Spectrum

Evolution in arid Australia

An Australian fish, the desert goby, can survive up to 27 days in distilled water, and more than 60 days in sea water. It tolerates, at least for short periods, temperatures as low as 5°C or as high as 40°C. When the oxygen concentration falls to a low level in the creek or artesian bore in which it lives, the goby may take refuge among algae giving off oxygen as they photosynthesize. As a last resort, the fish can even breathe air.

This capacity for physiological gymnastics equips the desert goby well for life in Australia's arid zone, an environment with a harshness that resides not, as popularly imagined, in relentless heat and drought, but in rapid switches from one severe adversity to another.

For example, one of the biggest hazards facing burrowing spiders in the arid zone is not aridity but flooding. Members of the funnel-web and trapdoor spider group variously seal their nests with doors looking remarkably like bathplugs or deflect water from the entrances by miniature turrets or levees of soil and other materials. Rains are rare but heavy, and to survive the spiders must take out flood insurance.

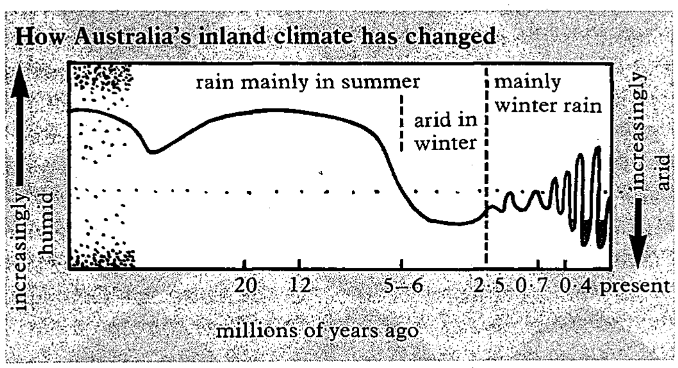
The survival strategies of desert animals and plants, and current theories of how they evolved, formed the theme of a symposium held in Adelaide in 1980. From that gathering has grown a book, 'Evolution of the Flora and Fauna of Arid Australia', almost entirely made up of papers delivered at the meeting.

Our knowledge of the arid and semi-arid flora and fauna is uneven. Vertebrates have been relatively well studied, flowering plants less so, and work on the terrestrial invertebrates, hampered as it is by taxonomic difficulties, has a long way to go. Yet the 42 papers in this book combine to paint a picture, albeit faint in places, of desert life and the forces that have shaped it.

The organisms and their habitats are no more uniform than the weather they experience. Invertebrate animals make the overwhelming contribution to this biological diversity; the ants, in particular, seem far more diverse than those of comparable arid areas anywhere else in the world. Soils, too, show great variety, even over short distances.

The student of flowering plants, on the other hand, is soon struck by the relatively small number of arid forms. The 'Flora of Central Australia' lists only about 2000 species, although it treats an area one-quarter that of Australia. Contrast this with the 'Flora of Sydney Region', which describes more than 2000 species occurring within a mere 20 000 sq km.

Adapted to rain, the spider that owns this burrow seals it with a 'bathplug' (above).



Our inland has not always been arid; in fact since lower Miocene times (the start of this chart) it has been mostly humid. Salt lakes and sand dunes only formed relatively recently, during the most arid conditions (coloured areas on the chart).

The arid vegetation has another striking characteristic: patchiness. The level of the ground needs to rise or fall by only 2 cm to redistribute rain-water in a pattern of 'puddles' and 'islands' that can give rise to a corresponding pattern of plants. Patchiness reflects other factors, too — variable soil depth, uneven compaction of calcareous soils, erosion, fire, and so on.

In its broadest sense, 'arid Australia' denotes more than 70% of the continent, and its major plant formations comprise low and shrub woodlands, shrub steppe (low shrubland of saltbush and bluebush), *Acacia* shrublands, mallee (eucalypt shrublands), and hummock and arid tussock grasslands. At finer resolution we find characteristic communities associated with such habitats as flood plains, saline drainage channels, and creek beds.

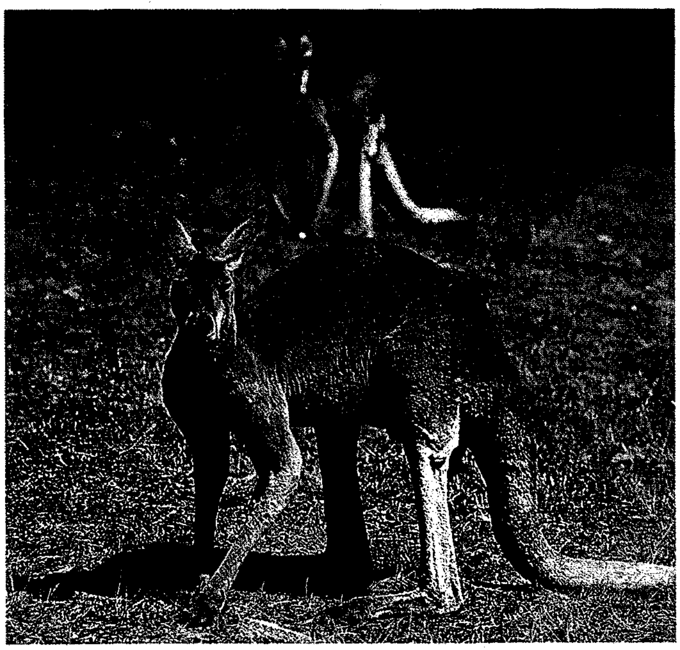
How, according to the book's contributors, did this landscape, its patchwork of plants, and its rich fauna evolve? The ultimate modellers of our deserts and their climate have, it seems, been continental drift and a fall in global temperature.

