same biogeographical region, the information that we obtain will indicate the importance of ecological elements in the observed biodiversity.

   Both of these comparison exercises will bring us closer to a question that is central to understanding biodiversity: What is the relative importance of ecological elements as compared to historical elements?

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STRESS BIOLOGY:
A Challenging Area in Integrated Biology
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Introduction

Biology has been and is being studied at various levels ranging from taxas to populations to individuals to its organ systems, tissues, cells and molecules. With the advent of biochemical and molecular approaches and the consequent excitement of being able to unravel the molecular details of a given life processes, an integrated approach to Biology was sometimes lost. Fortunately, as the tools available to Biologists have become more precise to allow deeper probing into the mysteries of living world, the wheel has now fully turned and there has been a resurgence of an integrated approach in Biology. Such an integrated approach has permitted correlation of very specific molecular events within a cell with individual or even population level macro events.
Living systems are continuously interacting with their environment and many a factors in the environment are not kind to the organisms. The entire history of living organisms is a reflection of this incessant antagonism between the organism and its environment: the diversity of life forms is primarily the result of this dynamic conflict. Since the environment is ever-changing, the living organisms cannot remain static entities. A most remarkable feature of this dynamic interaction between the genome and the environment is the apparent monotony of the manner in which the genomes of very diverse organisms respond to situations which individual cells perceive as some kind of stress. These stresses range from toxic and harmful chemicals, generated from within or present in the environment, to physical factors, like various kinds of ionizing and non-ionizing radiations, unphysiological temperatures, to emotional or neural stresses. All stressful situations may be harmful to the biological organization and therefore, even the most primitive organisms have evolved means to protect themselves from such damaging stresses.
The discoveries of appearance of new puffs in polytene chromosomes of salivary glands of Drosophila larvae that were briefly exposed to elevated temperature or to certain other conditions that disrupt oxidative metabolism in the cell during the sixties and of induced synthesis of certain new polypeptides in heat shocked cells of Drosophila in early 70s laid the foundation of cell stress studies. One of the most exciting finding of the 1970s was that a variety of chemical and physical factors evoke a highly conserved common cellular response in all organisms from the primitive prokaryotes to the most highly evolved eukaryotes. This common stress response is more widely known as "heat shock response".
During the past 10 years or so a large number of studies have focused their attention on the biological significance of the stress response, particularly functions of the stress proteins. Once again, a common theme has emerged that nearly all of the stress-activated gene products (and their cognates synthesized in a developmentally regulated or constitutive manner in unstressed cells) function as molecular chaperones

and are primarily involved in preventing mis-folding and aggregation of polypeptides and in translocation of proteins across the membranes separating different compartments in a cell. The concept of chaperone function has revolutionized our understanding of many of the basic problems or issues that have been confronting biologists.

Heat shock response: A General Paradigm for Diverse Stress Responses

The seminal observation by F. Ritossa in 1962 of activation of a new set of "puffs" in polytene chromosomes in salivary glands of Drosophila larvae following a brief exposure to sudden elevated temperature (heat shock) or to chemical agents that disturb oxidative phosphorylation in cells and the subsequent finding of Tissieres et al in 1974 of synthesis of a common set of new proteins (the heat shock proteins) in different cell types of Drosophila in response to heat shock, initiated new chapters in our understanding of gene regulation and of the way the different biological systems cope with a variety of stresses experienced in day to day life. Historically, this response was termed "heat shock response" because heat shock was the most common inducer used; however, it was soon obvious that a variety of stress conditions also elicit a similar response. Therefore, the term "stress response" has also been often used. The heat shock response is one of the most conserved responses in biological systems, since all organisms ranging from bacteria to mammals and higher plants display induction of a remarkably homologous set of proteins in response to different stresses.

A variety of chemical agents induce synthesis of some or all the heat shock proteins in different organisms: these include oxidizing agents and drugs affecting energy metabolism, transition series metals, sulfhydryl reagents, chelating drugs, amino acid analogues, certain inhibitors of transcription and translation, steroid hormones, glucose deprivation (including treatment with 2-D-glucose, glucosamine, tunicamycin etc.), ionophores, teratogens, ethanol etc.; in addition, recovery from anoxia, wounding and several viral infections are also associated with induction of Hsps. A common response to such diverse stresses highlights the importance of these proteins in biological systems and this is reflected in growing interest in these proteins, their functions and regulation.

The heat shock response is a cellular response comprising of transient but complex reprogramming of gene expression that takes place when cells or organisms are subjected to a wide variety of physical or chemical stresses. This reprogramming, in most cases, includes depression of ongoing chromosomal transcription, induction of transcription of the heat shock genes, inhibition of RNA processing, inhibition of translation of general mRNAs and a preferential translation of the heat shock mRNAs. These coordinated changes in transcriptional and translational activities result in a massive accumulation of the newly synthesized heat shock proteins in the stressed cells. The stress response is an adaptive mechanism that enables cells to survive environmental insults that may otherwise be damaging to cell or be even lethal. The adaptive value of the heat shock response is obvious from the known thermotolerance acquired by exposure to a prior milder stress and from the fact that if RNA or protein synthesis is inhibited during the period of stress, the cells are unable to recover from stress-induced damage.

The different major heat shock proteins are grouped, on the basis of their apparent molecular sizes (in kilodaltons), into different families, viz., Hsp100, Hsp90, Hsp70, Hsp60 and the small heat shock proteins family. Many of these stress proteins or their cognates (e.g. Hsc70) are also expressed constitutively and remain localized to different compartments within the cell. The stress proteins have important roles in a multitude of protein biosynthetic events, including protein folding, assembly and transport of proteins across membranes.

While the induced synthesis of Hsps in different tissues of a given organisms is generally similar, some studies have revealed significant differences in induction of Hsps in relation to developmental conditions and specific tissue types (Singh and Lakhotia, 1988; Lakhotia and Singh, 1989; Krebs and Feder, 1997). Such results emphasize the need to re-examine stress response of a wide variety of organisms under their natural habitats.

Although the expression of heat shock proteins in response to physical and chemical stresses is well known, recent evidence shows that neuro-hormonal stress also leads to synthesis of heat shock proteins. This suggests that in addition to the cell level functions, the heat shock response may also have important homeostatic roles at individual level in higher organisms in coping with the stresses of everyday life.

The increased radio-sensitivity of cancerous cells under conditions of hyperthermia may also be related in some ways to heat shock proteins. The basis of this phenomenon remains to be well understood. A pre-exposure to mild heat shock has been reported to reduce the cell-killing by UV in Dictyostelium although a post exposure to hyperthermia can enhance cell death by UV. The fact that low dose ionizing radiation evokes an adaptive response, analogous to that of the heat shock response, suggests some commonality in these adaptive response pathways. Although DNA damage by itself may not induce Hsps, several DNA damaging agents, like alkylating agents, nitrosoureas etc., are known to induce some of the Hsps probably through other direct pathways.

Besides the heat shock, many other stresses (like cold shock, oxidative stress, salinity stress, metal stress, starvation stress etc.) are now known to evoke analogous cellular responses in the form of induction of synthesis of specific set/s of new proteins. Many of these "stress proteins" are common to a variety of stresses while others are uniquely induced by a specific stress.

Many recent studies have also revealed intriguing relationship of heat shock proteins with the immune response in higher organisms, including man. In addition, heat shock protein have also been shown to provide protection against ischaemic damages to human organs. The heat shock response has, therefore, become very important from a clinical viewpoint as well.

In view of the ubiquitous nature of the stress responses and their importance for the day-to-day life of any living organism, it is not surprising that the number of "stress biologists" has been on the increase. The literature in this field is very extensive and now even specialized journals (e.g. Cell Stress & Chaperones) that deal with this area are also available. Some of the recent books, reviews etc. that provide details of the various aspects of Stress Biology are: Nover and Scharf (1997), Lakhotia (1996), Michaud et al (1997), Morimoto et al (1994), Feige et al (1996), Mogk et al (1997), Csermely (1998), Csermely et al (1997), Srivastava (1994); Minowada and Welch (1995); de Pomerei (1997). In view of the ever growing importance of this field, several conferences (at international and national levels) are organized every year to discuss new developments in the field of Stress Biology.

International Workshop on Molecular Biology of Stress Responses

An international Workshop on "Molecular Biology of Stress Responses" was organized by S. C. Lakhotia (India) and W. Schumann (Germany) at the Banaras Hindu University (October 14-17, 1997) to bring together specialists from different countries studying responses of cells of diverse organisms (bacteria, plants and animals) to a variety of stresses (thermal, oxidative, starvation, osmotic etc.) and their regulations. This meeting, which was also sponsored by the IUBS, provided a good opportunity for cross-talks between scientists from different countries and working in different areas of "Stress Biology" and utilizing different organisms.

Approximately 100 scientists from 12 different countries assembled at the ancient city of Varanasi to discuss latest developments in molecular aspects of stress-research. A summary of the scientific discussions at this meeting is given in the following (for more details, see Csermely and Lakhotia, 1997) to illustrate some of the current trends in stress research.

Heat Shock Response in Eubacteria. T. Yura (HSP Research Institute, Kyoto, Japan) discussed the strategies of transcriptional and translational regulation of the heat shock response during evolution of gram-negative bacteria and the g proteobacteria. W. Schumann (Univ. Bayeuth, Bayreuth, Germany) presented evidence for the GroE chaperonin machine as the major regulator of heat hock response in Bacillus subtilis. U. Voelker (Phillips-University, Marburg, Germany) discussed regulation of the general stress response in Bacillus subtilis.

Salt Stress and Other Stresses in Bacteria. D. Le Rudulier (Univ. Nice-Sophia, Nice Cedex, France) discussed the various osmoprotection devices used in various bacteria. E. Bremer (Univ. Marburg, Marburg, Germany) presented his group's data on synthesis and uptake of glycine-betaine by B. subtilis. A. Tripathi (Banaras Hindu University, Varanasi, India), also the Convenor of the meeting, presented data on functions of the periplasmic glycine-betaine binding protein in Azospirillum. A. Strom (Norwegian Univ. Science & Technology, Nordheim, Norway) discussed the roles of glycine-betaine and trehalose in osmoprotection in E. coli. C. K. K. Nair (Bhabha Atomic Res. Ctr., Mumbai, India) reviewed the organization of dnaK locus in haloarchaea.

S. K. Apte (Bhabha Atomic Research Ctr., Mumbai, India) reviewed stress responses of the nitrogen fixing cyanobacteria Anabaena. M. Bazzicalupo (Univ. Florence, Florence, Italy) discussed the role of heat shock proteases in stress response in Azospirilllum. V. Braun (Univ. Tubingen, Tubingen, Germany) summarized the iron-uptake mechanism in bacteria while S. Ohtake (Hiroshima Univ., Hiroshima, Japan) talked about adaptation of bacteria to phosphate starvation.

