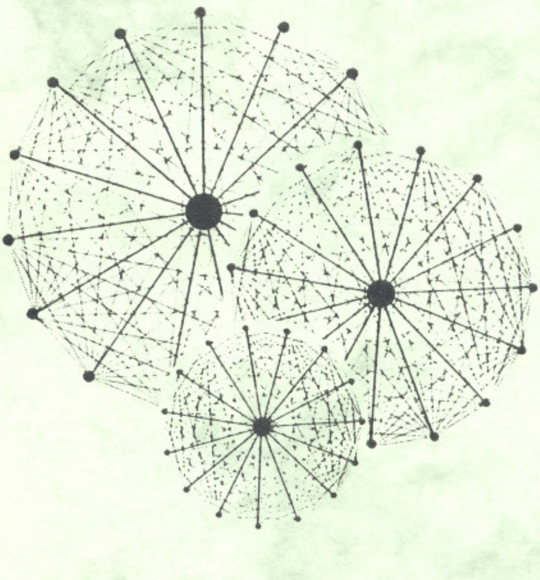
Biotic Diversity and the Function of Mediterranean-type Ecosystems

PROGRAMME



a symposium organized under the auspices of SCOPE/IUBS

Education Centre, Middle Campus
University of Cape Town

7 & 8 September 1992

WELCOME TO OUR

OVERSEAS VISITORS

On behalf of all the conference delegates we would like to extent a warm welcome to :

DR JON E KEELEY — **Occidental College, Los Angeles**

Prof Jon Keeley is in the Department of Biology at the Occidental College in Los Angeles, and was coordinator of the Californian synthesis for mediterranean-type ecosystems in the SCOPE Programme.

PROFESSOR EDUARDO R FUENTES — **Catholic University, Santiago, Chile**

Eduardo Fuentes is Professor in the Faculty of Biological Sciences at the Universidad Católica de Chile, and part-time Professor at the Universidad de Chile. His academic interests include scientific research in the field of population, community and landscape ecology, as well as conservation, and the study of humans as triggers of landscape change.

DR RICHARD J HOBBS — **CSIRO, Division of Wildlife & Ecology, Western Australia**

Richard Hobbs is a Principal Research Scientist with CSIRO, Division of Wildlife and Ecology in Perth, Western Australia. Originally from Scotland, he has worked in California and been in Australia for 8 years. His chief research interests are the ecology, management and restoration of vegetation in fragmented ecosystems, integrated landscape management, and long term vegetation dynamics.

PROFESSOR JACQUES BLONDEL — **Centre Nationale de la Recherche Scientifique, France**

Jacques Blondel, Directeur de Recherche, Centre National de la Recherche Scientifique, Centre Louis Emberger, Montpellier. Fields of research and teaching : Evolutionary biogeography in the Mediterranean region, population biology of birds in island and habitat mosaics. Analysis of the consequences of Mediterranean constraints (bioclimate, evergreenness) on the adaptation of birds to local environments.

PROFESSOR BYRON LAMONT — **Curtin University of Technology, Perth, Australia**

PhD in 1974 on soil-plant relationships in Australian Proteaceae. Sabbatical leave in 1980 to work at University of Cape Town on South African Proteaceae. Senior Fulbright Award in 1987 to work with Hal Mooney at Stanford University, California. Currently, Associate Professor in Plant Biology and Coordinator of Postgraduate Studies in Biology at Curtin University, Perth, Western Australia. Has produced over 150 papers, book chapters and reports on soil-plant relationships, reproductive ecology and population dynamics of sclerophyll vegetation.

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BACKGROUND

Ecological science has not yet been able to determine in any detail the role of biotic diversity in the functioning of natural ecosystems. Furthermore, it is not known to what extent humanity depends on those functions for its own survival. SCOPE International is currently embarked on a programme to address these issues, in which the focus is placed on two central questions :

* Is biodiversity important in the maintenance of system processes, and if so,how will it be affected by anticipated global changes such as those of climate, land use and plant/animal invasions?
* Is the stability and resilience of systems affected by biodiversity, and will global changes alter these relationships?

