Jack Kinnear

Enderby Island; pristine and unspoilt niche of rock-wallabies.

Outfox

Jack Kinnear, Senior Research Scientist with CALM, talks about niche theory, islands, and the fox problem.

Bert & Babs Wells

The fox (*Vulpes vulpes*) arrived in the 1900's and has spread throughout a large area of the state.

The word 'niche' is normally used to convey the idea of place or position - a slot or pigeon-hole in which to put things. In ecology, it is also used in like manner: a species' niche usually refers to its place, or role in a typical community of microbes, plants and animals.

This definition of the niche, however, is not very informative. For example, when a species, previously known to be widespread and abundant, is now known to be rare (and hence, liable to become extinct), all one can say is that it is struggling to maintain its place and role in a community. But that is obvious anyway; what conservation biologists would like to know is ***why*** that is so.

In 1957 G.E. Hutchinson, an eminent ecologist, conceived of a

king The Fox

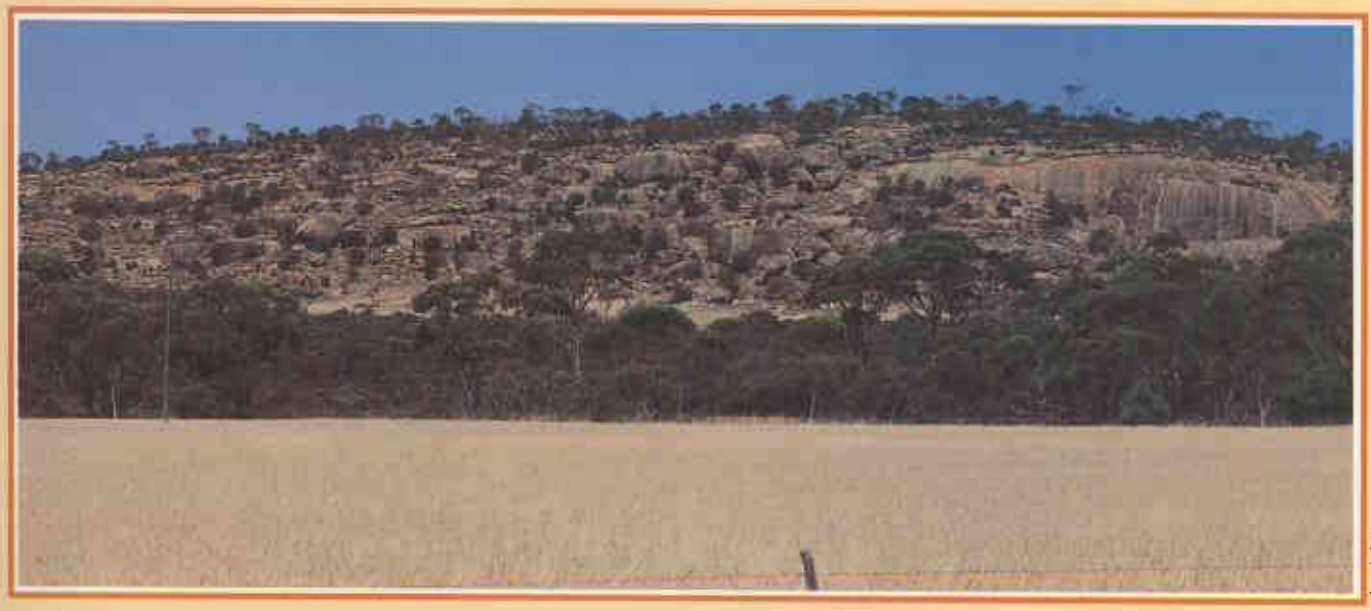
novel and more useful way of defining the idea of niche. As the closing speaker at a prestigious conference of biologists, he was expected to review the highlights of the conference, but instead he chose to launch his new niche concept. In retrospect, it must have been a rather inauspicious beginning for such an original idea, for it was quite likely that hardly anyone in the conference-weary audience understood what in the world he was talking about.

This was because Hutchinson used a very abstract and unfamiliar branch of mathematics to express his ideas. Nevertheless, over the years the Hutchinson niche concept gradually became accepted. Understandably, the symbol-loving theoretical ecologists were quick to appreciate its significance, but most practising ecologists view niche theory as far too airy-fairy to be useful in the field. It is my view, however, that niche theory can be applied profitably to real conservation problems, and, as an example, I will describe how we used niche theory to help us find out why some remnant wheatbelt rock-wallaby colonies were battling to survive.

