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UNDER THE ICEBERG

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Abstract

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This paper provides a general introduction to the theme of the Conference on Invertebrate Biology and Conservation. The introduction is centred around general consideration of biodiversity patterns and processes, changes to patterns and processes and changes in biodiversity and ecosystem function. Three challenges are posed to biologists who study invertebrates: cooperation among specialists across the taxa; the development of analytical techniques to determine ecosystem/landscape health; and, the presentation of research findings in forms accessable and usable by planners and managers.

Introduction

A small visible portion and the larger submerged portion of icebergs have made the iceberg a familiar simile. Tim New (1995) carried the iceberg allegory further in his latest book on invertebrate conservation. As is the case with the icebergs, much of biodiversity is out of sight. So much, actually, that we can emphasise this by saying that a large portion even is "below the iceberg". Species and genetic levels immediately come to mind, but there unquestionably are entire communities or ecosystems of microorganisms, structurally and functionally complete. In most discussions of biodiversity, turbellarians and leeches seldom rate a mention, let alone the denizens of the buccal cavity of a water snake, the fauna of the fur of a sloth or the temporary denizens on the carcass of a whale, which died and sank at depth. Occasionally, we remember such things as the relationship of termites to the protozoans of their gut. Generally speaking, however, the invertebrates with a public profile are likely to be in one of three categories: well-known pests or parasites, popular food items or those notable for their physical beauty or other distinctive peculiarities. One may fairly say that the knowledge base for the species in these three categories greatly exceeds the knowledge of all other invertebrates.

Patterns and Processes of Biodiversity

Biodiversity exists in time and space. Human perceptions of time and space are best when their characteristics are familiar, i.e., most like our own. Time and space for invertebrates varies greatly. The world of an individual protozoan is vastly different from that of the giant squid, life in the gall bladder of an insectivorous bat differs markedly from that in a tunnel of a fallen, decaying spruce. For invertebrates, space and time involves dimensions and durations of such diversity and complex relationships that patterns seemingly act as if they were whole organisms and processes develop unimaginable pathways. Scale is seemingly a paradoxical jumble.

Ecological terminology so clearly useful and precise for vertebrates becomes vague and imprecise when applied to invertebrates. Biological structures and processes vary almost endlessly among invertebrates. Basic and fundamental biological concepts often are challenged. While biologists are terribly fond of counting almost anything, taxonomists are unalterably fond of describing, naming and revising arrangements of organisms, the sheer number of different kinds of invertebrates, organisational patterns within and among individual populations and communities are of such daunting magnitudes that there is little rational hope that counts, descriptions, naming and revisions will ever be completed — or even if so, then fully useful. Space and time interacting with invertebrates yield phenomena that are of such complexity that the identification of particular trends, cycles or other patterns may not be a realistic goal.

Without doubt, the patterns and processes among invertebrates are of immense intellectual interest. They are, moreover, of great importance to functioning of the complex living systems of which they are part. We have made passing reference to scale, but rate is equally important. Change is continuous, but the diversity of rates among patterns and process of invertebrates is seldom appreciated. The apparent obsession with rare and endangered species, as the key to biodiversity, has obscured those species which are exploding in numbers (individuals and populations) or increasing in geographic distribution. Focus on the rare and endangered almost suggests that the flora and fauna are static displays of nature and that evolution and natural selection have ceased. Nothing could be further from the truth. Resistance to pesticides and drugs, exploitation of new man-made environments, successful new distributions and associations in environments far removed from their original are just some of the easily identifiable indicators of the rates of change among invertebrates.

Another myth, that people are somehow not part of natural systems, that "nature" must be kept safe from human influence, is widepread — and nonsense. People are a biological species. We eat many invertebrate species, we live in a state of tolerance with a wide array of invertebrate species, quite a number of invertebrate species depend upon the various activities of people and some live inside or on the outside of our bodies. These associations have arisen over time and space with great diversity of scale and rate, of pattern and process. As the number of people increase, ever greater alteration of the biosphere will occur and the opportunity for invertebrate evolutionary changes and variations in natural selection are magnified. The need, therefore, for us to understand invertebrate patterns and processes also increases. In addition to the important ecological services such as energy and nutrient recycling, invertebrates are competitors for resources and can be the reservoirs, vectors or agents of disease.