M. K. Ray (Ctr. Cell Molec. Biol., Hyderabad, India) and S. K. Mahajan (Bhabha Atomic Res. Ctr., Mumbai, India) discussed features of psychrotophic bacteria and adaptations of bacteria to cold temperatures, respectively. S. Srinivasan (Univ. New South Wales, Sydney, Australia) discussed survival of non-differentiating bacteria under conditions of starvation. R. Chowdhuri (Ind. Inst. Chem. Biology, Calcutta, India) discussed relation between stress response and virulence of Vibrio cholerae.

Regulation of Eukaryotic Stress Response and Heat Shock Factors. S. H. Satyal (Northwestern Univ., Evanston, USA) discussed the regulation of heat shock transcription factor 1 by cis-regulatory domains and trans-regulatory proteins. P. Sadhale (Ind. Inst. Science, Bangalore, India) raised the possibility of stress-induced changes in the RNA-polymerase II subunits as important regulators of transcriptional regulation of stress response in eukaryotes. K. -D. Scharf and L. Nover (Goethe Univ., Frankfurrt, Germany) detailed the roles of constitutive and inducible heat shock transcription factors in plants. U. K. Srinivas (Ctr. Cell. Molec. Biol., Hyderabad, India) presented her lab's finding that albumin is heat shock inducible in embryonic rat liver. E. S. Gonos (Inst. Biol. Res. Biotechnol., Athens, Greece) suggested that while constant large stresses accelerate, milder and repeated stresses can decelerate the cellular senescence clock and thus life expectancy.

Heat Shock Proteins, RNA and Molecular Chaperones. R. Tanguay (Univ. Laval, Quebec, Canada) showed a link between small heat shock proteins and a ubiquitin-conjugating protease in D. melanogaster. A. Richardson (Cent. Med. Univ., Geneva, Switzerland) described the structure and function of a T4 bacteriophage chaperonin. Several papers at this meeting dealt with the Hsp90 family proteins which are fairly abundant even in unstressed cells. P. Csermely (Sommelweis Univ., Budapest, Hungary) discussed this protein's wide ranging roles in building and reorganizing the cellular architecture and suggested that its low affinity ATP/ADP-binding property plays a role in regulation of Hsp90-protein complexes. J. K. Pal (Univ. Poona, Pune, India) showed that interaction of Hsp90 with eIF-2a kinase in mammalian cells is important in translational regulation in normal and stressed cells. S. C. Lakhotia (Banaras Hindu University, Varanasi, India) presented his lab's data on genetic interactions between the non-protein coding, developmentally active as well as stress inducible hsr-omega gene of D. melanogaster and the hsp83 and some Ras-signaling pathway genes, raising possibilities of novel roles for the non-translatable hsr-omega transcripts in normal and stressed cells. P. K. Srivastava (Univ. Connecticut, Farmington, USA) reviewed his pioneering studies on participation of heat shock protein-peptide complexes in MHC mediated antigen presentation and the possibilities of using this property for generating tumor-specific vaccines for human trials.

Stress Response in Plants. A. Grover and S. Singla (Univ. Delhi, N. Delhi, India) presented their lab's data on Hsp90 and Hsp100 family proteins in rice in response to heat, salt, desiccation, cold stress etc. M. V. Rajam (Univ. Delhi, N. Delhi, India) reported genetic engineering of polyamine and carbohydrate metabolism to develop plants that can better tolerate osmotic stress. K. C. Upadhyaya (Jawaharlal Nehru Univ., N. Delhi, India) showed that Arabidopsis ACaM5 calmodulin is a heat shock protein. Discussion on these talks brought out an important point that stress-resistant transgenic plants may not always be as attractive as they may appear since over-production of some of the stress proteins may also alter other desirable or essential properties of the plant.

Stress Proteins as Bio-markers. D. N. Deobagkar (Univ. Poona, Pune, India), D. de Pomerai (Univ. Nottingham, Nottingham, U.K) and D. Kar Chowdhuri (Industr. Toxilcological Res. Inst., Lucknow, India) discussed stress proteins in relation to environmental pollution and their roles as bio-indicators. Deobagkar showed that insecticides induce stress proteins in mosquitoes and this allows mosquitoes to carry higher loads of disease causing parasites. De Pomerai showed that microwave radiations in the range produced by domestic appliances and mobile phones can also induce cellular stress proteins.

Most of the presentations at this meeting will be published in a special issue of the Journal of Biosciences (Indian Academy of Sciences, Bangalore, India) by mid 1998.

Relevance of Stress Biology to the IUBS program of "Integrated Biology"
Deliberations at the Varanasi meeting amply demonstrated the relevance of this field of study to the program of "Integrated Biology" which has recently been adopted by the IUBS. A group of leading participants in this International Workshop got together and decided to suggest to the IUBS that the field of Stress Biology should be integrated in the new program of "Integrated Biology". This group included Prof. S. C. Lakhotia (Department of Zoology, Banaras Hindu University, Varanasi, India), Prof. W. Schumann (Institute of Genetics, University of Bayreuth, Bayreuth, Germany), Prof. L. Nover (Department of Molec. Cell Biol., Goethe Univ. Frankfurt, Frankfurt, Germany), Prof. Peter Csermely (Department of Medical Chemistry, Sommelweis Univ., Budapest, Hungary), Prof. R. Tanguay (Lab. Cell. & Dev. Genet., Univ. Laval, Quebec, Canada) and Prof. P. Srivastava (Ctr. Immunotherapy Cancer & Infect. Diseases, Univ. Connecticut, Farmington, USA). The following has been compiled from inputs by these individuals to highlight some of the many areas in the field of Stress Biology that are of direct relevance to Integrated Biology and therefore, need to be actively pursued and supported internationally.

Organism Diversity, Adaptation and Stress Responses

The enormous variety of environmental conditions under which the diverse organisms live is well known. It is also well known that what is the optimal set of environmental conditions for one organism, can be stressful to other, even related, organisms. Therefore, in order to understand and appreciate the organism diversity, it is necessary to understand the genetic basis for the capability of related organisms to live in very different environmental conditions. Although the stress responses have been intensively studied, most of the studies have remained confined to a few model organisms and, therefore, the relation between organism diversity, adaptation and stress responses has largely remained unexplored. Such studies will provide a very good bridge between the IUBS programs of "Diversitas" and "Integrated Biology". Some possible areas are highlighted in the following:

Heat shock induced gene expression is mediated by a heat shock transcription factor (HSF) which is activated by the heat stress (oligomerisation and phosphorylation) and binds to highly conserved regulatory sequences in the promoter region of the stress inducible genes (the heat shock elements or HSEs). It is remarkable that the temperature at which cells of a given species begin to "feel" the stress is highly species specific although the HSEs are highly conserved and the HSFs are also moderately conserved. This species-specificity of HSF activation is a challenging area of study for evolutionary biologists (evolution of the genes that code for HSF), structural biologists (amino acid sequence variations in HSFs of related species and their consequence on the 3-dimensional structure of the HSF in relation to its stress-sensing property), cell and molecular biologists (compartmentalization and other interactions of the HSF in cells).

Bacterial Stress Response: Bacterial cells are relatively simple entities with small haploid genome. Despite their simplicity they are capable of coping with sudden and severe changes in environment. This adaptability enables bacteria to colonize a wide range of ecological niches. In their natural environment, bacteria spend most of their life in a starving or non-growing state because of different growth-limiting conditions. In addition, they may be exposed to different chemical and physical stress factors such

as changes in temperature (heat or cold stress), changes in their external pH (acid or alkaline shock), osmotic or oxidative stress, pressure or UV irradiation. In order to adapt to these stressful situations, bacteria have developed a highly sophisticated regulatory network including sensors to monitor the stress factors (only a few are known) and a signal transduction pathway resulting in the transient induction of stress proteins which fall into two groups: general stress proteins (GSPs) and specific stress proteins (SSPs). While the GSPs most probably serve a general and non-specific protective function allowing adaptation to stress and starvation, regardless of the stress factor, the SSPs may exert a specific protective function against a unique stress factor. Comparative studies on different stress responses in bacterial species living in extremes of environmental conditions (high or very low temperatures, high salinity, high metal concentrations, anaerobic conditions, highly acidic or alkaline pH of their surrounding media either in the body of their host or soil or water etc.) are required to understand the basis of the success of these most ancient living group of organisms.
Complexity of the plant stress responses: The unfavourable environmental changes generally affect plants more than animals due to their local fixation. The usual situation for plant growth and development is best characterised by daily multistress challenges. As a result, a multiplicity of partially overlapping stress response systems has evolved. The tight and highly flexible stress network is characterised by a number of multivalent or even general stress metabolites and proteins. Hormones, in particular ethylene, abscisic acid and jasmonic acid, are not only frequently found as stress metabolites, but they are also part of systemic and developmental signalling systems. The increasing number of physical, chemical or biological stressors affecting plants may be linked to each other by virtue of a 'natural coupling'. Some of the aspects of plant stress responses that deserve in depth studies are:
Heat shock and reduced supply of water are a natural pair of stressors with highest impact on plant productivity. Evaporation of water from the soil and the plants strongly increases with the environmental temperature, and the ensuing closure of the stomata results in increased leaf temperature. In addition to this, water deficiency may result from chilling or freezing and from osmotic or salt stress.
In many cases, biological stress by pathogen attack is dependent on or coincides with wounding or leads to local cell death. Many parts of these stress response systems are identical or very similar. They can be mimicked by application of plant- or pathogen-derived cell wall fragments (elicitors). Starting with the local cell death by apoptosis and probable elicitor formation, an unknown wounding signal is spread systemically inducing changes or resistance mechanisms in fairly distant parts of the plant.
Starvation or partial nutrient deficiency are frequently encountered, e.g. as a consequence of reduced photosynthetic activity due to low light intensities, damage of chloroplasts by photo-oxidation, stress-induced destruction of thylakoid membranes or closure of stomata because of drought or salt stress. On the other hand, unbalanced or poor nutrient uptake by the roots and inefficient distribution within the plant may result from nutrient deficits in the soil, salt stress, anaerobiosis, flooding, phytopathogen attack, poor transpiration or heavy metal intoxication.
In many plants, environmental factors like temperature, osmotic conditions etc. are important regulators of germination, growth, flowering and fruit development (Callahan et al 1997). The role of various "stress proteins" in these important developmental aspects of plants have been studied only to a limited extent in certain

model systems. Such studies need to be extended to a wide variety of plant species thriving in different habitats, not only to gain basic information on biological systems but also to provide a rationale for biotechnological exploitations.