The SCOPE programme is designed to synthesize our knowledge of the functional role of biodiversity, and to develop an experimental programme for possible inclusion in the International Geosphère Biosphere Programme (IGBP). The SCOPE programme is a component of a larger venture run jointly with the International Union of Biological Sciences (IUBS) and the UNESCO/Man in the Biosphere Programme (MAB). The SCOPE initiative via which this symposium is being organized, concentrates on the role of biodiversity in ecosystem function, while the UNESCO/MAB and IUBS components are concerned with the monitoring of biodiversity, and with the origins and maintenance of biodiversity respectively. A major thrust of the SCOPE programme is based on the study of relevant issues within specific system types, one of which has been identified as the set of mediterranean-type ecosystems. Cape Town, South Africa's mediterranean climate city, has been chosen as the location for activities designed to synthesize global knowledge regarding the relationship between biodiversity and the function of mediterranean-type ecosystems.

AIMS OF THE SYMPOSIUM

This symposium, which is one of the synthesis activities, will assess mediterranean-type ecosystems with regard to the following issues as defined by the SCOPE guidelines :

* natural diversity;
* the impact of change on diversity;
* assessing the role of diversity in ecosystem function;
* reconstruction and maintenance of diverse systems; and
* refining of our knowledge through monitoring and experimentation.

PROGRAMME

MONDAY, 7 SEPTEMBER 1992

08:00-09:00	REGISTRATION and SETTING UP OF POSTERS
	SESSION 1 - Chair : RD Walmsley, Foundation for Research Development
09:00-09:10	**RD Walmsley** : Welcome and Introduction
09:10-09:30	**BJ Huntley** : A background to the global interest in biodiversity and ecosystem function of mediterranean-type ecosystems.
09:30-10:00	**WJ Bond** : Keystone species and the analysis of complex systems.
10:00-10:30	**GW Davis, MT Hoffman and GF Midgley** : Measuring diversity of form and function: looking for links in fynbos.
10:30-10:45	**B McKenzie** : POSTER SYNOPSIS
10:45-11:15	TEA
	SESSION 2 - Chair : Annelise le Roux, Cape Nature Conservation
11:15-12:00	**BB Lamont (Australia)** : Conceptual issues in biodiversity and ecosystem functioning with examples from southwestern Australia.
12:00-12:30	**HP Linder and JJ Midgley** : Taxonomic diversity : what does it mean?
12:30-13:00	**MC Rutherford** : Plant equitability and system function.
13:00-14:00	LUNCH

SESSION 3 - Chair : WJ Bond, University of Cape Town

14:00-14:45	**RJ Hobbs (Australia)** : Function of biodiversity in mediterranean ecosystems of Australia.
14:45-15:15	**RM Cowling, PJ Mustart, MB Richards & H Laurie** : Species diversity, functional diversity and functional redundancy in fynbos communities and landscapes.
15:15-15:35	TEA

SESSION 4 - Chair : C Boucher, University of Stellenbosch

15:35-16:20	**J Blondel (France)** : Space and time as determinants of biological diversities in the Mediterranean region.
16:20-16:50	**JJ Midgley, DM Richardson and WJ Bond** : Different ecosystems in the same environment: determinants and consequences.
17:30	SOCIAL HOUR
18:30	FINGER SUPPER

TUESDAY, 8 SEPTEMBER 1992

SESSION 1 - Chair : DA Everard, FORESTEK - CSIR

08:00-08:30	COFFEE
08:30-09:15	**E Fuentes (Chile)** : Function of biodiversity in mediterranean ecosystems of Chile.
09:15-09:45	**WD Stock and N Allsopp** : System processes and their relationships to diversity.
09:45-10:15	**M Wright and J Donaldson** : Insect diversity and the role of insects in ecosystem function.