The Fundamental Niche
a hassle-free living space

Hutchinson first of all reminded us that every species has a certain number of requirements which must be met if it is able to live and reproduce in any particular place. He also stated that every species can only survive and reproduce under conditions that do not exceed its tolerances. So far, nothing new has been introduced: common sense recognises that a species has a requirement for food, shelter and so on, and common sense tells us that species are limited in their ability to tolerate environmental factors such as high and low temperature extremes, humidity extremes, and so forth. He then defined these requirements and tolerances mathematically, and reached the conclusion that a species can be thought of as living within its own particular mathematical volume or space. He named this space *the fundamental niche.*

Rock-wallaby habitat, which can now be considered an island haven in a sea of wheatfield.



Jack Kinnear

Thus a species can be thought of as living within its own unique volume or space, but this space is peculiar in that it has more than three dimensions, and, therefore, it cannot be visualised. Fortunately, a conservation biologist does not have to worry about all of the dimensions of a niche, because if too many dimensions are affected, then existence is not possible. Relevant and productive research will result if it is possible to identify that part of the niche under stress.

It is helpful to simply imagine a niche space as a box, a box that can be damaged. Niche boxes may be burnt, crushed and flattened by bulldozers pulling chains, or trodden on by foreign animals with sharp hooves, with obvious consequences. Less obvious damage leads to niche boxes that have become shrunken and distorted in different ways. The volumes in which species live become smaller and oddly shaped, and if the pressure becomes too great the box collapses and the species becomes extinct.

The Realised Niche: *facing reality*

Hutchinson's fundamental niche represents an idyllic world where every need is satisfied and where life is hassle-free. But any realistic and useful ecological theory has to recognize that life was not meant to be easy, and so Hutchinson introduced some complications. He next asked the question - what happens to a species' niche volume when predators and competitors are present? He concluded that the niche spaces will contract - the boxes will become smaller. He called this smaller niche volume *the realised niche*. It acknowledges that species have to contend with other organisms in the real world who compete for the available resources, and that a species may be a resource itself (prey) for predatory organisms.

Islands: *Simplified Niches*

A island ecosystem can illustrate niche concepts very simply. Let us put a species on an island which contains no predators and no competitors. If it survives and reproduces throughout the island, we can be assured that the island satisfies all its requirements, and the species is occupying its fundamental niche space. It will thrive in its box because it has a monopoly on the resources it needs. It may be compared to a manufacturer whose product has a 100 percent market share, and who pays no taxes to predatory government agencies.

If an effective predator is also introduced on to this island, however, then we will observe that the species is less abundant and less widespread in its use of the island environment. Fewer individuals will exist, and only in places where the shelter provides a refuge from predation. A similar contraction of the niche space would also be observed if a competitor was introduced. Conversely, the elimination of predators and competitors from the island would relieve the pressures on the niche space, allowing niche expansion, and the species to flourish throughout the island once again.

Wildlife Conservation and Niche Theory

With this brief background to niche theory in place, we can now apply it to a conservation problem in which islands played an important role. A case in point concerned rock-wallabies (*Petrogale lateralis*), a widespread, adaptable species apart from its specialised requirement for a rocky habitat. It was once common in the Western Australian wheatbelt, but by the 1960s it was reduced to living on six rocky outcrops surrounded by farmlands. Our detailed surveys in 1978 revealed that all the populations had declined, and one population had become extinct sometime during the period 1969-70. The timing of the extinction was intriguing because it occurred during a drought-declared year; this suggested that the fundamental niche might be the problem area.

By trapping the populations over a four year period, we learned that the total number of rock-wallabies occupying the five outcrops was less than 100. One outcrop supported only seven animals and another about ten. We also learned that the rock-wallabies were fit and healthy, and that even during another drought-declared year there was no great loss in weight or body condition. Moreover, most females were carrying young in their pouches, but for some reason hardly any of the young wallabies were surviving to maturity after leaving the pouch.