The well advanced analysis of stress interactions at the cellular level in the preceding years must now be complemented by investigations on the role of modulators and phytohormones, on enhancing or inhibitory effects between stressors and on the molecular basis of cross-tolerance. Studies on signal systems involved in the environmental integration and stress protection of plants will ultimately help to understand and possibly improve plant stress resistance.

Environmental factors in development, differentiation and thermotolerance in animals.

Environmental factors, particularly temperature plays very important role in development and differentiation (including sex determination) of many animal species. It is known that depending upon the ambient conditions, the developmental paths may dramatically vary in certain species. For example, many species of butterfly, moths etc. develop different pigment patterns in different climatic conditions of the year (Pigliucci, 1997). In other instances, related species living in different ecological conditions (like temperate and tropical species of Chironomus) differ in their thermotolerance. Role of heat shock and other stress proteins in such adaptive phenotypes needs to be examined in much more wider groups of species.

Diversity in stress response in relation to tissue differentiation and habitat: A general dogma that has developed in relation to the heat shock response is that all cells of an organism respond nearly uniformly to a given stress. This dogma is based on studies in a limited set of laboratory animals and within them in the few easily manipulatable tissues/organs. Although there have been some indications of subtle but significant differences in the "stress response" of different cell types in some cases, this aspect has not received the attention that is due. Just as we realize the diversity of different organisms in their ecological contexts, we need to appreciate tissue and cell diversity in the ecological contexts applicable within the body of an organism. A systematic search for differences and similarities in stress responses in different tissues and different organisms will certainly be very rewarding from the point of view of adaptive significance of stress proteins in relation to organism diversity.

Gene Regulation, Protein Function and Stress Proteins

In view of the conditional and rapid response of specific set/s of genes to stresses at cellular level, molecular biological studies on different stress responses have contributed significantly to our understanding of regulation of gene activity at transcriptional and post-transcriptional (RNA processing, transport and turnover) and translational levels. Likewise, the elucidation of the role of stress proteins (and their normal developmentally expressed cognates) as molecular chaperones has been a significant achievement of recent years. We now know that correct folding of newly synthesized or damaged proteins in our cells depends upon a significant amount of help provided by the stress proteins. A great variety of stressful events, like heat shock, cold shock, salt stress, light stress, poisoning, injury, abrupt changes in hormonal concentrations, mental stress, etc., result in extensive protein damage. The increased amount of stress proteins protects the cells from such damages by helping to preserve structure of various proteins, to re-fold the damaged proteins and finally to remove the irretrievably damaged proteins through specific proteolytic pathways. While these phenomena have now been established, their mechanistic details need to be worked out using genetic, molecular and biophysical approaches. Such studies in relation to the above noted issues in organism diversity and adaptations are typical examples of an integrated approach in current Biology.

Stress Proteins and Biotechnology

The understanding of the genetic regulation of the stress network and of the function of the stress proteins is not only of basic interest, but the identification of stress genes and their function may have important impacts on Biotechnology. A few of the many possibilities are given in the following:

* Nitrogen-fixing bacteria living the rhizosphere of plants of agricultural interest can be manipulated by genetic engineering methods in such a way to withstand adverse conditions
* Bacterial stress genes can be transferred to cereal plants leading to salt and desiccation resistant plants to allow their growth in soils where growth of non-transgenic plants is not possible
* Enhanced production of molecular chaperones and protein folding catalysts may result in overproduction or over secretion of desired proteins
* Free radicals, generated during stress, are strongly oxidizing agents and have manifold effects on cellular macromolecules leading to their damage. Improving the cell's potential to overcome the oxidative stress and destroy these radicals will increase life span of the useful bacteria.

Knowledge gained from biology of stress proteins will thus be highly useful in Biotechnology since expression of proteins in most systems requires help in appropriate folding of the expressed proteins. This help can be provided by the addition or co-expression of stress proteins or chemical chaperones. Elucidating the molecular mechanism of how stress proteins help the folding of other proteins will also help us to design more folding-competent artificial proteins/enzymes. Stress proteins may also help in the correct folding of RNA which can be another area of widespread applications in biotechnology and related fields.

Clinical Applications of Stress Proteins

Recent studies have uncovered a broad role for stress or heat shock proteins in a variety of clinical applications:

* Hsps have been demonstrated to provide significant protection to brain, heart and other organs from ischaemic damages. This opens up a variety of newer applications in treatment and organ transplantation.
* Different heat shock proteins are involved in a number of auto-immune disorders.
* The pattern of heat shock proteins in mammalian brain, either synthesized in a developmentally regulated manner or in response to stress, is non-random. This has been related to specific functions of different parts of the brain, including role of Hsps, particularly the Hsp70, in short- and long-term memory and making different parts of the brain more or less susceptible to stress-induced injuries.
* A variety of pollutants induce detectable levels of stress proteins and therefore, relatively simple methods are being developed to use the stress-proteins as important bio-markers for environmental pollution. Such studies will be of significance in public health.
* Recent studies have shown significant roles for different Hsps in the immune response. A number of Hsps such as Hsp70, Hsp90 and Gp96/Grp94 have been shown to chaperone a broad array of peptides, derived from different cellular proteins, from

the cytosol to the Major Histocompatibility Complex I molecules which in turn display the peptides on the cell surface. The Hsps therefore play a key role in antigen presentation. Hsp-peptide complexes, whether isolated from cells or reconstituted in vitro, have the ability to vaccinate against the complexed peptides. Such vaccination elicits powerful CD8+ cytotoxic T lymphocyte response. Hsps have thus become the first adjuvants of mammalian origin. Interaction of mammalian and microbial Hsps with phagocytic cells has been shown to result in secretion of a number of cytokines by the phagocytic cells. Hsps have been shown to stimulate proliferation of gamma/delta T cell receptor-bearing T lymphocytes. While the mechanistic details of this interaction are not yet clear, this observation is significant in providing a clue to the functions of gamma/delta lymphocytes. Hsps have come to be recognized as major antigens in a variety of infections. Despite the significant cross-reactivity between the Hsps of hosts and infectious agents, Hsps of the infectious agents have been shown to elicit strong antibody responses, and in some cases T cell responses also, in a variety of hosts.

Collectively, these observations show that just as Hsps play a role in protection of individual cells from a variety of stresses, they also play a protective role in multicellular organisms through immunological mechanisms. Two types of roles are observed :

Role in innate immunity : The Hsp-phagocyte interaction results in release of cytokines. This response has no antigen-specific component and presumably plays a role in innate immunity in maintaining a particular type of immunological 'environment' within a particular niche (such as a lymph node, or a site of infection) within the host. This is presumably the more primitive immunological role of Hsps.

Role in adaptive immunity : The peptide-binding property of Hsps plays the key role in adaptive or antigen-specific immunity. Peptides provide the antigen-specificity lacking in the innate immunity, discussed above. This property is clearly a simple extension of the chaperoning function ascribed to a major sub-set of prokaryotic and eukaryotic Hsps and has been commandeered by the immunological functions expressed through MHC molecules and the T lymphocytes as they arose in evolution. In this view, the modern peptide-binding MHC molecules have been viewed as functional descendants of the primitive peptide-binding Hsp molecules.

These discoveries have opened the way for the use of Hsps in therapy of cancer and infectious diseases through the use of Hsp-peptide complexes isolated from cancer tissues and from infected cells, especially in cases where the protective antigenic epitopes are undefined or highly mutable, as vaccines to immunize patients against specific cancer or infection. These approaches are presently in the process of being tested in a number of clinical trials and have already become the cornerstones of a number of privately and publicly held biotechnology companies such as Antigenics in the USA and Europe and StressGen in Canada.

IUBS and Stress Biology

The above is not an exhaustive list of the various issues that are relevant to the general field of Stress Biology. Nevertheless, the various aspects as briefly discussed above reveal that a concerted effort of the international scientific community is required to permit a comprehensive understanding of the different facets of Stress Biology and to be able to optimally exploit this knowledge for betterment of human and other lives. The IUBS has already prepared the ground for such studies by adopting programs like

Diversitas and Integrated Biology. The general field of Stress Biology easily integrates with both of them without any "stress"!

There are several possible ways through which the IUBS may facilitate and promote substantial progress in this important field of Integrated Biology:

* With its global network of affiliating institutions in nearly all countries, the IUBS may encourage this field to be considered as the priority or thrust area in individual countries' scientific programs.
* Since the IUBS also sponsors a large number of Workshops and Conferences, those dealing with this general area may be increasingly supported. It is suggested that instead of the developed countries hosting such workshops/conferences etc., these should be organized in different developing countries. Meetings of this kind in developing countries would promote the field of study in more widespread geographical areas so that more diverse groups of organisms are studied rather than the studies on stress response remaining confined to a few model organisms, as is more likely to happen in the developed countries. Holding of such meetings/workshops. in developing countries would also be more economical and at the same time promote wider international collaborations and concerted programs.
* The IUBS may help establish a Stress Forum as part of the BioMedNet network. This Forum would be a versatile medium for very meaningful communications.

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Ethology is dead! Long Live Ethology!

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The twenty-fifth International Ethological Conference was held in Vienna (Austria) from August 20 to 27, 1997. The main feeling coming out of the meeting is that though animal behaviour studies have considerably evolved from their early stages, ethology is still alive and has diversified into several branches according to the angle or the level of analysis that is chosen.

First of ail, it seems that the era of conflict between schools of thought has ended. Of course Lorenz was quoted several times during the conference (see for instance Bolhuis's talk). Vienna was the right place for this! But scientists seem to have agreed on integrating the different theories, taking from each of them the components that can explain the behaviour they observe. Some of us may be disappointed by this "single thought". However, we must admit that ending the opposition between rival schools has led to an expansion of the research in animal behaviour in several directions, from the study of physiological bases to behavioural ecology, through genetics and developmental biology. As Potts said during his lecture on immunology and ethology of the major histocompatibility complex, ethology has been devoured by its 'cannibalistic children'.

Despite these developments, the theoretical models of behaviour are still used. Classical models, where behaviours are explained by intermediate variables (such as motivation or emotions) that are related to each other and to environmental inputs and behavioural outputs by arrows, remain the mainspring of a lot of studies. It is sometime possible to find the physiological basis of a hypothetical intermediate variable. This is the case for the male reproductive behaviour of *Lymnaea stagnalis.* When isolated for some days then mixed again with mates, the lymnaea copulates immediately; and this is merely due to the increase in the ... size of the prostate gland! For copulation, the size of the prostate gland may thus correspond to the specific energy described in the hydraulic model of Lorenz. However, as Lamprecht pointed out, there is often a huge gap between the complexity of behaviours and the components of behaviours we can explain by physiological mechanisms. It has been suggested that the concept of motivation, which has been defined as "the physiological state which determines the frequency and intensity of occurrence of a behaviour when elicited by a given endogenous or exogenous stimulus" (Zupanc), corresponds to the way neuro-modulators act (Huber, Zupanc). These substances do not produce behaviours by themselves but, by modifying the actions of neurones, they may affect behavioural reactivity and play a role in the orchestration of behaviours. For instance, in the crab, the Crustacean Cardioactive Peptide can act on the rhythmic activity of neurones of the pyloric circuit and thereby control the movements of the stomach.