10:15-10:45	**SD Johnson** : The role of pollination in the generation and maintenance of floristic diversity in fynbos.
10:45-11:15	TEA

SESSION 2 - Chair : C Marais, Cape Nature Conservation

11:15-12:00	**J Keeley (California)** : Biodiversity and ecosystem function in mediterranean California.
12:00-12:30	**AG Rebelo** : Diversity in vegetation types of the Cape Floristic Region : are guilds more diverse in species rich systems?
12:30-13:00	**J King and J Day** : Biodiversity in fynbos rivers and wetlands : patterns past and present.
13:00-14:00	LUNCH

SESSION 3 - Chair : IAW Macdonald, South African Nature Foundation

14:00-14:30	**BW van Wilgen, DM Richardson and A Seydack** : Managing fynbos for biodiversity.
14:30-15:00	**JE Parkington** : Biodiversity, climate and human behaviour.
15:00-15:30	**J Donaldson, G Scott and F Archer** : Current patterns and relationships between humans and biodiversity
15:30-16:00	TEA
16:00-17:30	CLOSING PANEL DISCUSSION - Chair : WJ Bond, University of Cape Town

ABSTRACTS OF PAPER PRESENTATIONS

KEYSTONE SPECIES AND THE ANALYSIS OF COMPLEX SYSTEMS

WJ Bond
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The flora of the south-western Cape is bewilderingly diverse. What are the important processes which maintain this diversity? What will the consequences be of losing one or many species? How should one study these complex systems in the context of shrinking habitats, shrinking economic resources and changing climates? Here I compare some approaches to addressing the questions andsome problems in generalizing results. I suggest that many species depend on the continued existence of a few (keystone) species and key abiotic processes. Identification and study of keystone species is an important tool for analysing complex ecological systems.

MEASURING DIVERSITY OF FORM AND FUNCTION : LOOKING FOR LINKS IN FYNBOS

GW Davis, MT Hoffman and GF Midgley
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Biotic diversity is a concept which biologists use as a descriptive para= meter for ecological systems, and one which it is suspected may be of critical importance to the maintenance of function and stability in some systems. In this paper we review the current interpretations of diversity, both with regard to system components, and the processes which are regarded as reflections of system function. Having delineated the terms, we will apply our operational understanding of diversity to systems which typify the mediterranean-type systems in general, and fynbos ones in particular.

Firstly, the concept of diversity will be investigated with regard to the biological components of systems, with consideration of the different scales and organizations levels normally recognized in the biologists in the fynbos.

Secondly the diversity of processes will be considered. This will adopt as a starting point the assumption that processes are linked to the identifiable transfer of energy, matter and information within the system, and between the system and its environment (depending on the definition of boundaries). The processes concentrated on will be those of: energy capture for photosynthesis (and incidental heat loading), the transfer of water and nutrients within fynbos systems, and syndromes of pollination and seed dispersal.

Thirdly, these annotated definitions will be inserted into a schema which conceptualizes the interrelationship between different types of system components and the processes which link them.

Finally, the schema will be used as a template for reviewing some of the ecophysiological data generated by fynbos research in the past, and assessment made of the importance of the links between diversity and function. The implications of these links will also be used as an hypothetical basis for the study of management options in the region.

CONCEPTUAL ISSUES IN BIODIVERSITY AND ECOSYSTEM FUNCTIONING, WITH EXAMPLES FROM SOUTHWESTERN AUSTRALIA

BB Lamont
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Perth, Western Australia

Is it biotic or biological diversity? If the latter, then ecosystem function is a component of biodiversity. The keystone concept shows some promise as a means of valuing species for their contribution to ecosystem function. Limitations to its usefulness include : a) there is a continuum in the number of functional pathways to which species contribute, directly or indirectly, b) the quantitative contribution of species to these pathways is paramount, c) it is difficult to study empirically. Symbiotic microbes are most likely to contribute to the 'highest order' functional pathways, ultimately controlling the way the ecosystem functions and thus biodiversity. Usually, rare species will contribute more to the biological novelty component than the ecosystem functioning component of biodiversity. Examples of plant-abiotic, plant-plant, plant-animal and plant-microbe interactions which have major effects on productivity, population sizes, species composition and ecosystem functioning in southwestern Australia will be used to illustrate some of these issues.

TAXONOMIC DIVERSITY : WHAT DOES IT MEAN?

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JJ Midgley
FORESTEK - CSIR
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Ecologists are usually the passive users of the taxa as defined and determined by systematists. In many ecological studies all taxa are assumed to carry equal information and to be comparable.