It was now evident, however, that the original hypothesis of damage to the fundamental niche was wrong. The prevailing rocky habitats were still providing the rock-wallabies with their needs, as evidenced by their general well-being and the high level of reproduction. Clearly, it was necessary to focus on the *realised niche* of the rock-wallabies, which meant that we had a predation problem, or a competition problem, or both. Competition was dismissed as unlikely.

With the problem now reduced to predation, we were required to focus our research on the fox and the feral cat. Since feral cats co-exist with thriving populations of tammar wallabies on Garden Island and also with the Rottnest Quokka, foxes became the chief suspect. While fox predation was implicated initially by default, evidence acquired elsewhere soon strengthened our suspicions.

Bert & Babs Wells

The black-flanked rock-wallaby (*Petrogale lateralis*) is a broad-niched species that ranges from the south Kimberleys to the Esperance region.

Island Wallabies and Foxes

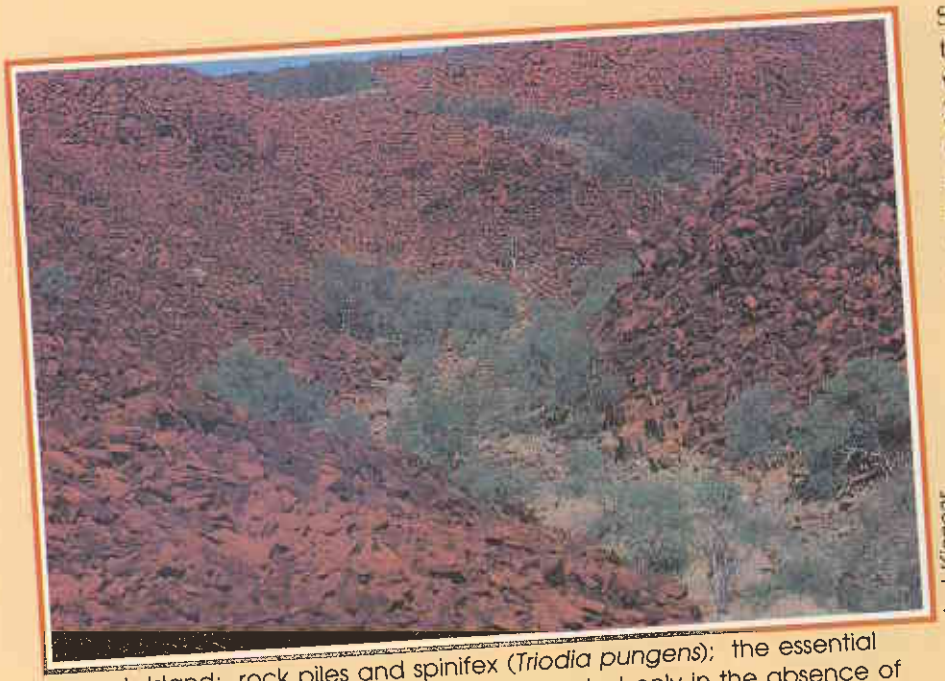
Some compelling evidence, which seemed enough to convict the fox without a trial, was collected from islands off the Pilbara coast. We took advantage of a ready-made ecological experiment in the Dampier Archipelago, where three islands supported rock wallabies. Two of the more remote islands were free of foxes, while the third island had foxes. We proposed the following hypothesis: if foxes are an effective predator of wallabies, then there should be fewer wallabies when the fox is present.

Counts of rock-wallabies confirmed this hypothesis; on average, during traverses of a fox-free island, we would sight a wallaby about every three minutes, but where the fox was present we would encounter a wallaby every three hours. These values, and some other information, provided a rough estimate of the number of rock-wallabies - more than 1 000 living under fox-free conditions and about 50 in the presence of foxes.

Such evidence was very convincing because there was no reason to suspect that the differences were due to environmental and habitat factors. Almost the same size, the islands were relatively undisturbed habitats subject to the same climatic conditions with similar vegetation, soils and landforms.