Australia's climate comes under the influence of subtropical high pressure cells. From lake-bed cores and other evidence, scientists have inferred that some 20 million years ago these cells occurred at about latitude 50°S, where Tasmania then stood. Since then, the theory goes, the continent has drifted some 10° northwards, but the high pressure cells have overhauled it, being centred now over mainland Australia at about 30°S.

To put this in meteorological terms, 20 million years ago all Australia experienced a 'summer-rainfall regime', more or less like that of present-day Darwin. The seasons differed less strongly from one another, and inland Australia experienced a foggy, humid winter climate.

The high pressure cells have intensified since then, wind and ocean currents have grown stronger, and sea surface temperatures have fallen. These changes, coupled with the cells' shift northwards, have shaped modern Australia, with its arid interior and with cold winter rains falling in the south of the continent.

According to this hypothesis, the earliest severely arid conditions would have appeared about 6 million years ago in the Nullarbor region. This does not mean that desert animals and plants have evolved all their distinctive features within the last 6 million years. Aridity has been with us far longer than that, and some rainforest plants may have begun acquiring adaptations to dry conditions as far back as the Eocene — say, 40 or even 50 million years ago.



Symbol of arid Australia, the red kangaroo may be a johnny-come-lately to the deserts.

Among mammals, perhaps the hare wallabies (*Lagorchestes* spp.) and the nail-tailed wallabies (*Onychogalea* spp.) evolved their adaptations to aridity back in the summer-rainfall days, when a shortage of water occurred seasonally. Each of these genera includes one species living in the monsoonal climate of northern Australia, possibly perpetuating a way of life common to the whole genus in Miocene times, 20 or 25 million years back.

Vertebrate fossils tell a story that fascinatingly complements the hypothesis of the high pressure cells.

By the middle of the Miocene, some 15 million years ago, tree-climbing mammals were disappearing and terrestrial species increasing. Grazing kangaroos had arrived in the arid zone by the early Pliocene, about 5 million years ago.

From the early Pliocene to the middle or late Pleistocene (that is, from 5 million to 700 000 years ago), aquatic species such as lungfish, crocodiles, and flamingoes gradually declined, but remains of many genera that now typify the arid region (like the hare wallabies) turn up in the same deposits, indicating a fairly long period of overlap when the essentially dry inland contained permanent bodies of water.

Today the red kangaroo symbolizes arid Australia, yet it seems to be a johnny-come-lately to the deserts. Its remains rarely occur in Pleistocene deposits, even in western New South Wales, where red kangaroos now abound. Perhaps it, and other species that react to droughts with nomadic migrations, evolved their arid way of life only within the last million years or so.

About 400 000 years ago, plants and animals that had adapted to the relatively slow climatic changes of the previous 6 million years received a rude shock. Large and possibly rapid fluctuations in rainfall began, which have affected wide areas of the continent. Man arrived perhaps 100 000 years ago, and since then has probably obscured the patterns of biological communities formed by these recent major shifts of climate.

Where did desert plants and animals originally come from? All possible sources, it seems: some, like *Acacia* spp., apparently evolved overseas and spread to Australia; others, like the Myrtaceae (the plant family containing the modern eucalypts) and the *Casuarina* genus, occurred in Australian rainforests more than 50 million years ago. Some plant groups probably originated in the tropics, and others in the ancient southern supercontinent of Gondwanaland.

The arid fauna probably has equally diverse origins.

All these topics make up just part of the book. Other papers describe the adaptations of that successful genus *Atriplex* (saltbush), the role of fire in arid communities, the methods by which arid zone plants regenerate, and much else besides.

The volume falls into five sections: an ecological and historical background; the ecological and reproductive adaptations of plants; vertebrates; invertebrates; and individual groups of plants. The editors have provided a preface, and Professor Spinny Smith-White, formerly of the University of Sydney, wrote the concluding summary.

The 46 contributors come from universities, botanic gardens, State government departments, CSIRO (seven Divisions), private companies, and elsewhere. The book was published in association with the Australian Systematic Botany Society and the South Australian Division of ANZAAS; CSIRO helped meet the cost of publication, and Western Mining Corporation underwrote the project.

'Evolution of the Flora and Fauna of Arid Australia', ed. W. R. Barker and P. J.M. Greenslade and published by Peacock (Adelaide 1982), is available from Peacock Publications, 6 Grenfell Street, Kent Town, S.A. 5067, for $32.95 plus $4 postage and handling.

A data bank of Australian resources

In 1979, the CSIRO Division of Water and Land Resources began work on a challenging job: creating a computerized system for storing and analysing a diversity of information about Australia and its people.

Known as the Australian Resources Information System (ARIS), it now contains data on, among other things, terrain, climate, vegetation, soils, dwellings, industry, and roads. The current list of subjects covered is given in the table, and more data will be included.

The data-storing aspect of the system is called ARDB — the Australian Resources Data Bank.

A key feature of the system is that all the data sets are related to standard geographic areas covering the whole country, without gaps