We explore some definitions of various taxonomic levels and examples of their application in the Cape flora. Based on this we show that in terms of biodiversity and functional diversity, not all species carry equal information. We argue that phyletic diversity or higher taxonomic levels are better correlates of functional and biotic diversity.

PLANT EQUITABILITY AND SYSTEM FUNCTION

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SCOPE OF PAPER

- General hypotheses in relation to complexity and function
- Relationship between equitability and diversity; the confounding effect of richness
- The expression of equitability, the sampling completeness problem, and "diversity-independent measures of evenness"

- Patterns of relative abundance of species and functional types in Mediterranean-type ecosystems, also relative to those in other ecosystems
- Dominance versus rarity at community level; the nature of dominants and local rares
- Equitability and the regulation of community organization:

  tolerances, interactions and niche dimensions (habitat, life form, phenology and regeneration); capacity and allocation rules; broken symmetry and hierarchical control structures; differentiation of population dynamic probabilities; dominance persistence/non-persistence; cross- scale dependencies; contagion/dispersion; density dependence; abundance-size relations; generalists/specialists; community discontinuities;
- Conclusions: contributions to theory

FUNCTION OF BIODIVERSITY IN MEDITERRANEAN ECOSYSTEMS OF AUSTRALIA

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Mediterranean ecosystems in southwestern and southern Australia have a characteristic climate of cool wet winters and hot dry summers, but experience some summer rain. The flora of southwestern Australia is very diverse, with many endemic species, high species turnovers and high levels of intraspecific variation. A diverse array of vegetation responses to water and nutrient limitation is apparent. Vegetation mosaics are complex, resulting from the interaction of landform and soil types, disturbance regime and localised species distributions. Mediterranean regions of Australia have been extensively modified by human activity over the past century, particularly in relation to agriculture and timber harvesting.

Few studies of the importance of biodiversity to ecosystem function have been conducted. Numerous examples are available of complex biotic interactions in mediterranean systems which indicate that components of biodiversity are important in community functioning, but it is not immediately clear how these relate to the primary ecosystem functions of water, nutrient and energy transfers. This is primarily because of the mismatch between population and community processes and ecosystem-level processes. A model is presented which suggests that ecosystem functions require a number of sub-functions operating at the population and community level, and in this way biodiversity can be linked directly to ecosystem function.

Natural ecosystems are compared with human-modified systems, and the management implications are explored. In extensively fragmented systems, ecosystem functions have been disrupted in both the remaining native vegetation and in the agricultural system. In agricultural systems, replacement of functional groups removed during agricultural development is seen as a solution to many land degradation problems. In conservation areas, the goal is to conserve biodiversity, and hence all the various functions and sub-functions present need to be maintained. The relative importance of the various functions and sub-functions will depend on the land use. I suggest that, although research into the ecosystem function of biodiversity is important, it is also essential to recognise that the maintenance of biodiversity is an important goal in its own right. The maintenance of ecosystem function is essential for the conservation of biodiversity, regardless of whether the converse is also true.

SPECIES DIVERSITY, FUNCTIONAL DIVERSITY AND FUNCTIONAL REDUNDANCY IN FYNBOS COMMUNITIES AND LANDSCAPES

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This paper analyzes the relationship between species diversity and functional (growth form) diversity within and between fynbos communities. The analysis provides insights into the determinants of fynbos community structure and boundaries which are important for predicting the effect of species loss on ecosystem processes.

Specifically, we ask the following questions :

1. What is the relationship between species diversity and functional diversity in fynbos communities?
2. How do functional analogues co-exist in fynbos communities?

3. What are the implications of functional redundancy for long-term community structure?
4. What is the relationship between changes in species composition and functional diversity along resource gradients in fynbos landscapes?
5. What is the role of competition and fundamental specialization in determining fynbos community boundaries?