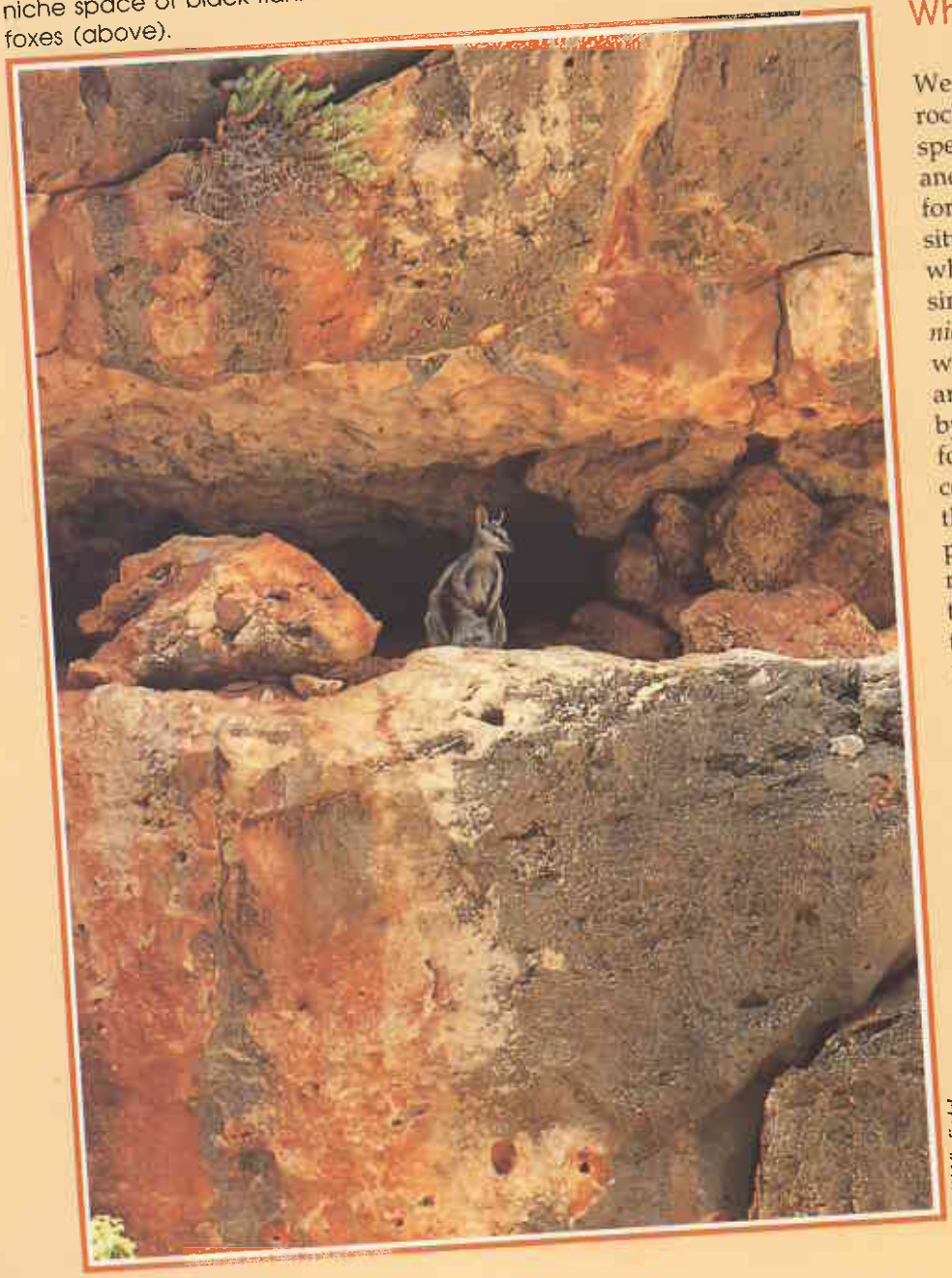
More incriminating evidence came from Depuch Island 3.2 km from the coast in the vicinity of Whim Creek. Rock wallabies were first recorded by the Baudin expedition in 1801, and again 40 years later by crew members of the famous ship H.M.S. Beagle. A rock-wallaby was shot (some were flushed from their rock-piles, which indicates they were numerous) and later identified in England as the same species of rock-wallaby collected earlier at the Swan River Colony.