However, taking into account the complexity of neuroendocrine networks and the fact that one network can act on different behaviours, some authors propose models that are more flexible than the classical models of ethology (Leonard, Koolhaas). Intermediate variables, which are thought to be set in precise parts of the nervous System, are then replaced by neuronal networks which can be involved in several behaviours. The notions of parallel-distributed processing and self-organisation of neural networks might explain the complexity of both behaviours and physiological mechanisms. This recalls us the opposition between classical artificial intelligence, based on relations between clauses, and connectionism, which deals with layers of formai neurones between which the links can vary and organise (Vignaux 1992).

At a higher level of analysis, that of the population or the ecosystem, mathematical models are the rule. Variations in behaviour are explained by curves defined on X/Y graphs. For instance, when habitat is reduced due to degradation by human activities, population density increases and breeding output declines. Density dependence is plotted on curves where the X axis represents the habitat degradation, and the Y axis the mortality or the breeding output. A slope break is sometime observed in the density dependence curve and this is explained by individual strategies: floating animals, which could breed, but decide not to do so, allow the population to survive (Sutherland). Similarly, phylogenies between iguanas have been described by regression curves (Martins) and the behavioral modifications due to domestication, by variations of the benefit/cost ratio of a strategy (Gustafsson and Jensen). In the wild, animals that use a costly strategy can be selected over animals using a less costly one if the costly strategy brings higher benefits. This will not be the case for domestic animals since food and protection against predators are provided by man. Thus domestication should favour animals that use less costly strategies. This hypothesis is confirmed by the foraging behaviour of the domestic pig compared with the wild boar: the former stays on grass patches longer than the latter.

Although ethology has evolved into several branches - some being more interested in ultimate causes of behaviour and others in proximate causes -, experimental results show how these two types of causation are linked together. For instance, it is necessary for the larvae of the wasp *Cotesia congregata*, which live as parasites on the tobacco hornworm, to suppress the feeding behaviour of its host when they emerge, or else they would be eaten by the worm. This suppression is obtained during emergence by the stimulation of octopamine production by the host, octopamine being involved also in immune responses (Adamo). Another example of the link between proximate and ultimate causes is found in mate choice, a topic that was often approached during the conference. Choice of mate appears to be driven, at least in part, by phenotypic eues related to immunity. In several fish or bird species, male ornaments (bright colours, long tail feathers) are related to body condition, specifically to the absence of parasites, and this absence is linked to genetic résistance (Milinski). Females choosing ornamented males select those resistances for their offspring. Also, in mice and human beings, body odours are involved in choice of mate. These odours depend on the Major Histocompatibility Complex. Mice and human beings associate preferentially with mates which are dissimilar regarding the major histocompatibility complex. This favours heterosis, which in turn enhances immunity (Milinski, Potts). Thèse two processes (preference for resistant males or for dissimilar males) can explain populations have resisted against infectious diseases.

Information processing and cognitive abilities of animals were discussed in several talks. First of ail, Rolls showed that the orbitofrontal cortex of primates contains neurones which are able to recognise visual or olfactory signais and assign a reward value to them, and this allows learning. Heyes then brought up the question of the existence of a theory of mind in apes. If apes had a theory of mind, they would attribute to their peers the aptitude to believe or to reason. Strategies like hiding behind a tree and waiting for another animal to get food by an operant task in order to steal the food, have been interpreted as signs of a theory of other mind. However, Heyes argued that these strategies, which look elaborate, may simply rely on associative learning. She proposed checking the existence of a theory of other mind by analysing whether apes attribute any value to the fact that a human being who has to show an object can or cannot see that object. During the conference, the topic of animal cognition was mainly approached in primates. This may have something to do with the difficulty in linking psychological to ethological concepts. Even so, a very interesting poster presented results on pigs able to form an abstract concept of identity/dissimilarity (Keddy-Hector *étal.).*

Finally, interesting developments in applied ethology were reported at this conference which, by tradition, is rather theoretical. In addition to several posters on farm animals, a plenary lecture was devoted to the use of behavioural indices to measure animal welfare (Webster). Also, behavioural pathology was invoked to explain the behaviour of abusive mothers in captive macaques (Maestripieri).

The abstracts of contributions to the conference are published in a supplement to the journal *Ethology* entitled *Advances in Ethology 32.*

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The International Association for Plant Taxonomy (IAPT) announces: Registration of Plant Names

Test and Trial Phase (1998-1999)

Introduction

Subject to ratification by the XVI International Botanical Congress (St Louis, 1999) of a rule already included in the *International code of botanical nomenclature* (Art. 32.1-2 of the *Tokyo Code*), new names of plants and fungi will have to be registered in order to be validly published after the 1st of January 2000. To demonstrate feasibility of a registration system, the International Association for Plant Taxonomy (IAPT) undertakes a trial of registration, on a non-mandatory basis, for a two-years period starting 1 January 1998. The co-ordinating centre will be the Secretariat of IAPT, currently at the Botanic Garden and Botanical Museum Berlin-Dahlem, Germany. Co-ordination with present indexing centres for major groups of plants is being sought, in view of their possible active involvement at the implementation stage. The International Mycological Institute in Egham, U. K., has already accepted to act as associate registration centre for the whole of fungi, including fossil fungi.

Registration procedure

The co-ordinating registration centre (IAPT Secretariat), and any associated centre operating under its auspices, will register and make available all names of new taxa, all new combinations or rank transfers that are brought to their attention in one of the following ways:

- by being published in an accredited journal or serial;
- by being submitted for registration (normally by the author or one of the authors), either directly or through a national registration office; or
- (for the non-mandatory trial phase only) as a result of scanning of other published information by the registration centres' own staff.

Registration by way of publication in accredited journals or serials

For a journal or serial to be accredited, its publishers must commit themselves, by a signed agreement with the IAPT, to

- point out any nomenclatural novelties in each individual issue of their journal or serial, either by including a separate index of novelties or in another suitable, previously agreed way;
- submit each individual issue, as soon as published and by the most rapid way, to a pre-defined registration office or centre.

Accredited journals and serials will be entitled, and even encouraged, to mention that accreditation on their cover, title page or in their impressum.

A permanently updated list of accredited journals and serials is being placed on the World Wide Web (http://www.bgbm.fu-berlin.de/iapt/registration/journals.htm). This list will be published annually in the journal *Taxon*.

Registration by way of submission to registration offices

Authors of botanical nomenclatural novelties that do not appear in an accredited journal or serial (but e.g. in a monograph, pamphlet, or non-accredited periodical publication) are strongly encouraged to submit their names for registration – and will be required to do so once registration becomes mandatory – in the following way:

- all names to be registered are to be listed on an appropriate registration form, using a separate form for each separate publication;

the form (in triplicate) must be submitted together with two copies of the publication itself, either to a national registration office (see below) or, optionally, directly to the appropriate registration centre. Reprints of articles from books or non-accredited periodicals are acceptable, provided their source is stated accurately and in full;

one dated copy of each form will be sent back to the submitting author in acknowledgement of effected registration.

Registration forms can be obtained free of charge (a) by sending a request to any registration office or centre, by letter, fax or e-mail, or (b), preferably, by printing and copying the form as available on the World Wide Web (http://www.bgbm.fu-berlin.de/iapt/registration/regform.htm).

Registration offices are presently being arranged for in as many different countries as possible. They will serve (a) as mailboxes and forwarding agencies for registration submissions and (b) as national repositories for printed matter in which new names published locally appear.

A permanently updated address list of all functioning national registration offices is being placed on the World Wide Web (http://www.bgbm.fu-berlin.de/iapt/registration/offices.htm). This list will also be published annually in the journal *Taxon*.

Registration date

The date of registration, as here defined, will be the date of receipt of the registration submission at any national registration office or appropriate registration centre. For accredited journals or serials (and, for the duration of the trial phase, for publications scanned at the registration centres), it will be the date of receipt of the publication at the location of the registration centre (or national office, if so agreed).

For the duration of the trial phase, i.e. as long as registration is non-mandatory, the date of a name will, just as before, be the date of effective publication of the printed matter in which it is validated, irrespective of the date of registration. Nevertheless, the registration date will be recorded, for the following reasons:

to make clear that the name was published on or before that date, in cases when the date of effective publication is not specified in the printed matter;

to assess the time difference between the (effective or stated) date of the printed matter and that of registration, since it is envisaged that the date of registration be accepted as the date of names published on or after 1 January 2000.

It is therefore in the interest of every author to submit nomenclatural novelties for registration without any delay, and by the most rapid means available.

Access to registration data

Information on registered names will be made publicly available as soon as feasible, (a) by placing them on the World Wide Web without delay in a searchable database (http://www.bgbm.fu-berlin.de/iapt/registration/regdata.htm), (b) by publishing non-cumulative lists biannually, and (c), hopefully, by issuing cumulative updates on a CD-ROM-type, fully searchable data medium at similar intervals.

[Liv Borgen, Oslo; Werner Greuter, Berlin; David L. Hawksworth, Egham; John McNeill, Toronto; Dan H. Nicolson, Washington; Officers of the IAPT, c/o Botanbischer Garten & Botanisches Museum Berlin-Dahlem, Koenigin-Luise-Str. 6-8, D-14191 Berlin, Germany.]

Registration as a positive step

Registration of nomenclatural novelties seems to me a natural way to go, heading into the 21st Century. It will enable us to find quickly what new names have been published, and to be sure that we have not missed any new name hidden in the paper mountain of botanical literature that comes out each year around the globe. This is particularly important for one-off publications (floras, field guides, etc.), which are notorious for `hiding' new names.

Some people seem to think that registration implies censorship, but this is wrong. As in the current *Index kewensis* all names will be listed, and without comment as to status, and as soon as received at one of the registration centres. My only caution to those looking at the mechanisms for making registration effective is that they should ensure there is a large network of registration centres or offices spread evenly around the world. This is necessary to make it easy to submit novelties for registration, given the apparently worsening state of mail services in all areas.

[Karen L. Wilson, Royal Botanic Gardens, Mrs Macquaries Road, Sydney, N.S.W. 2000, Australia.]