SPACE AND TIME AS DETERMINANTS OF BIOLOGICAL DIVERSITIES IN THE MEDITERRANEAN REGION

J Bondel
Centre National de la Recherche Scientifique
Montpellier, France

The diversities of Mediterranean biotas, especially those of plants, mammals and birds, are analyzed in the light of their geographical and historical determinants at several scales of space and time. Although some elements of the present Mediterranean flora are remnants of an old Tropico-Mediterranean vegetation (Laurisilva), a large part of the vegetation differentiated during the late Miocene and the Pliocene, which is the time when the Mediterranean climate set up. However, the climatic viccisitudes of the Pleistocene largely determined the present assemblages and diversities through extinction and speciation processes. In contrast to the flora which presents a high endemism rate (50%), mammals and especially birds entered the Mediterranean region from various biogeographic realms but few speciation events occurred within the limits of this region (low endemism rate). This will be explained from historical cues related to the Pleistocene history of the region.

The role of man over the last 8 millenia on the dynamics of biodiversities will be discussed from palaeobotanical and archaeozoological data. In the present climate, most habitats at low and mid altitudes should be forested, man had not destroyed the climatic vegetation. Therefore most matorral like formations are of anthropogenic origin. The consequences of such changes on the dynamics of biodiversities will be discussed. Few species became extinct as a result of human activities (except large mammals and most mammals on islands) but distributional patterns and population densities dramatically changed. The large extension of shrublands combined with an increase in habitat fragmentation produced changes in ecosystem function. One example will be given using the population biology of insectivorous birds in habitat mosaics.

DIFFERENT ECOSYSTEMS IN THE SAME ENVIRONMENT; DETERMINANTS AND CONSEQUENCES

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Changes to the biosphere may cause extinctions by reducing population sizes to below critical levels (ie demographic extinctions). Changes in the biosphere may also cause extinctions indirectly, by inducing shifts of present community boundaries. It is therefore important to understand the determinants of community boundaries.

In the Cape, very different natural ecosystems (eg species-rich fynbos and species-poor forest) can occur under the same environmental conditions. Furthermore, many Cape ecosystems have been severely altered by alien invasions. These provide ideal situations to analyze (i) the determinants of ecosystem boundaries; and (ii) the consequences of different species assemblages on ecosystem processes.

In this paper we explore the relative importance of factors that determine community boundaries in the Cape. We examine feedback mechanisms between ecosystem components and the environment, and the consequences of different species assemblages for ecosystem functioning. We conclude that the nutrient-rich / nutrient-poor paradigm has been over-emphasised. Fynbos does not merely depend on fire for its existence, but creates a more fire-prone environment. Alien invasions show clearly that fynbos is easily replaced by ecosystems that are totally different in terms of species composition, structure and function. The species-poor forest and strandveld and systems invaded by aliens apparently have much greater ecosystem stability than the fynbos they replace. This argues against any simple link between biodiversity and ecosystem stability.

SYSTEM PROCESSES AND THEIR RELATIONSHIP TO DIVERSITY

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Main thrust of chapter is to address the question : "Should we be conserving biodiversity or diversity in ecosystem function?"

Using experimental evidence we will attempt to show that species richness/diversity is a poor starting point upon which to base conservation priorities.

Diversity of ecosystem processes essential (ie, functional diversity) for conservation of stable ecosystems:

1. show that litter quality and hence decomposition unrelated to spp diversity/also little association between decomposition and guild diversity.

2. fire (ie, abiotic factor) predominant nutrient cycling process - also determines which spp survive ie : reseeder/resprouter mixes.

3. diversity of nutrient acquiring structures and processes more important than number of spp with same attributes in particular deal with N_2-fixation, mycorrhizas, cluster rootlets, etc.

4. diversity of nutrient conserving structures and processes more important than number of spp with same attributes leaf longevity, nutrient withdrawal, etc.

5. changed ecosystem processes results in decreased spp diversity - use examples from alien invasions ie : nutrient enrichment by N_2-fixers cf with effects of hakeas and pines.

Against background of experimental evidence assess whether species control processes or if abiotic controls only ones in force.

Problem here is circularity of arguments - fynbos high fire environment - due to species present - which are carbon rich and don't decompose self perpetuating.

Number of species a function of speciation - is there any indication that environmental constraints drive this process - overlap with pollination chapter not too much discussion.

