

The karoo

Ecological patterns and processes

The succulent and Nama-karoo form part of the arid south-western zone of Africa, a vast region of rugged landscapes and low treeless vegetation. Studies of this unique biome have yielded fascinating insights into the ecology of its flora and fauna. This book is the first to synthesise these studies, presenting information on biogeographic patterns and life processes, form and function of animals and plants, foraging ecology, landscape-level dynamics and anthropogenic influences. Novel analyses of the factors distinguishing the biota of the Karoo from that of other temperate deserts are given and generalizations about semi-arid ecosystems challenged. The ideas expounded, the ecological principles reviewed and the results presented are relevant to all those working in the extensive arid and semi-arid regions of the world.

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Foreword

Since the turn of the twentieth century, and in particular since the 1920s, grave concern has mounted over the evident degradation of the semi-arid and arid rangelands of South and southern Africa. Climate change, desert encroachment, soil erosion, salinization of the few irrigated lands and, above all, overstocking by domestic livestock, were thought to be responsible for changes in the apparent production potential of the land. This led to a number of research programmes being set up by the Department of Agriculture, all designed to obtain some predictive understanding of the biology of organisms in the southern African arid and semi-arid rangelands, particularly the karoo. The karoo covers 35% of South Africa, and extends into neighbouring Namibia, and, as such, represents a significant proportion of southern Africa. Despite the accumulation of a large amount of knowledge on vegetation, grazing effects and the management of rangelands in the karoo over several decades, there still remained a serious gap in understanding the dynamics of vegetation and plant–animal interactions in this region.

The various 'Biome Projects' (see, for example, Scholes and Walker, 1993), set up by the South African National Programme for Ecosystem Research from the early 1970s, were designed to develop some understanding of ecosystem functioning in the major biomes and inland waters in South Africa. Research within the biome projects focussed on climate and soils, adaptive physiology and behaviour, reproductive biology, population dynamics, species interactions and community processes, and the protection of biodiversity and ecosystem modelling. Projects were funded mostly by the National Programme for Ecosystem Research, the Department of Environment Affairs and Tourism and the Department of Agriculture through the universities, nature conservation organizations and NGOs.

Despite the concern over the 'degradation' of the

karoo, and the perception that agriculture (*sensu lato*, including ranching) in the karoo was less productive than it could have been, the Karoo Biome Project was only set up in 1985 (Cowling, 1986) and had been largely dismantled by the early 1990s. It was thus the youngest and most short-lived of the biome projects, but it produced exciting new findings and provided training for many biologists at a relatively low cost. Goegap Nature Reserve and the Richtersveld National Park in Namaqualand, where studies on plant and animal population dynamics were carried out, the Worcester Veld Reserve in the south-western succulent karoo, where numerous studies of vegetation and soils were done, Grootfontein Agricultural College at Middelburg, where research on management of karoo rangelands was carried out, and the Tierberg Karoo Research Centre at Prince Albert, where more academic research on plant physiology, vegetation dynamics, plant–animal interactions and animal population dynamics was carried out, are among the places in the karoo where many studies were successfully completed. All these sites, with the exception of Tierberg, were in use by researchers before the Karoo Biome Project was initiated. Recently, research in the karoo has focussed on natural resources in communal rangelands. Research in the karoo is never easy, with a harsh and unpredictable climate, rough terrain and long distances to contend with, but the rewards were often great, and results of experiments often totally unexpected.

The information on patterns and processes in the karoo is fairly widely scattered and has never been synthesized or made available in a single volume. The objectives of this book are to succinctly review the state of knowledge of patterns and processes in the karoo. The book is primarily aimed at researchers, lecturers, graduate students, conservationists and other land managers in southern Africa

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and elsewhere. This review differs from others in that, in addition to information on biogeographic patterns and life forms, a great deal of the book focusses on form and function of plants and animals, foraging ecology, landscape-level dynamics of plants and animals, models that simulate the dynamics of various organisms, and Man's past, present and perhaps future place in the karoo. The ideas expounded here, the ecological principles reviewed and the results that are presented here are applicable and relevant to a large number of more or less similar sites and conditions elsewhere in the world.

The authors of the various chapters can all be regarded as experts and experienced in their fields of research. It stands to reason that all the aspects pertaining to the karoo could not be treated in the space of a single book. Of special interest to me, as these fit in more with my field of interest and experience, are the chapters on the driving variables, plant biogeographic patterns, animal foraging and food, modelling karoo populations and dynamics, human impacts, historical and contemporary land use, and comparisons of ecosystem processes in the karoo and other deserts. From a South African point of view, this book can be regarded as a significant advance in the understanding of the karoo.

This book, and the reports and papers published by the various contributing authors, are prime examples of what can be achieved through a small amount of funding in the hands of enthusiastic and dedicated researchers. Many projects in the karoo, have been extremely cost-effective, and the scientific outputs from such projects have been of a high standard. As such, results have been incorporated into the curricula of universities and other institutions of

learning. From a practical point of view, results from research in the karoo have contributed significantly to the interpretation of past land use and to policy for land use in the present and future.