Highlights of the 26th IUBS General Assembly

17-22 November 1997, Academia Sinica, Taipei

The IUBS Scientific Programmes 1997-2000

The 26th General Assembly of the IUBS held 17-21 November, 1997 at Academia Sinica, in Taipei, adopted the recommendations of the Scientific Programme Committee (Resolution 1), related to the IUBS scientific programmes for the period 1997-2000

DIVERSITAS

The Committee applauds the progress DIVERSITAS has made during the last three years, both in the scientific programme and its relationship with SBSTTA. It endorses the DIVERSITAS Operational Plan. It remains concerned about the stability of its Secretariat and the prospects of adequate funding for its several Programmes. The Committee recommends that IUBS pledges its continued support to DIVERSITAS and that it reiterates its sponsorship and co-sponsorship of several of its programmatic elements with the attempt of helping to facilitate their progress.

A perception exists that IUBS has stepped back from its leadership of DIVERSITAS. This is not the case. IUBS will continue to emphasize its significant role in the deliberations of the DIVERSITAS Steering Committee and in the facilitation of the several DIVERSITAS Programmes with which it is associated.

SYSTEMATIC AGENDA 2000-International

The Committee appreciates the advances of this Programme both in the focus put on the crucial scientific problems founded in the approaches on phylogenies and evolutionary processes and in the establishment of links with most bodies concerned with systematics in view of the services and training the scientific community requires. Both per se and through its contribution to DIVERSITAS the Programme is encouraged to continue its development and should consequently be supported in the years to come.

SPECIES 2000

The Committee acknowledges the progress of Species 2000, especially the successful development of its prototype and plan for implementation. It encourages Species 2000 to seek means of providing full access to its database at no cost to its users. The Committee recommends that the Species 2000's link to the activities of Systematics Agenda 2000-International to the overall IUBS Biosystematics Programme, be maintained and encouraged.

BIONOMENCLATURE

Concerning the report of the International Committee of Bionomenclature (ICB), the *ad hoc* Committee expresses its full appreciation of the efforts invested and of the effective progress made towards the goals of ICB. The Committee realizes that the elaboration of a unified code for the whole living world where universal bases and processes support life and give birth to its diversity is a difficult challenge. These difficulties stem from the pragmatic and historical approach started by identifying differences making use of the concepts of species. Moreover, it has established its roots into the scientific community and society in general. No wonder, consequently, that the initiatives of ICB led to a debate that is evidently not closed.

The ad hoc Committee considers that in such a situation the recommendations proposed by ICB are somewhat premature. More consultations with the systematics societies, the National IUBS Members and the mandated bodies responsible for the present five Codes appear to be necessary in order to explain the goals and interests of the project, reach the largest possible number of actors and take advantage of their suggestions in return.

In conclusion the *ad hoc* Committee proposes to congratulate the ICB for its achievements and asks for a continuation of its efforts:

1. to develop the awareness of the scientific community and its responsible bodies;

2. to pursue the fundamental scientific discussion and improve the draft of the BioCode.

REPRODUCTIVE BIOLOGY AND AQUACULTURE (RBA)

The ad hoc Committee on Scientific Programs considers that the RBA Program is essential for the development of aquaculture and in view of the needs of mankind in its products. The Committee states that the second phase of the RBA Programme is quite successful and recommends that the IUBS General Assembly to continue its support. The efforts of Profs. Van Oordt and Okada in initiation and restructuring of the Programme should be specifically mentioned.

However it is important that the Programme be modified to include new objects (species) and other methods, such as traditional fish breeding, rather than be focused on cytogenetic and molecular biology approaches. For example, contacts may be established with the sturgeon group working on recovery of populations of various sturgeon species in North America, Europe and Asia. It would also be advisable to use the paddlefish for artificial breeding. It might also be useful to contact the IUCN Commission on Conservation of rare and disappearing species, where aquatic animals are also involved.

INTEGRATIVE BIOLOGY

The Committee considers that the proposal presented at the General assembly on November 17th has the potential to be a key Programme for IUBS because it can address critical questions within basic biological research as well as easily address critical questions on the environment and society. It offers opportunities for interdisciplinary and collaborative research.

In its present state the Committee considers the text presented as a working document that will facilitate in the elaboration of a full IUBS Programme. In order to implement the

Programme, the Committee formulates the following recommendations for immediate action:

1. Approval of the perspective by the General Assembly.

2. Nomination of a core Scientific Steering Committee by the next IUBS Executive Committee.

3. The tasks of this core Scientific Steering Committee should be:

a) to elaborate an advanced, evaluative and conceptual framework for the Programme that should serve as an umbrella for the development of initiatives on specific themes.

b) to consult the IUBS constituencies on the structure of the framework and its possible amendments.

c) to consult external institutions that may be interested, starting with ICSU and the ICSU family, in order to implement the essential integrative property of the Programme at both intellectual and operational levels.

d) to receive from the community the first research initiatives on specific themes, considering that, by its essence, the Programme has no restriction, except quality, and includes all aspects of living phenomena from molecules to society.

e) to report to the IUBS Executive Committee in order to assess the development of the initiative and eventually to implement it.

In the eventuality of progress approved at the next formal Executive Committee meeting, future steps should provide the comprehensive presentation of the Integrative Biology Programme, the basic elements of its operational implementation as well as the appointment of an extended representative Scientific Steering Committee where all partners sharing interest in the Programme will be represented.

BIOLOGY AND SOCIETY

That Integrative Biology becomes a major framework for future IUBS activities has advantages to the development of fundamental biology, its applications and the evolution of societies. In this respect it emerges as a logical development of DIVERSITAS and prepares new advanced contributions to it.

The Committee views the future IUBS themes and research activities, devoted to questions about the living world where queries integrate according to their specificities, the approaches of biological and social sciences. The Committee would not encourage proposals that would treat in isolation of human dimensions or impacts or would center on questions which do not intrinsically concern the living world and simply use it as a vector.

Essential problems of our societies such as health, nutrition or the structuring of societies by gender for instance, will find their niches in DIVERSITAS when biologically centered questions like the functioning of suburban ecosystems, are relevant to IUBS own responsibilities. The Committee consequently stresses the extent of the perspectives offered by the Integrative Biology Initiative to all disciplines and their possible collaborations.

Regarding Education, the *ad hoc*Committee applauds the development of training programs in biodiversity understanding and management or in the Integrative Biology formation that have been initiated in the last years. It recommends that the IUBS Commission for Bological Education take advantage of these successful examples to support their development and stimulate other new initiatives that would value human resources and develop knowledge and expertise. The IUBS Commission for Biological Education should find support from the future Executive Committee to implement these activities.

BIOETHICS

The Committee, after considering the documents "Bioethics and International Biology" and "Opportunities for New IUBS Activities" presented at the General Assembly, proposes the following:

The IUBS shall set up a formal Bioethics Programme with a Steering Committee to be established by the Executive Committee. This Programme will be concerned with the ethical implications of biological research and its applications.

The IUBS Bioethics Programme will promote awareness of Bioethics and variation in its concepts, will advise on ethical issues in IUBS activities, and will liaise with other relevant bodies and Programmes.

The choice of the activities and their priorities, other than those urgently referred to it by other IUBS groups, shall be determined in consultation with the Executive Committee of IUBS. For initial attention, the development of regional resource centres, the encouragement of educational activities, including instructional courses, conferences and discussions, and the preparation of a series of reviews each on an ethical problem are suggested.

The Bioethics Steering Committee shall report to the IUBS Executive Committee that will in turn report to the General Assembly.

The 26th G.A. Resolutions

The following resolutions were adopted by the 26th General Assembly:

Resolution No 1

The 26th General Assembly **ENDORSES** the report of the Scientific Programmes Committee, **ADOPTS** the Programmes recognized in it, and **THANKS** all those who led and participated in the Scientific Programmes approved by the 25th General Assembly.

Resolution No 2

The General Assembly **RECOGNIZES** that increasing urbanization tends to result in a distancing of human populations from nature.
It **NOTES** the importance of promoting awareness amongst urban citizens on issues of biodiversity.
It also **NOTES** the potential role that governmental agencies, the educational system, information technology, and the media can play in achieving this objective.
The General Assembly **ENCOURAGES** its Members to liaise with their relevant authorities and bodies towards this end.

Resolution No 3

The General Assembly, **ACKNOWLEDGING** the importance of modern communication and information technologies,
RECOMMENDS that these are used to full advantage in the development of research, in the promotion and study of Biological Sciences, in training and educational activities, and in the discussion and dissemination of the results of the cooperative research Programmes of the Union.
The General Assembly further **ENCOURAGES** its Members to promote the use of modern communication and information technologies within their respective institutions, bodies, and agencies, who are charged with the implementation of any of the above, especially in developing territories.
The General Assembly also **NOTES** the importance of seeking funding in order to implement the above objectives.
Simultaneously the General Assemnbly **RECOGNIZES** that information technologies and modern communications are the most expedient and cost-effective methods in networking researchers and in the sharing of their resources.
It **ENDORSES**, in particular, the recent developments shown in the sub-Programme 3 of the IUBS Systematic Agenda 2000-International.

Resolution No 4

The General Assembly, **RECOGNIZING** the continuing need for well trained systematic biologists to meet the world's needs for biodiversity studies and to ensure that a critical discipline in the biological sciences is adequately represented, **RECOMMENDS** that the IUBS establish a committee to investigate methods for capacity building in this area and to report to the Executive Committee within one year.

Resolution No 5

The General Assembly **RECOGNIZING** the need, importance, and potential of a unified voice within biology, **URGES** The Union to work in consultation with ICSU and the biounions within the ICSU family to realize this objective.

Resolution No 6

The General assembly **REALIZES** that it would be helpful for IUBS to have in place a special set of guidelines for internal management and the execution of routine activities.
The General Assembly **REOLVES** that an ad hoc Committee be appointed to develop such a set of guidelines. The Internal Rules Committee should be composed of three members from the Executive Committee plus three other representatives chosen from the Scientific and Ordinary Members. The first draft of these guidelines should be available for consideration by the National Committees within one year. Circulation and comments on this draft should be executed during the following year so that they could be implemented in a timely manner by the Executice Committee. A report on the success of this endeavour should be presented at the next General Assembly.

Resolution No. 7

Conscious of the need to improve communication among the different disciplines within biology, and of the requirement for a stable and coherent set of rules for the naming of organisms in order to store, transmit, and readily access biological information, the 26th General Assembly of the IUBS **ENDORSES** the work of the International Committee on Bionomenclature (ICB)
RECOMMENDS to the relevant bodies responsible for existing Codes of biological nomenclature the adoption, after due study, of the harmonized nomenclatural terms proposed by the ICB in future editions of the existing Codes.
ENCOURAGES all bodies responsible for the current Codes to study the Draft BioCode (1997), to make it widely available, and to respond to the ICB.
REQUESTS the relevant bodies for the existing Codes to implement provisions of the Draft BioCode (1997) in due course, by including selected items from the BioCode in future editions of their Codes.