Conclude that there is little relationship between biodiversity and ecosystem function in fynbos - therefore might be better to assess conservation worth in terms of functional guilds.

Such a conclusion is merely a restatement of the habitat vs species conservation debate - as impossible to conserve all species when we do not understand individual requirements, let alone species interactions.

INSECT DIVERSITY AND THE ROLE OF INSECTS IN ECOSYSTEM FUNCTION

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Seed predators and herbivores may contribute to the maintenance of diversity at the community level by limiting seed stores and plants' competitive ability, thus preventing single species dominance. Predacious and parasitic insects play a role in limiting herbivorous insects. Detritivorous insects may contribute to otherwise slow nutrient cycling in Fynbos. An attempt will be made to identify keystone/guilds of insects and to elucidate their role in the maintenance of 'ecosystem function' in fynbos.

THE ROLE OF POLLINATION IN THE GENERATION AND MAINTENANCE OF FLORISTIC DIVERSITY IN FYNBOS

SD Johnson
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Many of the current perceptions of speciation in fynbos are based on the premise that steep edaphic and moisture gradients coupled with genetic isolation through limited gene flow has led to rampant speciation in the area. There is little evidence, however, that edaphic and moisture gradients are any steeper than those in equivalent montane areas elsewhere with fewer species eg Drakensberg. Furthermore there is no evidence that pollen mediated gene flow differs from other areas. The only evidence for limited gene flow is that c20% of the flora have seeds dispersed short distances by ants. Traditional approaches to fynbos speciation have some limited application to myrmecochorous taxa and also to the few areas of edaphic diversity eg the agulhas plain.

An alternative model of speciation is based on the observation that many fynbos genera show great floral diversity and relatively little vegetative diversity. As floristic diversity is largely associated with adaptation to pollinators, it follows that pollinators have been a prime force in speciation. Pollination shifts, which in this model are the prime cause of speciation, occur when previous pollinators are scarce or inefficient and selection modifies the flower to attract more abundant or efficient pollinators. This may occur when a plant invades a new area or when there is a turnover of pollinators through time.

The model is essentially a botanical application of the speciation theory of the zoologist Hugh Paterson in which speciation occurs entirely in allopatry with no need for reinforcement of isolation mechanisms in sympatry. In this model speciation is no more than an incidental consequence of adaptive evolution of the flower which leads to character changes used by taxonomists to delimit species.

Many fynbos plants are dependant on specialised pollinators, therefore disturbances such as habitat fragmentation which leads to a lower biomass or diversity of pollinators are likely to lead to plant extinctions. The hypothesis that seed set is regulated by pollinators, rather than resources, is testable and could be a valuable means of predicting extinction before it occurs.

BIODIVERSITY AND ECOSYSTEM FUNCTION IN MEDITERRANEAN CALIFORNIA

J Keeley
Occidental College, Los Angeles

This paper will report the proceedings of a workshop held in Los Angeles in February 1992, which was attended by Californian biologists working in mediterranean-type systems on the west coast of the USA. Topics covered at that workshop included the following :

- Bird diversity pattern (Cody)
- Lepidoteran diversity and food plant distribution (Powell)

- Diversity and food web structure of annual grasslands and coastal sagescrub (Price)
- Growth form and resource utilization (Rundel)
- Modelling geographic patterns of species richness at the landscape level (Davis)
- Habitat fragmentation (Quinn)
- Annual plant diversity patterns (Zedler); and
- An historical perspective of climate change and distribution and diversity of chaparral plant taxa.

DIVERSITY IN VEGETATION TYPES OF CAPE FLORISTIC REGION : ARE GUILDS MORE DIVERSE IN SPECIES RICH SYSTEMS?

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The Cape Floristic Region (CFR) contains several vegetation types which replace one another under different edaphic, climatic and fire frequency regimens. One of these vegetation types, Fynbos, has an unusually high abundance of species, so that it ranks amongst the richest of the temperate and tropical floristic hot spots. In contrast to these other hot spots, however, the majority of plant species diversity is concentrated in a few speciose taxa. In contrast, although animal diversity in the CFR is low, endemism of fishes, amphibians, reptiles, butterflies and birds to the region in high, with the vast majority occurring in Fynbos vegetation.