In 1962, the W.A. Museum carried out a comprehensive survey of Depuch Island. Rock-wallabies were still judged to be abundant, but the island had acquired an intruder in the form of the fox, and there were clear signs of predation. Twenty years later, almost to the day, Mike Onus and I landed on Depuch to carry out surveys which we had been doing on the rock-wallabies in the Dampier Archipelago. We began our search confidently, fully expecting to sight some rock-wallabies, but forty-eight hours later we departed the island with no recorded sightings, not even a dropping or a footprint. A longer more intensive survey a year later again found no traces.



Jack Kinnear

Depuch Island; rock piles and spinifex (*Triodia pungens*); the essential niche space of black-flanked rock-wallabies; but only in the absence of foxes (above).



Cliff Winfield

Black-flanked rock-wallaby sheltering in its protective cave in Cape Range National Park (left).

Surely such evidence confirms that the fox is a destroyer of Australian wildlife. If the fox can cause, or at least contribute significantly, to the extinction of a species which shelters in massive indestructible rock-piles, then what chance has a wallaby that shelters more commonly in vegetation? But compelling as the evidence might be, it remains circumstantial; one can argue that the rock-wallabies on Depuch could have died out due to disease, drought, wildfire or whatever. What was needed was some additional research which would experimentally support the contention that foxes have been, and still are, a serious threat to native wildlife. Niche theory suggested an experiment.

Wheatbelt Islands

We noted that on fox-free islands rock-wallabies (and other wallaby species) were relatively abundant and conspicuous, and that they foraged widely. The opposite situation prevailed on islands where the fox was present. A similar pattern (*contracted realised niche*) was apparent in the wheatbelt rock-wallaby sites which are, in effect, islands surrounded by a sea of agricultural land. It followed, therefore, that if we could eliminate foxes from some of these 'wheatbelt islands', then the populations should eventually mimic the fox-free islands - that is, their numbers should increase and the wallabies should use more of their habitat.

In the wheatbelt, five 'islands' carrying rock-wallaby populations were available, and we selected two of these rocky outcrops as experimental sites which we planned to make fox-free for an extended period. Three other outcrops were designated as sites where no fox control was attempted. All of these sites had been censused previously, and we censused them all again before we commenced fox control.

Jack Kinnear

Excellent rock-wallaby habitat in the Central Wheatbelt. Wallabies have increased since the fox has been controlled (left).

Controlling the Fox: *Some Surprises*

We then set out to create our fox-free islands in the wheatbelt. By systematically patrolling an extensive system of graded tracks on the site for fox footprints, it proved relatively easy to detect the presence of foxes. By using poison baits, it was possible to eliminate all of the foxes, but only for a surprisingly short time. Initially, this was somewhat disturbing, because our experiment required us to create and maintain fox-free islands. Fortunately, we learned that the baits were controlling foxes, but this was not readily apparent because the sites were being constantly invaded by new foxes. Evidently, we were trying to maintain our islands fox-free in a landscape swarming with foxes.

After four years of fox control, and despite the fact that we found it impossible to make our wheatbelt islands completely fox-free all of the time, we were successful in reducing the predation pressure on the niche space of the rock-wallabies. The 'fox-free' populations increased mainly because more young rock-wallabies survived to breed. In addition, and of equal significance, they also began to behave (as predicted by niche theory) like island wallabies by spreading out to areas of the habitat that were previously not utilised.

The Fox Problem: Short and Long-Term Solutions

What can be done about the fox? It is clear from our experiences with rock-wallabies that predation pressure can be reduced sufficiently to allow wildlife populations to increase. This is a critical point, because for a small population the risk of extinction increases alarmingly. There are several reasons for this, but a major cause for concern is inbreeding. If populations remain small for too long, inbreeding leads to a loss of genetic variability, and the capacity to adapt to environmental and biological stresses such as drought, disease and so on. The impending climatic change predicted to result from the Greenhouse Effect will challenge our fauna's capacity to adapt, and it is important, therefore, that we try and maintain genetically robust populations capable of meeting the challenge.

It is also clear that controlling fox predation by baiting is not a long-term solution. Baiting is best viewed as a necessary holding action, to be applied to selected populations of rare and endangered species, until a better solution such as some method of biological control becomes available. There are reasons to be optimistic about the prospects of biological control because of the tremendous advances in molecular biology and genetic engineering. It is my belief that it is just a matter of time before the necessary knowledge and techniques will be available to tackle the fox problem in Western Australia.