Resolution No 8

The Committee **NOTES** on behalf of the 26th General Assembly, its appreciation for having the opportunity to meet in this wonderful institution and have available the excellent facilities of Academia Sinica, Taipei.
RECORDS its gratitude to all those who have made this event possible, and in particular to President Y.T. Lee, Professor C.H. Chou, Professor K.T. Shao, and the Local Organization Committee for their hard work, preparation, and contribution to the success of the 26th General Assembly of the International Union of Biological Sciences, and to several organisations in the City of Taipei for their wonderful hospitality over the last week.

The Committee also **RECORDS** its gratitude to all those who presented papers, and in particular to Professor Arber, President of ICSU, whose presence at this Assembly was a great honour.

The IUBS Executive Committee Members
(1997-2000)

The 26th General Assembly of IUBS elected a new Executive Committee for the period 1997-2000 as follows:

President:		
Mounolou,Jean-Claude	France	(Cell Biology & Genetics)
Vice-Presidents		
Chou, Chang-Huang	China/Taipei	(Botany)
Galizia Tundisi, José	Brazil	(Ecology/ Limnology)
Secretary General		
Wake, Marvalee H	USA	(Evolutionary Biology)
Treasurer		
Hänninen,Osmo	Finland	(Zoology/Physiology)
Executive Committee Members:		
Baas, Pieter	Netherlands	(Botany)
Baijnath, Himansu	South Africa	(Botany/Taxonomy)
Biro, Peter	Hungary	(Limnology/Ichthyology)
Goren, Menachem	Israel	(Aquatic Ecology)
Hausmann, Klaus	Germany	(Protozoology)
Hoshi, Motonori	Japan	(Reproductive & Development Biology)
Khrushchov,Nicolay.	Russia	(Developmental & Cell Biology)
Loreau, Michel	Belgium	(Ecology)
Machado-Allison, Antonio Jose	Venezuela	(Ecology & Population Biology)
Ramakrishnan, P.S.	India	(Ecology)
De Stefano, Gian Franco	Italy	(Human Biology)
Whittaker, Peter	Ireland	(Microbiology)

Wilson, Karen	Australia	(Botany)
Yan, Shaoyi	China,Beijing	(Developmental Biology)

OBITURARIES

Frans Antonie STAFLEU

1921 - 1997

We are mourning a great man. One of those who, during their lifetime, change the course of events and the nature of things in a durable way. Frans Stafleu has formed his science, plant taxonomy, to make it more efficient and more creditable. During the high years of his professional career he was a leading figure in global science policy, far beyond systematic botany, beyond even the domain of biology. In the sixties and seventies he served, in succession, as Treasurer then Secretary General then Vice-President of the IUBS, while also holding the Secretariat of its Division of Botany. He was Secretary General of the ICSU from 1970 to 1974, and for many years thereafter, Secretary-General-Treasurer of the Dutch Academy of Sciences.

Frans Stafleu always served science, most prominently in his own discipline. A hard worker if there ever was one, he invested his immense, inexhaustible energy into facilitating and expediting research. The main achievements that will forever bear his name are, all of them, basic working tools for the plant taxonomist, beginning with *Index herbariorum* and *Index nominum genericorum* and culminating in his masterly multi-volume bibliography *Taxonomic literature* -- for which many other disciplines envy plant taxonomists.

It is characteristic for Frans Stafleu that most of the positions he held were managerial, not honorific. While not on occasions disdaining flagpole leadership, such as during his term of presidency (1987-1993) of the International Association for Plant Taxonomy (IAPT), he preferred the discreet but powerful real work in the background to the glamour of the public scene. The IAPT, his creature and favourite child, was virtually his alone to run for the first forty-odd years of its existence: he started as Scientific Secretary of the International Bureau for Plant Taxonomy and Nomenclature, acted as treasurer of the Association until 1964 when he became Secretary-General for 4 consecutive terms of office -- 23 years! In parallel he held the function of Vice-Rapporteur then Rapporteur of botanical nomenclature, being secretary (of course!) of the Editorial Committee for four and chairman for another two editions of the *International Code of botanical nomenclature*. Perhaps most importantly, he was co-editor then editor of IAPT's journal Taxon for 41 years, starting with volume 1, gradually transforming what had started off as a sophisticated newsletter into the world's leading periodical of taxonomic botany.

Frans Stafleu is no longer among us as a person, but he lives on in his works and achievements. He will also live on in the memory of those who were privileged with his friendship and sympathy, to whom he proved a warm-hearted companion and fair adviser -- much as he could stand up against mischief and foulness when he sensed it. Alas, the number of his old friends has been dwindling. Of those who founded the IAPT with him in 1950, forming its first Managing Board, only one (Reed C. Rollins) survives. But we of the (for him) younger generation, we who have admired him and endeavoured to follow his precepts, we will never forget him even though ourselves coming of age. Fare well, Frans!

[An extensive obituary and full list of publications is due to appear in the February 1998 issue of *Taxon*.]

by Professor Werner Greuter, Berlin
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Tamiji INOUE

1948 - 1997

Tamiji Inoue was killed by an aircraft accident near Miri, Sarawak, Malaysia, on 6 September 1997. He was 49 years old.

Tamiji was a prominent scientist of Tropical Ecology, and was discovering the mechanisms of general flowering of rain forests and its effects on whole community structure of the forests. His sudden death was extremely grieved by all ecologists all over the world.

Tamiji got a degree of B. Agr., M. Agr and D. Agr. from Kyoto University in 1971, 1973 and 1978, respectively under the supervision of Professor Syunro Utida and late Professor Syun'iti Iwao. After getting doctor degree he became Instructor and Lecturer in Laboratory of Applied Entomology, Faculty of Agriculture, Kyoto University. At the starting date of the Center for Ecological Research, Kyoto University in April of 1991, he became Professor of the Centre and took Chair of the division of Tropical Ecology until the date of his death.

Although he started his biological interests as an amateur naturalist in young age, Tamiji's first remarkable work was dispersal pattern of carnivorous diptera. He got D. Agr. by a brilliant work on mathematical analysis of hunting behaviour of mantes, carnivorous grasshopper. Since late 70s, he went to tropical rain forests in Panama and in Southeast Asia, for investigating on social structure of stingless wasps, in collaboration with late Professor Shoichi Sakagami, Hokkaido University. After that time, he turned his work mainly to pollination ecology in tropics and then, he had devoted his efforts greatly to canopy biology of tropical forests in Asia.

In a mixed dipterocarp forest in Lambir Hills National Park in Sarawak, East Malaysia, Tamiji has made a team for canopy biology in collaboration with Dr. Summathiri Appanah, Forest Research Institute of Malaysia, Professor Kazuhiko Ogino, Ehime University, Professor Peter Ashton, Harvard University, et al., mainly under the financial aids from Japan Ministry of Education, Science, Sports and Culture since 1992. He made 2 tree towers with a areal walkway, 300 m long for investigating pollination issues in the forest canopy.

In 1996, Tamiji met a general flowering in the forest, and discovered many relationships between flowers and pollinators, most of which are new to science. Before the year he had made some hypotheses on proximate and ultimate causes of simultaneous flowering, on the effects of simultaneous flowering upon population dynamics of insects, etc. Since the autumn of 1996 he repeatedly said to me, with excitement, that most of them would be proved by observing the general flowering.

Tamiji did also devote his efforts to develop the International Network of DIVERSITAS in Western Pacific and Asia (DIWPA). At the first workshop of DIWPA, held in Singapore in 1995, for example, he proposed that Biological Observation Year (BOY) and Asian Biodiversity Summit (ABY) in 2001 and 2005, respectively, and his proposal was enthusiastically accepted by the participants. Also at the International Symposium of Transect Studies held at Beijing in 1996, he suggested that the 3 relations, herbivory, pollination and decomposition, would be the target relationships, instead of target taxonomic groups, for inventory and monitoring of forest ecosystems in the area of DIWPA for future discussion.

Tamiji was not only a brilliant ecological scientists but also an excellent project leader, a teacher to general public as well as a negotiator with politicians and decision makers in Japan and abroad. In almost all Asian countries I visited, I was rather astonished that he was recognized as a good friend and admirable person by most people in various stand points.

In 1969 I noticed Tamiji, at first as a leader of student power movement in Kyoto University. Then, after entering the graduate school, he became a brilliant field and theoretical ecologist, and many of his works attracted our great attention. So, for establishing the Center for Ecological Research in Kyoto University, as the first Director of the Center, I invited him as the professor in the division of tropical ecology.

The loss of Tamiji is a very hard blow to tropical ecology in Asia. Not only his young age, his sudden death was extremely sad because he entered just recently to his much more excellent and productive step in tropical ecology. However, he has paved the way for future research in canopy ecology in order for his colleagues to succeed his efforts and legacy, I believe and pray.

by Hiroya Kawanabe
Lake Biwa Museum,
Kusatsu, Shiga, Japan.

Heinz ELLENBERG

1913 - 1997

A very sad news from Germany was the recent death of Heinz Ellenberg, on May 2, 1997 in Göttingen. His scientific works and outstanding personality have touched and influenced several generations of vegetation and plant ecologists, not only in Europe, but also throughout the world.

The fifth edition of his life's synthesis work (in German), "Vegetation Mitteleuropas mit den Alpen", Eugen Ulmer Verlag, Stuttgart, 1996, had only recently arrived on my desk. His fourth (1986) edition was translated into English and appeared under the title "Vegetation Ecology of Central Europe", Cambridge University Press, 1988. An earlier book in English, "Integrated Experimental Ecology", edited by H. Ellenberg, was published by Springer-Verlag in its now well-known "Ecological Studies Series" as Volume 2 in 1971. It dealt with the methods and preliminary results of the German contribution to the IBP (International Biological Program), the first Internationally coordinated big biological science program. In Germany, this was directed by Heinz Ellenberg and there known as the "Solling Project." The complete results appeared as a 20 year study in 1986 in the Ulmer book entitled "Ökosystemforschung-Ergebnisse des Solling Projekts 1966-1986", edited by H. Ellenberg, R. Mayer, and J. Schauermann.

I had the great fortune to sit in H. Ellenberg's introductory botany lectures in 1948/49 at the University of Stuttgart-Hohenheim. At that time he had just obtained his rehabilitation as university lecturer and was teaching the course in tandem with the botanical institute's director, Professor Heinrich Walter. As I later realized, both were impressive teachers, whose lecturers and personalities inspired me for the rest of my life. Dr. Ellenberg, at that time, introduced vegetation ecology by field excursions in which we learned how to do relevés (vegetation samples). Later, after I had emigrated to Canada in 1952, and when I was inspired by Vladimir J. Krajina to continue my studies with a Ph. D. in forest ecology, I resumed active contact again with both, Profs H. Walter and H. Ellenberg.