However, it is not only in species richness that Fynbos is unique among the vegetation types of the CFR. It is also the only vegetation type that features ant-dispersed seeds, pyric serotiny, rodent-pollinated plants, supports a very high nectarivorous bird population, has a very high proportion of plant species killed by fire and a low herbivore abundance. All these features relate to the low nutrient status of the soil and the regular fire perturbation of Fynbos relative to other vegetation types. In the Proteaceae species richness can readily be explained by three parameters of their ecology; regeneration strategy, pollination syndrome and seed dispersal.

In this paper I explore these features of the various vegetation types and show that Fynbos is characterised by more than just high species richness - it also has a high guild diversity within these ecological parameters, and these guilds are characterised by species from several clades. This implies that speciation in the CFR cannot simply be relegated to the preponderance of a few clades - unique adaptations have evolved in situ and are parallelled by similar adaptions in other heathlands of the world.

BIODIVERSITY IN FYNBOS RIVERS AND WETLANDS : PATTERNS PAST AND PRESENT

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The biological uniqueness of the fynbos biome is reflected as clearly in its aquatic systems as in its terrestrial flora. The biome's rivers and wetlands are distinct within southern Africa in terms of their water chemistry, hydrology, riparian vegetation and aquatic biota and, indeed, are more similar to systems in other mediterranean biomes than to those in neighbouring aquatic ecosystems.

Endemism is known in most biological components of the ecosystems, from trees to aquatic invertebrates and, in groups such as the fish, Amphibia and Crustacea, some species are known to be restricted to single systems or small areas. In rivers, the sensitive, endemic invertebrate species mostly occur in the upper reaches; they have strong Gondwanaland affinities and many similarities to the Afromontane, Australian and South American fauna. Lower reaches of the same rivers contain a widespread hardy fauna shared with much of the rest of southern Africa. The fauna and flora of wetlands comprise many endemic forms, presumable because of the Gondwana origins of several groups, the mediterranean climate and the acidic nature of many of the soils.

The causes of the biotic diversity and the degree of endemism of the systems are not well understood. It seems clear, however, that maintenance of these phenomena is threatened by human activities. Changes in flow regime, temperature, water chemistry and sediment load, the eradication of riparian zones, and the introduction of alien species, have changed species composition of the aquatic systems and commonly eradicated endemic species. The resulting trend is one of altering ecosystems with naturally pure waters to resemble those found naturally where water is less pure; these systems, in turn, are being degraded to polluted ecosystems with a hardy biota of low diversity.

The ethical responsibility for maintaining at least some ecosystems in their own right, and for future generations, is particularly important in this case. The aquatic biota of the fynbos biome is highly diverse, truly unique, covers an extremely small area (perhaps less than 1% of the biome?) and is sensitive to anthropogenic changes. As yet the role of diversity in these ecosystems is not known, but if all of them were allowed to slide down the scale of degradation, the sensitive endemic forms of the most pristine areas would be completely eradicated. Any future attempt to revert these systems to pristine might then fail through lack of the biota adapted to those conditions.

MANAGING FYNBOS FOR BIODIVERSITY

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The mountain catchment areas of the Cape are managed mainly by the CDNEC, who use prescribed burning and alien weed control measures to achieve their aims which include the maintenance of biodiversity. In this paper we explore the options open to managers of fynbos. These options include varying the season, frequency, intensity and size of fires, and of implementing systems ranging from "natural burning zones" to intense management. Modern data analysis and modelling techniques, including geographic information systems, expert systems and fire modelling are currently being linked into a powerful catchment management system, which allows the users to store, retrieve, analyze and display data on fire history, vegetation communities, alien weed populations, and fire hazard, and to prioritize areas for prescribed burning and weed control. Targets for the achievement of fire patterns are set, using a combination of knowledge of the ecology of plants and their responses to fire, and measured against actual achievement. The systems that have been devised locally are unique to the Cape and should provide an interesting basis for the development of similar systems in other mediterranean-type ecosystems.