As a member of the 'old school' of biologists, to whom field work was the most important part of the project, I am appalled at the fact that field studies have been relegated to subordinate positions by today's young biologists. Reworking old databases has become a popular pastime (and in some cases with exciting new interpretations), but there is the danger that no new databases are being assembled at the same time. Breaks in historic databases are disastrous and irretrievable, and cannot be contemplated in ecosystems, such as the karoo, where turnover is slow and projects on population dynamics almost worthless unless funded over long periods. It is essential, for the sake of further advancement of ecosystem research, environmental conservation and management in the karoo, that adequate funding and support for research is at least maintained, if not increased. Funding for research in this region has always been a problem and the Karoo Biome Project was always the 'Cinderella' of the South African Biome Projects. This book is an example of the results that can be obtained through personal motivation, initiatives, a positive approach and a burning curiosity about South African arid and semi-arid ecosystems. There never was much money, but it was money that was very well spent.

P. W. Roux,
Former Chairman of the Karoo Biome Project Steering
Committee

Preface

The arid south-western zone of Africa, which includes the Namib Desert, the arid savanna of the Kalahari, and the succulent and Nama-karoo (Fig. 0.1), is a vast region of rugged landscapes and low treeless vegetation, bounded on the west by the cold Atlantic coastline, in the south by the winter rainfall fynbos and evergreen forest biomes, and in the north and east by arid and mesic savannas. The fauna and flora of the karoo, *sensu lato*, combine elements from the desert, arid and moist savannas, grasslands and, in sheltered sites, from the forest. There is a gradient from succulent dwarf shrublands to woody dwarf shrublands and to grasslands. The animals of the karoo have been drawn from the surrounding biomes, and the level of endemism among the best-studied groups is not high. Conversely, although the vegetation has been similarly drawn from surrounding biomes, there is a high percentage of endemics, particularly in the succulent karoo.

The karoo is an ancient landscape. The varied rocks and sediments that underlie it span 500 million years of geological time and range from glacial moraines and lacus-

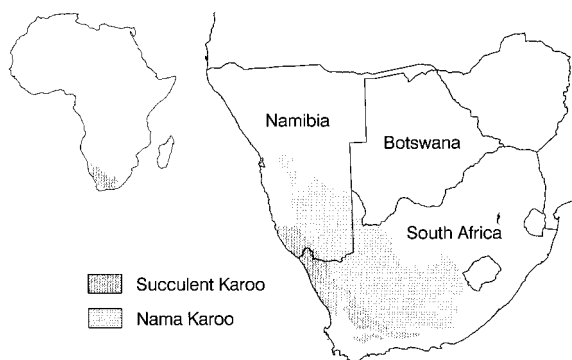


Figure 0.1 Southern Africa, showing the succulent and Nama-karoo biomes.

tral deposits to recent aeolian sands. Fossil-rich sediments bear testimony to the changing environments through which the karoo has passed. Within the archaeological record, recent climate change has modified plant distributions, animal assemblages and human behaviour. The karoo has a long history of utilization by hunter-gatherers and herders whose populations remained low, whose shifting settlements were unstable, and whose impact on the landscape was localized in space and time, like those of the indigenous and naturalized plants and animals on which these peoples depended.

Two hundred years ago, the karoo was colonized by peoples of European origins, who brought with them agricultural traditions, livestock and crops more appropriate for a less stochastic mesic climate. Settled agriculture dependent on underground water combined with ploughing of alluvial soils for dryland crops has since changed the structure and composition of karoo habitats and biota (Roux and Vorster, 1983; Macdonald, 1989; Hoffman and Cowling, 1990b; Milton and Hoffman, 1994; Dean and Macdonald, 1994; Dean and Milton, 1995; Steinschen et al., 1996). Ploughing lands to plant crops was a novelty in the karoo ecosystem, and a largely unsuccessful experiment during the first 150 years of occupation (Macdonald, 1989; Dean and Milton, 1995). Grazing by domestic livestock was thought to be sustainable in the karoo and to be the best agricultural use for this arid region, but it, too, has associated problems.

Research in the karoo was motivated by the need to develop a predictive understanding of ecosystem functioning so that this knowledge could be applied to grazing management systems and thus increase, through sound management, the proportion of the gross national product that came from the karoo. Research in the karoo was in four phases:

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- Up to the early twentieth century, most biologists simply collected organisms in the karoo.
- From about 1920 to the early 1950s, applied, rather than basic research was encouraged because of the perceived need to solve problems associated with grazing or aridification (Anon, 1923, 1951; Schumann and Thompson, 1934; Wallis, 1935; Kokot, 1948; Tidmarsh, 1948).
- From the 1950s to the 1980s, research focussed on succulent plants, centres of endemism and the biogeography of plants in the karoo. This was really phytosociology on a broad scale.
- Since the 1980s, research has been directed towards gaining an understanding of ecosystem processes in the karoo (Cowling, 1986).

Conceptual models of ecosystem function are urgently needed for conservation and land use planning in the

karoo, and for addressing the question of how the vast and biologically diverse, but unproductive karoo region should be used in a country with a growing land-hungry population.

In this book, we have attempted both to bring together the findings of basic and applied ecological research in the succulent and Nama-karoo, and to highlight fields that are still poorly known. Subject reviews have been grouped into those dealing with: broad-scale geographical patterns (that set the biotic and physical stage for the book); the links between form and function in living organisms characteristic of the region; population and community dynamics; and brief reviews of the past and present influences of humans on the karoo ecosystems. The final section presents comparisons between the karoo and other similar arid regions.

W. R. J. Dean and S. J. Milton

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