One of Ellenberg's fundamental questions in vegetation ecology was, "what controls the combination of plant species in field communities?" For this, the "Hohenheimer Groundwater Experiment" suggested by H. Walter and carried through by H. Ellenberg, gave a compelling answer. Ellenberg clearly demonstrated the difference between physiological and ecological behaviours of plants, the first relating to the absence of competition, the second to plants growing in competition to other plants. He coined the terms physiological optimum and ecological optimum, which helped to clarify the causality of plant distribution patterns in nature.

These, and other aspects, such as Ellenberg's "ecological group concept" were retained in the book Mueller-Dombois/Ellenberg "Aims and methods of Vegetation Ecology",Wiley and Sons, 1974, which represented the first synthesis of European and Anglo American approaches to vegetation ecology. The book could be written because of Ellenberg's prior work, and it undoubtedly contributed to a broader familiarity with Ellenberg's name among English-speaking ecologists.

Heinz Ellenberg produced over 200 scientific papers, including several books, listed in part in his first "Festschrift" published by the German Ecological Society (Göttingen 1983) at the occasion of his 70th birthday. A second "Festschrift" in honor of his 80th birthday appeared in Phytocoenologia, Vols. 23 (1993) and 24 (1994). Excellent accounts on H. Ellenberg's professional life and his impact on modern ecology, including ecosystem analysis and landscape ecology as well as the application of vegetation science to agriculture and forestry, are summarized in both his "Festschrifts" by Wolfgang Haber, Gisela Jahn, and Otti Wilmanns.

Heinz Ellenberg's great contributions were increasingly and repeatedly recognized. For example, he was invited by the British Ecological Society to give the prestigious "Tansley Lecture" in 1977, which was subsequently published with the title "Man's influence on tropical mountain ecosystems in South America" in J. Ecol. 67: 401-416, 1979. Moreover, he received honorable degrees from four universities: Dr.agr.h.c. (Munich), Dr.rer.nat.h.c. (Zagreb), Dr.phil.nat.h.c. (Münster), and Dr. phil.h.c. (Lüneburg).

His major works, the five successive editions concerned with the "Vegetation Ecology of Central Europe", were always dedicated to his closest and strongest supporter, his wife of 60 years, Charlotte Ellenberg, herself a professional geographer and partner in his life's work. I cannot conclude this short obituary without thinking of her unimaginable suffering by loosing her husband, the man who will continue to live in the memory of all those who were touched by his outstanding personality.

by Dieter Mueller-Dombois
Kailua, Hawaii

PUBLICATIONS REVIEW

ANIMAL COMMUNITY, ENVIRONMENT AND PHYLOGENY IN LAKE BAIKAL

Edited by Nobuyuki Miyazaki, published by, Ocean Research Institute, the University of Kyoto, Kyoto, Japan, 1997 (174 pages).

This volume presents an account of the Japan-Russia joint research on "Animal Community, Environment and Phylogeny in Lake Baikal" carried out from 1995-1997. It focused on Taxonomy, Phylogeny and Ecology of freshwater sponges, amphipods, copepods, sculpin fish and seals. Ecological study was also made using stable N and C isotopic compositions, and Baikal seals were used as the effective indicator for monitoring pollution in the lake. ,

ANTARCTIC COMMUNITIES
Species, Structure and Survival

Edited by B. Battaglia, J. Valencia and D.W.H. Wallon, Published by Cambridge University Press, 1997 (464 pages).

This book contains chapters characterising the present approaches to both aquatic and terrestrial communities in the Antarctic and the Southern Ocean. Papers which were taken from the 6th Biological Symposium of the Scientific Committee on Antarctic Research (SCAR), held in 1994 in Venice, Italy, address a wide range of issues from biodiversity to tropic flows, from ecophysiolgical strategies to the impacts of environmental changes and the effects of human disturbance on Antarctic communities.

BIOLOGICAL MODELS

Edited by A. Rinaldo and A. Marani, Published by Istituto Veneto di Scienze, Lettre ed Arti, 1997 (196 pages).

This volume collects selected writings originated from the works of the Summer School on "Biological Models" held at the Istituto Veneto di Scienze, Lettre ed Arti, in June 1993. The collection of papers, which may seem, at first sight, unrelated to one another, reflects the interdisciplinary approach pursued by the School within the general context of studies on environmental dynamics and the complexity of biological processes.

BRYOZOANS In Space and Time

Edited by D. P. Cordon, A. M. Smith and J. A. Grant-Mackie, Published by NIWA, Wellington, New Zealand, 1996 (442 pages).

This volume consists of the Proceedings of the lOth International Bryozoology Conference, held in 1995 in Wellington, New Zealand and sponsored by IUBS. It includes 43 papers representing the wide range of bryozoan research, and bryozoans as a source of marine natural products.

CONSERVATION AND THE FUTURE:
Trends and Options toward the Year2025

by Jeffrey A. McNeely, Published by IUCN, 1997 (118 pages).

In this paper, the author drew on the work carried out mainly within the IUCN Secretariat to make projections upon past trends that were supported by available data. He makes no claim of comprehensiveness and recognises that many useful perspectives, especially from the South have been overlooked. Reviewing ten major areas, ail inter-related where significant changes will affect conservation: population and resources, cultural diversity, climate, pollution, economies, institutions, technology, national security, biological diversity, and information and com-munications, the author concludes that adaptive management is the key.

EVOLUTION AND DIVERSIFICATION OF LAND PLANTS

Edited by K. Iwatsuki and P.H. Raven, Published by Springer and The Botanical Society of Japan, 1997 (330 pages).

This monograph published by the Botanical Society of Japan, presents a review and a general outline of the major advances and trends in understanding the evolution and diversification of land plants. These advances resulted especially from the application of a greatly deepened understanding of the fossil record and the development of new and improved objective methods of analysis employed in the comparison of taxa and the addition of biochemical analysis and evidence based on sequencing nucleic acids.

FOOD, NUTRITION AND THE PREVENTION OF CANCER: A Global Perspective

Published by World Cancer Research Fund in association with American Institute for Cancer Research, 1997 (670 pages).

This volume consists of a review of the literature on diet and cancer and is concerned explicitly with the primary prevention of cancer on a global perspective. It includes a review of the scientific and other expert literature linking foods, nutrition, food preparation, dietary patterns and related factors, with the risk of human cancers worldwide, and contains recommendations suitable for all societies and designed to reduce the risk of human cancers.

LE MODELE ET L'EXPERIENCE

by Jean-Marie Legay, Published in French by INRA, France, 1997 (112 pages).

This book which focuses on models and modelling in scientific research, represents an excellent introduction to the theory and concept of models as a tool for a better understanding of the complexity of biological Systems, as well as an indispensable tool in an approach to integrative biology. Also, it provides good examples of how modelling can be used to develop decision support systems.

REVIEWS IN ECOLOGY
Desert Conservation and Development

Edited by H.N. Barakat and A. K. Hegazy, Publication sponsored by IDRC, UNESCO and South Valley University, Egypt, 1997 (331 pages).

This volume which is published as a festschrift for Prof. M. Kassas on the occasion of his 75th birthday published by the Botanical Society of Japan, represents a compilation of contributions by Kassas' colleagues and students on subjects of ecology, sustainable development and conservation of arid lands, with emphasis on the Arab region.

Calendar of Meetings

IUBS-sponsored meetings are indicated in bold type-face
Additional information may be obtained from addresses in ( ) parentheses

AEROBIOLOGY

-6th Int'l Congress on Aerobiology

August 31-Sept. 5, Perugia, Italy
(Chairman Organizing Committee: Dr. Giuseppe Frenguelli, Dept. of Plant Biology, University of Perugia, Borgo XX Guigno 74, 1-06121 Perugia, Italy.
Ph + 39 75 5856406 Fax + 39 75 5856425
http://www.fisbat.bo.cnr.it.

ECOLOGY

Vllth International Congress of Ecology: New Tasks for Ecologists after Rio 1992

19-25 July, Florence, Italy
(Almo Farina -Vice-President INTECOL, Secretariat, VII International Congress of Ecology, Lunigiana Muséum of Natural History, Fortezza délia Brunella, 540111 Aulla, Italy
Tel/ 39-187-400252, Fax: 39-187-420727
E-mail: afarina@tamnet.it
http//www.inteco!98)

EDUCATION

Education and Training in Integrated and Costal Area Management

25-29 May 1998 Genoa Italy
(International Centre for Coastal and Ocean Policy Studies-ICCOPS
c/o University of Genoa
Department Polis Stradone di S. Agostino 37-16123 Genoa, Italy.
Fax:+39 10 2095840
E-mail:iccops@polis.unige.it)

HORTICULTURAL SCIENCE

25th International Horticultural Congress

2-7 August, Brussels, Belgium
(H. Willcox, Dept. of Horticulture, Ministry of Agriculture, Blowerklaan 21, 14th floor, B-1210 Brussels Belgium
Fax:+3222117209)

HUMAN BIOLOGY

DUAL CONGRESS 1998

IV International Congress of Human Palaeontology

Jointly with

International Meeting of International Association of Human Biologists

28 June- 4 July Johannesburg, South Africa
(Dr. Lee R. Burger, Dept. of Anatomical Sciences, Univ. of Witwatersrand, 7 York Road, Parktown 2193, Johannesburg, South Africa.
Fax: 27 11 643-4318, E-mail
055dc98@chiron.wits.ac.za) ,,y";

GENETICS

XVIII Int'l Genetics Congress
Genetics - Better Life for Ail

22-28 July Beijing, China
(Prof. Li Zhensheng, Director of the Key Laboratory of Plant Breeding and Bio-technology.CAS Beijing, China)

INVERTEBRATES

3rd European Workshop of Invertebrate Ecophysiology

Sept., Birmingham, U.K. (Jeff S. Baie, Univ. of Birmingham, School of Biol. Sciences, Birmingham, B15 2TT, U.K.)