The demands for information on patterns and processes among invertebrate species will increase. The role of traditional invertebrate biologists must reflect the adaptability of their subjects. Taxonomy must be more than description and nomenclature, phylogenetic analyses and technique-driven research. It is not enough to put a face with a name in a kinship pattern determined by a trendy method. As important as this information is, it must be in the larger contexts of patterns and processes. The same applies to those working with invertebrates of agricultural, veterinary and medical importance. Solutions to specific problems will continue to be important, but these solutions must be set in the wider contexts of patterns and processes. Technology can provide assistance, but technology produces its own special sets of problems. Technology, whether in the form of equipment or techniques (especially genetic manipulation or modification) must be evaluated in the larger contexts of patterns and processes. The current emphasis on biosafety in the discussions of the Convention on Biological Diversity underscore these activities. One may easily become complacent and forget just how dynamic living systems can be.

Alterations to Patterns and Processes

At some point in the future, one may look back upon our present and readily identify trends and cycles of durations and amplitudes which to us are not obvious. While the biosphere is a mix of gradual change over time and cataclysmic alteration, invertebrate life not only has persisted, but evolutionarily elaborated patterns and processes to confront the selection pressures of adversity and opportunity. There is no reason to suspect that the forces of change, gradual or cataclysmic, have abated. Established patterns and processes are being altered.

The human population is now approximately 5.5 billion and there are no indications that the number will decrease. Food, fodder and fibre crops to feed the growing number of people will not be distributed as are the human population and their domesticated animals. If we believe the International Panel on Climate Change (IPCC) on global change then there will be more than the usual run of droughts and floods, frosts and hail, pests and pestilence, but most of all there will continue to be political and social disquiet that interrupts plantings, harvests, transport and financial systems and other aspects of traditional societal structure. Locally adapted strains of crops and domestic livestock will continue to be lost. In the midst of such disaster, few have given thought to the implications for invertebrate patterns and processes. The fauna of cropland soil will change, pests and parasites will find new and different hosts, entire ecosystems built upon human dwellings, stock pens, food stores and the like will disappear and patterns and processes associated with seasonal plantings, harvests, burnings, births, deaths and various cultural activities will alter to greater or lesser degrees. If such social unrest is temporary, little may be lost, but if prolonged or intense then desertification or other major change may be the product.

Even if there is no social unrest, human behaviour looms large as a modifier of patterns and processes. People alter landscapes and seascapes. Not only do they remove or change vegetation, but land form is changed. Hills and valleys are changed into land with minimum contour. Sediment and nutrient input is increased to coastal embayments. Ruthless fishing techniques destroy whole sub-marine communites, many undescribed or even unknown.

Not only is the diversity of vegetation decreased, but often reduced to huge expanses of a single species bordered and partially invaded by plants that indicate human disturbance. The addition of extra nutrients and the applications of pesticides (weed and insect control primarily) generate enormous changes to patterns and processes. Nutrient levels may target the dominant plants of the area, but the impact of the change in available nutrients is highly non-specific. Few pesticides are highly specific and many non-target species are hit. Some of the so-called down-stream effects of additional nutrients and pesticides are well documented, but the case may be that we do not wish to know about other effects.

People, like any other species, produce waste. In addition to biological waste, however, people produce cultural waste. Within any biological community, there are species which are waste converters. They begin the process of releasing energy and nutrients otherwise bound in waste, the flow of bound energy back through the ecosystem. Many of the species along the energy flow detoxify harmful substances and store others in an inaccessible state. Many of these converters and accumulators early in the recycling of energy and nutrients are invertebrates working alone or in partnerships with plants. Patterns and processes have evolved over time so that these organisms act as part of what can be considered as the immune system of the biosphere. Unfortunately, human waste, biological and cultural, occurs in such quantities, kinds and often in such confined space that the normal patterns and processes not only cannot cope, but are totally destroyed. There is also the probability that the few species capable of tolerating large concentrations of toxic substances may be toxic as well or produce wastes of increased toxicity.

Any discussion of this sort invariably includes reference to global warming, global change or both. Without venturing into the arguments about whether global warming is real, no rational biologist can deny that global change is a reality. Change is ever-present. Long before any "global" influence is a factor, local change will be the major factor in invertebrate patterns and processes. Landscapes are not simply biological, but bio-cultural entities. Species, especially including people, which interact with the local landscape, shape that landscape. Changes to the local landscape alter that portion of the biosphere. If the change is sufficiently drastic, the usual patterns and processes become dysfunctional. The interaction of various landscapes then is affected. Global change, then, is the aggregate of all local change, a situation where the total change may be greater than the sum of its parts.