BIODIVERSITY, CLIMATE AND HUMAN BEHAVIOUR

JE Parkington
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What we call the archaeological record is an invaluable set of ancient materials that have survived into the present. Bones, shells, charcoals and other organic remains reflect in fragmentary fashion ancient biota and their characteristics. In most cases they also reflect human selection and choice, making it difficult to distinguish often between what was and what was perceived by people as useful. The diversity of animal and plant communities in the past is thus not easily read from the record. In this paper examples are given which show that loss of diversity is the result of both climatic and human behavioural change. Loss is exaggerated when these two factors combine to put particular pressure on complex ecosystems.

CURRENT PATTERNS AND RELATIONSHIPS BETWEEN HUMANS AND BIODIVERSITY

JS Donaldson & G Scott
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F Archer
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The study of biotic diversity and ecosystem function focusses essentially on the consequences of reduced diversity on ecosystem processes (both biotic and abiotic).

The scientific question posed is "are all species important in sustaining ecosystems or is there some level of redundancy?" Since the concept of redundancy is unquestionably anthropocentric, the question can be more crudely phrased as, "How many species can we do without before the systems that sustain us collapse?"

If this is the question we wish to answer, then we are obliged to look at human dependence on biodiversity. This is done specifically for the MTE in southern Africa (definition, if not defined elsewhere). We concentrate only on the direct dependence on biodiversity (ie utilization), not on indirect relationships (eg the effects of diversity on water availability, etc) which are dealth with elsewhere.

WHAT IS THE RELATIONSHIP BETWEEN PEOPLE AND VEGETATION OF MTE

1. Original inhabitants
   - acquired in-depth knowledge
   - use often at specific or sub-specific level

2. Immigrants (white and African)
   - Substitution of local flora for traditional plants (crops)
   - Crude exploitation of plants (often at generic level) because they do not have adequate understanding of MTE flora (Timber, edible plants, fuel thatching)

3. Economic Diversification and new technologies

<u>Medicinal Plants</u>

- At what level do drug companies look for extracts - (sub specific)?
- How much potential exists at this level in MTE ecosystems?

<u>Essential oil market</u> -

- MTE has a high proportion of plants with volatile oils. How much is exploited, what is the potential and at what taxonomic level does this potential exist (data suggests specific chemical races within species).

<u>Horticulture</u>

- How much species are utilized?
- What is the importance of species and particular races for breeding purposes?
- What emphasis is placed on unusual varieties?

<u>Agriculture</u>

- To what extent can indigenous plants be incorporated into agriculture and forestry and how many species are likely to be involved.

This paper will show that the original inhabitants, and their descendents, had an in-depth knowledge of the biotic resources of their area. They utilized many species and often distinguish between closely related taxa.

Immigrants tend to use important species with which they are familiar or to replace traditional usage with local substitutes, with only a crude level of identification. As a result of both forms of substitution, fewer species are used.

However, substitution works best only under certain circumstances. The potential exists for much more reliance on biodiversity to diversify the economy. We explore this relationship in some detail.

LIST OF POSTERS

Cape Milkwood Thickets : Composition and Conservation
C Boucher / HC Taylor

The Hidden Component of Plant Biodiversity
V Hendricks / B McKenzie / L Raitt

Satellite Derived Changes in Fynbos Vegetation
M Jury / RM Cowling

Regeneration through Seeding of Shrubs in the Xeric Succulent Thicket, and Comparisons with Chilean Matorral
G la Cock

Do Proteoids Co-existing as Adults Partition Resources? Our data says no!
H Laurie / RM Cowling / P Mustart

Seasonal Diversity Patterns in Fynbos
N McKenzie / C de Lange / A Claassen

The Threat of Stratospheric Ozone Depletion to Floristic Diversity in Fynbos
CF Musil

Erica Diversity : Can it be explained?
AG Rebelo

Moisture : Degradation Relationships in Grazed Tanqua Karoo Veld
CJ Stokes / MB Bayer / RI Yeaton

Resilience of Mountain Renosterveld to Disturbance
CJ Stokes / MB Bayer / RI Yeaton

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