Meanwhile, research on the fox problem is continuing, with the objective of controlling the fox as efficiently as possible. Theoretical studies have already yielded some insights about the fox/native fauna interactions. For example, there have been times in the past when some local populations of marsupials have been abundant in the presence of the fox. This was puzzling until I learned about a theory by an eminent theoretical ecologist who showed that multi-population states are possible ... but that is the start of another story.

Bernhard Bischoff

Culling of foxes near Busselton (right).

LANDSCOPE

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EDITORIAL

It is difficult to remember a time when our daily news did not feature some environmental controversy. To people involved in environmental research and management, the popularity of 'the environment' is a mixed blessing.

Greater public consciousness of environmental issues has meant increased funding and, to some extent, greater prestige. But many scientists working on ecosystems are uncomfortable when their work is placed in the political spotlight.

The knowledge that a scientific observation that once would have been tucked away in a scientific journal to be read only by a few colleagues could become the centre-point of a political controversy is daunting.

Retaining objectivity in any research area is difficult. For those engaged in research on the natural environment it is even more difficult. Unlike the physical sciences in the natural sciences the truth is often camouflaged by interactions between factors which vary over time and space. When the results of this type of research are placed in the political arena, the mixture is often volatile and the truth a casualty.

To enable scientists to better seek the truth and communicate it, the scientific community has adopted what has been called "the scientific method". The scientific method is a code of conduct with rigid requirements. An offshoot of that code is a set of rules which scientists must follow, at least in reputable scientific journals, if they are to have their research published. Unfortunately, a byproduct of this is that scientific articles are not the easiest to read and are often plain boring.

Given that the environment has become a major political issue, it is important that those involved in the debate are fully informed. But scientists are faced with a dilemma. They need to popularise their work to reach a wider audience. On the other hand, they cannot afford to lose objectivity.

NATIVE CREATIONS

Nouvelle jardins, multiculturalism or laissez-faire; which garden fashion will you choose? Turn to ***page 22.***

WILD MARRON

Do our wild marron have a future or will local gourmets keep catching them to the point of extinction? Find out on ***page 4.***

KARRI MAGIC

What is really going on in the karri forest? On ***page 32*** *we take a look at the system of conservation reserves that have been established to preserve this awe-inspiring forest.*

STRANDED!

Relive the euphoria of the Augusta whale rescue on ***page 18.***

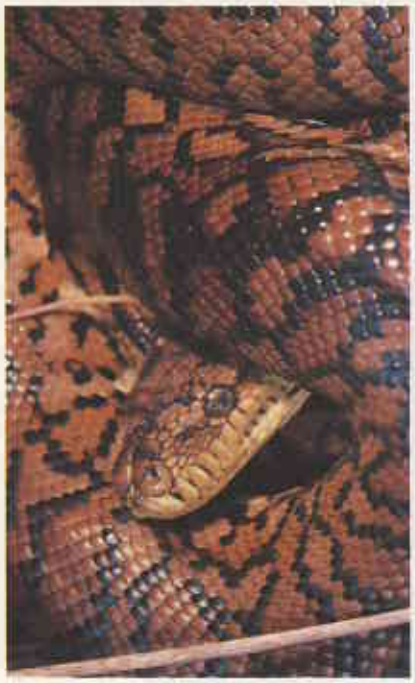
BACK TO BASICS

With today's massive land boom it's hard to imagine that the State once couldn't give land away fast enough. Now the government is buying back our valuable conservation areas. See ***page 43.***

DESERT GEM

The Gibson Desert Nature Reserve covers over 1.8 million hectares. It is a desolate but subtly beautiful landscape. Read about this unique area and the management problems it presents on ***page 48.***

SNAKES & ADDERS



Slim and active snakes have emerged hungry from their winter hibernation. But they're not all venomous. See ***page 51*** *for tips on living with snakes.*

AFTER THE FOX

Foxes pose a major threat to native mammals and other fauna. Can we outfox them? See ***page 12.***

A SIGHT TO BEHOLD

'Its pouch can hold more than its belly can', goes the popular rhyme. Find out more about this awkward but graceful bird on ***page 39.***

Cover Photograph

One of our natural wonders - the beaches of Hamelin Pool (Shark Bay) consist of billions of small shells.

Photo by Bill Bachman.

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