Biodiversity Change and Ecosystem Function

Discussions purportedly about conservation often convey the impression that ecosystems never change. Loss or addition of species is taken as failure of the ecosystem. Ecosystems are amazingly resilient. Many seem to have depth in species which are ecologically redundant. Again, change as a continuous process is worth re-emphasising. Communities exist in time and space. While there are indications that certain associations of species have persisted over considerable spans of time, we know very little about brief (our perception of brief) associations or whether what we think of as considerable spans of time represent portions of trends or cycles. While much is made of a supposed "balance of nature" equilibrium or homeostasis, in all probability these represent largely imaginary points about which various patterns and processes oscillate, what one might call the comfort range. Under the more usual circumstances of immigration, emigration and land form change, the ecosystem retains a distinctive character. If, however, the ecosystem suffers massive alteration in composition and land form a chaotic state prevails until fluctuations again become confined to a "comfort" range.

Others, and we, have suggested that new combinations and associations will be the dominant ecological feature of the future. While this may seemingly be a new thing for people, people have lived amid and been the agents of great change. There are examples where functional ecosystems have been destroyed and many examples where what we today think "natural" is the creation of people. Examples include tropical rainforests (in reality managed fruit orchards in Central America), the so-called wilderness of most of our country, and the now recognised cultural landscape of Uluṟu-Kata Tjuṯa National Park.

What warrants concern? Never before have people existed in such numbers. Never before has technological development been capable of making changes on such a great scale so rapidly. Never before have people made such demands for space and never has so much been extracted at such a rate from the land, water and sea. Most importantly, virtually all of the demands for space and the extractions have been opportunistic, unplanned forays with little or no thought of the consequences. We deal primarily with the results of accumulated small decisions to satisfy short-term goals. There is perhaps an explanation of the disparity in wealth observed in different populations of people in the inability to recognise and accept the carrying capacity of a region, unrealistic expectations of the benefits of technology with an unwillingness to accept the environmental impacts of technology and the acceptance of another's definition of wealth.

Ecosystem function is intimately bound to the expectations of people. What can be extracted from a system, how much disturbance can a system sustain and what defines a healthy system? We must have the answers to these questions.

Invertebrates and non-vascular plants, as well as those organisms which fall between, lie at the heart of any answer to these three questions. We cannot wait until all invertebrate species are collected, described and named. We badly need analytical systems which allow us to determine the health of ecosystems and their limits. We need to be able to identify usual fluctuations from chaos and not confuse biological change with xenophobia. Much is made of "rapid biodiversity assessment" and "all species inventories". But are these excercises useful or necessary? The answer is probably no. More important is to refine our knowledge of the pattern and process of invertebrates, within the framework of adaptive management.

Australia has experienced invasions of alien species at various time in the past. Certainly, in the more recent past there were different waves of immigration of Aborigines. Two hundred years ago Europeans arrived with cultural baggage that included an array of organisms, the number and variety of which continues to expand. Others have commented in detail on general and specific impacts of this baggage. Suffice to say that established biological patterns and processes have been severely disrupted. New combinations and associations of species have developed and others will most certainly emerge.

There is much ado about introduced invertebrate species and certain of them have been singled out for special attention. Without doubt, some of the introduced species have had devastating effects on established patterns and processes. While control is sometimes a viable and necessary option, one must be circumspect about the hope for success. Not all introduced species become established. Some seem to persist marginally until conditions become optimum for their spread. Other invertebrates have been deliberately introduced in the hope that they will either assist in the retention of existing patterns and processes or that they will aid in the establishment of new patterns and processes. The number and variety of alien species now established in Australia preclude the possibility that their eradication is even remotely possible.

Management issues must focus on the interaction of people with the environment. That is conservation. While vertebrate biologists may have the luxury of focusing on individual species, invertebrate biologists will not share this luxury. Valid and reliable indicators of the health of the invertebrate communities of a landscape must be developed. In fact, the complexity of patterns and processes among invertebrates requires multidisciplinary cooperation.

The wealth of detail which will emerge from research and the evaluation of management programs and plans will be such that those responsible for the development of policies, strategies, programs and their implementation cannot possibly absorb the detail. Data must be converted to information and presented in a readily useable form for managers. Detail of interest to seicntists must go into the scientific literature. The historic lack of communication between scientists and managers must be over-come. The re-establishment of communication may be tedious and, at times, frustrating, but it must be done. Invertebrate biologists, therefore, have three significant, but self-evident, tasks before them:

1. they must work together;
2. develop analytical techniques to determine ecosystem/landscape health; and
3. present their findings not only for scientists, but for planners and managers.

This is a formidable challenge. One suspects that one of the first steps will be to make an assessment of the requirements for invertebrate specialists and their employment prospects. Teams of specialists must be formed and appropriate analytical methods devised and evaluated, all in an atmosphere of communication with planners and managers. Only then can we begin to assess our efforts for the conservation of invertebrate species. Lists will give us history. Patterns and processes will tell us whether the systems are healthy.

Reference

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