NEMATOLOGY

24th International Nematology Symposium

Aug 4-9 1998 Dundee Scotland UK.
(Dr. David L. Trudgill c/o Mrs Fern Watt, Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, Scotland
Ph + 44 (0) 1382 562731
fax + 44 (0) 1382 561426)
e-mail F.Watt@scri.sari.ac.uk

PARASITOLOGY (ICOPA-9)

August 24-28 , Makuhari Chiba Japan
(Prof. Somei Kojima, Secretary General, Kth Intern'l Congress of Parasitology
c/o Department of Parasitology, The Institute of Médical Science, The University of Tokyo, 4-6-1 Shirokanedai, Minato-ku, Tokyo, 108 Japan.
http///icopa.med.uoeh-u.ac.jp/ welcome)

PATHOPHYSIOLOGY

The 3rd International Congress of Pathophysiology

28 June-3 July, Helsinki, Finland

(O. Hanninen, Dept. of Physiology, University of Kuopio, P.O.Box 1627, FIN-70211 Kuopio, Finland)

PLANT PATHOLOGY

7th International Congress of Plant Pathology

9-16 Aug., Edinburgh, Scotland
Hardwick, ADAS High Mowthorpe, Duggleby, Malton, Y017 8BP, UK, Tel: 44 1970622238, E-mail: m98901@adas.co.uk)

SPACE

COSPAR(Committee on Space Research)

32nd COSPAR Scientific Assembly 12-19 July 1998, Nagoya, Japan. (COSPAR Secretariat, 51 blvd de Montmorency, 75016 Paris
Ph + 33 145250679
Fax+33 1 40 50 98 27
E-mail: COSPAR@paris7jussieu.fr
http://www.mpae.gwdg.de/COSPAR/COSPAR.html)

SEED TESTING

25th Int'l Seedtesting Congress

15-24 April Pretoria, South Africa
(ISTA Secretariat, P.O. Box 412,8046 Zurich, CH-Switzerland
Fax 444 1371 34 2727
E-mail:istach@iprolink.ch)

SOIL SCIENCE

World Congress of Soil Science
20-26 Aug., Montpellier, France
(Alain Ruellan, President ISSS, Agropolis, Av. Agropolis, 34394 Montpellier Cedex 5, France Fax; 33467047549, E-mail: ,isss@agropolis.fr WEB Server http://www.cirad.fr/isss.html)

TAXONOMY

The Third Intern'l Symposium on thé Taxonomy of Cultivated Plants
July 20-26 1998
Royal Botanic Garden, Edinburgh Inverleith Row, Edinburgh EH3 5LR, UK (Dr. Crinan Alexander Ph: + 44 131 552 7171 Fax:+441315520382)

BOTANY

26th International Botanical Congress

1-7 Saint Louis, U.S.A.

(Secretary General, XVIIBC, c/o Missouri Botanical Garden, P.O.Box 299, Saint Louis, MO 63611-0299, U.S.A., Fax: 314-577 5175
Email: ibcl6@mobot.org.
http://www.ibc99.org)

International Conifer Conference

22-25 August 1999 Wye College, Kent, England
(Contact: Miss Lisa von Schlippe, The Royal Botanic Gardens, Kew Richmond, Surrey, TW9 3AE.
Ph:44 181 3325198
Fax: 44 181 332 5197
E-mail :L; von.schlippe@rbgkew.org.uk

ECOLOGY VIII

European Ecological Congress,

Sept. 18-23, Halkidiki, Greece.
(Secretariat EURECO '99, Dept. of Ecology, School of Biology,U.P.B.119 Aristotle University GR-54006 Thessalonki, Greece.
Ph +30 31 998316
Fax + 30 31 998379
E-mail: secretariat@eureco99.auth.gr)

PLANT PROTECTION

14th **International Plant Protection Congress (IPPC)**

Jerusalem, Israel
(D. Rosen, Chairman Organizing Committee, Faculty of Agriculture, The Hebrew University of Jerusalem, P.O.Box 12, Rehovot 76100, Israel)

BIOTECHNOLOGY 2000

llth International Biotechnology Symposium and Exhibition
3-8 September ICC, Berlin Germany
(DECHEMA e.V.c/llth IBS, Theodor-Heuss-Allee 25, D-60486 Frankfurt am main, Germany
Fax: + 49 69 7564 201 E-mail: info@dechema.de)

TRAINING COURSES 1998

UNESCO/INTERNATIONAL CELL RESEARCH ORGANIZATION (ICRO)

Human Molecular Genetics 11-20 April, Sfax Tunisia

(Prof. Hammadi Ayadi, Faculté de Médecine de S fax 3028 S fax, Tunisia
Fax 216 4 246 946)

Frontiers in Reproduction: Molecular and Cellular Concepts and Applications
28 May-July 4, Woods Hole U.S.A. (Dr. John Burris, Director, Marine Biological Laboratory, 7MBL Street Woods Hole, Ma 02534-1015, USA
Fax 508 457 1924
E-mail:jburris@mbl.edu)

Molecular Approach Toward Vaccine Development Against Viral Infections
June 17-30, Yogyakarta, Indonesia
(Dr. Joedoro Soedarsono.Gadjah Mada University, Intenmiversity Center for Biotechnology, Jl. Ternika Utara, Barek, Yogyakarta, Indonesia 56281
Fax:+274 63974)

Molecular Biology of Cancer Cells
July 16-17 Nagoya Japan
(Dr. Shonan Yoshida, Research Institute for Disease Mechanism and Control, Nagoya University School of Medicine, 65 Tsurumai-cho,Showa-ku, Nagoya 466, Japan.
Fax: + 81 52 744 2457 E-mail: syoshida@tsuru.med.nagoyau.ac.jp)

Embryogenesis: Fundamental Aspects and Cryobiological Principles Relating to Assisted Reproduction
July 27-August 12 Medunsa S.A.
(Dr. John Brinders, Department of Veterinary Physiology, Médical University of Southern Africa, P.O. Box 230, Medunsa, South Africa.
Fax: +27 12 521 4270
Em:brinders@mcd4330.medunsa.ac.za)

Biochemistry of Membrane, Transport and Signal Transduction August 16-29, Debrecen, Hungary '
(Prof. Sandor Darnjanovich
Dept. of Biophysics & Cell Biology, University Médical School of Debrecen, Nagyerdei krt. 98, H ^012 Debrecen, Hungary
Fax: 36 52 412 623 E-mail: dami@jaguar.dote.hu)

Molecular and Biotechnological Aspects of Sexual Reproduction in Higher Plants
August 23-Sept. 5, Martonvasar, Hungary
(Prof. Beata Barnabas, Agricultural Research Inst., P.O. Box 19, H-2462 Martonvasar, Hungary '
Fax:3622460213)

Membrane Receptors and Transmembrane Signal Transduction
August 31-September 12, Shanghai, China
(Prof. Q.S. Lin, Shanghai Institute of Biochemistry, Academia Sinica, 320 Yue-Yang Road, Shanghai 200031 China .
Fax: 86 21 6433 5474 or 8357
E-mail: qslin@sunm.shcnc.ac.cn)

Imaging and Microinjection of Aquatic Oocytes
Sept 5-18, Mombasa, Kenya
(Prof Eliud N. Waindi, Dept. of Zoology, Maseno University College.Private Mail Bag, Maseno Kenya
Fax: 254(0) 35 51221
E-mail: masenofs@arcc.or.ke)

Biomembranes and Molecular Medicine
Sept. 14-26, Cluj-Napoca, Romania
(Prof. Gheorghe Benga, "luliu Hatieganu" University of Médecine and Pharmacy, Dept. of Cell and Molecular Biology, 6 Pasteur St., 3400 Cluj-Napoca,
Romania Fax: 40 64 194373-40 64 197257)

Current Trends In Microbial Technology for a Sustainable Environment
October, Kuala-Lumpur, Malaysia
(Dr. Sabaratnam Vikineswary, Institute of Postgraduate Studies and Research (IPSP), University Malaya, 50603 Kuala Lumpur, Malaysia
Fax: 603 756 8940)

Patch Clamp and Fluorometric Calcium Monitoring
Nov. 15-26, Caracas Venezuela
(Prof. Walter Stûhmer, MPI fur Experimentelle Medizin, Hermann-Rein-Str. 3
D-37075 Gôttingen
Fax: 49 551 3899 644
E-mail:stuhmer@mail.mpiem. g wdg.de)

Long-Term Training Course on Selected Topics of Modem Biology
Sept.'97-Aug.'98 , Szeged Hungary
(Prof. Denés Dudits, Biological Research Centre, Institute of Genetics, P.O. Box 521, 6701 Szeged, Hungary
Fax: 36 62 433 434
E-mail: dudits@everx.szbk.u-szeged.hu

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Email: iubs@paris7.jussieu.fr

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The membership of the IUBS presently consists of 41 Ordinary Members, adhering through Academies of Science, National Research Councils, national science associations or similar organisations, and of 80 Scientific Members, ail of which are international scientific associations, societies or commissions in the various biological disciplines.

National Adhering Organisations

ARGENTINA- Consejo Nacional de Investigaciones Cientificas y Técnicas
AUSTRALIA- Australian Academy of Science
AUSTRIA- Ôsterreichische Akademie der Wissenschaften
BELGIUM- Royal Academy of Science, Letters & Arts
BRAZIL- Conselho Nacional de Desenvolvimento Cientifico e Tecnologico
BULGARIA- Bulgarian Academy of Sciences
CHILE- Sociedad de Biologia de Chile
CHINA- Association for Science and Technology, Beijing
CHINA- Academia Sinica, Taipei
CUBA- Academia de Ciencias
CZECH Republic- Czech Academy of Sciences
DENMARK- Det Kongelige Danske Videnskabernes Selskab
EGYPT- Academy of Scientific Research and Technology
FINLAND- Délégation of Finnish Académies of Sciences & Letters
FRANCE- Académie des Sciences
GERMANY - Deutsche Forschungsgemeinschaft
HUNGARY - Academy of Sciences
INDIA- Indian National Science Academy
IRELAND- Royal Irish Academy
ISRAEL-Academy of Sciences and Humanities
ITALY- Consiglio Nazionale délie Ricerche
JAPAN- Science Council of Japan
LEBANON- National Scientific Research Council
MEXICO- Consejo Nacional de Ciencia y Tecnologia
MONACO- Centre Scientifique de Monaco
NETHERLANDS- Koninklijke Nederlandse Akademie van Wetenschappen
NEW ZEALAND- The Royal Society of New Zealand
NORWAY- Det Norske Videnskaps Academi
PHILIPPINES- National Research Council of thé Philippines
POLAND- Academy of Sciences
ROMANIA- Academy of Sciences
RUSSIA- Russian Academy of Sciences
SAUDI ARABIA- King Abdul Aziz City for Science & Technology
SLOVAK Republic- Slovak Academy of Sciences
SOUTH AFRICA- Foundation for Research Development
SPAIN- Comision Interministerial de Ciencia y Tecnologia Tecnologia
SWEDEN- Kungliga Vetenskapsakademien
SWITZERLAND- Swiss Academy of Sciences
UNITED KINGDOM- The Royal Society
U.S.A.- National Academy of Sciences- National Research Council
VENEZUELA- Consejo Nacional de Investigaciones Cientificas y Técnicas