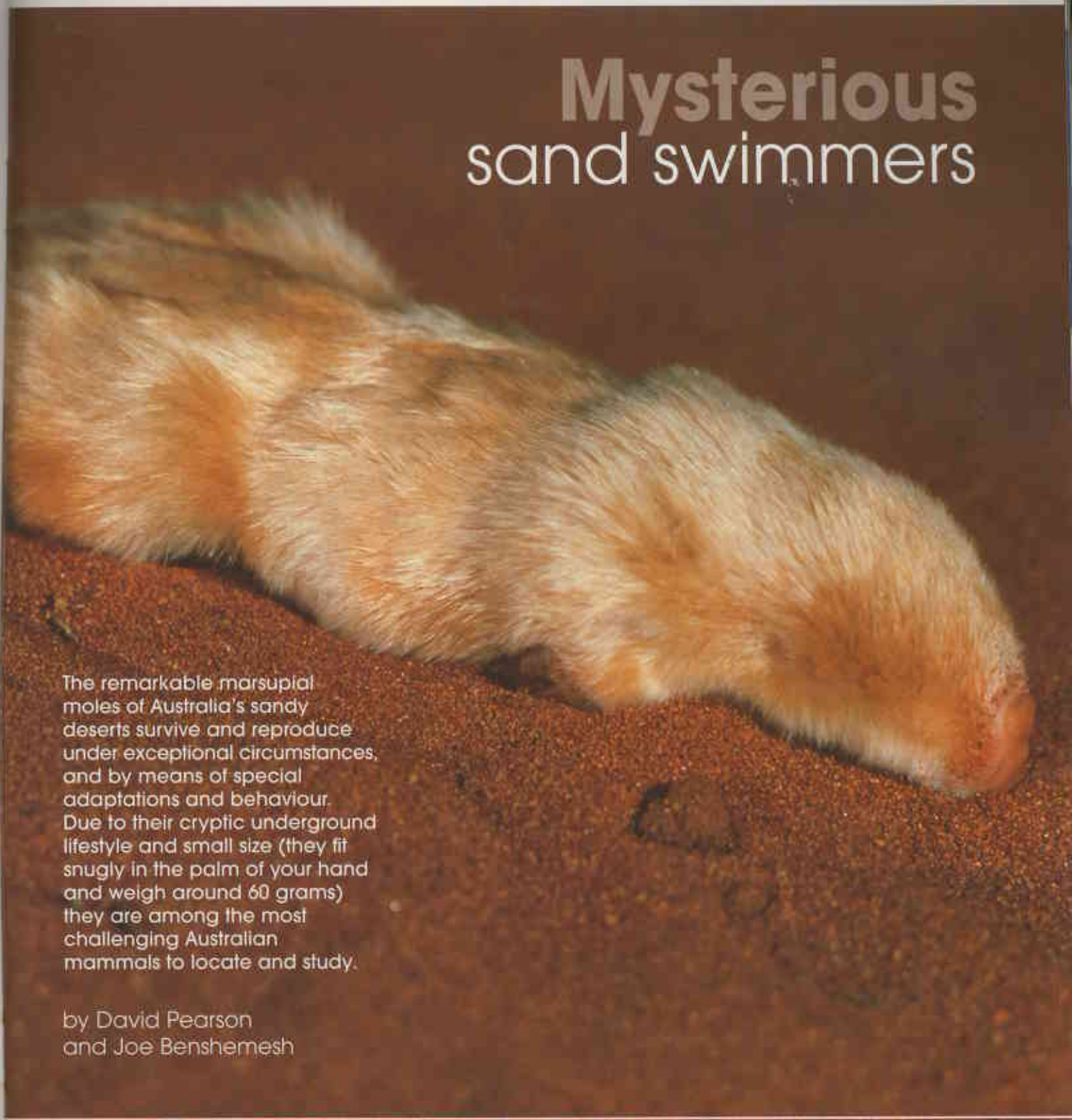
Mysterious sand swimmers



The remarkable marsupial moles of Australia's sandy deserts survive and reproduce under exceptional circumstances, and by means of special adaptations and behaviour. Due to their cryptic underground lifestyle and small size (they fit snugly in the palm of your hand and weigh around 60 grams) they are among the most challenging Australian mammals to locate and study.

by David Pearson
and Joe Benshemesh

Living your entire life burrowing below sand is a daunting enough prospect, but imagine if the sand above your head is searing hot and lies in the middle of some of the driest country in the world. The sandy deserts of Australia are home to the remarkable marsupial moles that can survive and reproduce under such exceptional circumstances.

Until recently, it was considered that the underground habits of marsupial moles would protect them from falling prey to feral cats and foxes. However, researcher Rachel Paltridge, in her studies on feral predators in the Tanami Desert in the Northern Territory, found that the remains of moles were present in 10 per cent of fox droppings and three per cent of feral cat droppings that she examined. This work has focused attention on the conservation status of marsupial moles, and resulted in some innovative techniques to survey for moles and to study the mysteries of their ecology.

Two species of marsupial moles are recognised. The kakarratul, or northern marsupial mole (*Notoryctes caurinus*), is confined to Western Australia, and occurs in an arc from Warburton through the Gibson and Great Victoria deserts to the north-west coast in the Eighty Mile Beach area. The more widespread itjaritjari, or southern marsupial mole (*Notoryctes typhlops*), occurs throughout the Great Victoria Desert in both Western Australia and South Australia, as well as the southern Northern Territory and north-western South Australia. The two species are difficult to distinguish in the hand, differing in skull characteristics and minor external features. Both are considered to be nationally threatened due to their apparent rarity and growing concerns that populations may be in decline due to foxes, cats and numerous landscape changes over the past century.

Distribution of marsupial moles
▲ Museum specimens ▲ Recent sightings

Tiny earth movers

Marsupial moles have some of the most bizarre physical features of any mammal, a consequence of evolutionary processes and ancestors that were able increasingly to adapt to a below-ground lifestyle. They do not excavate conventional burrow systems, but rather tunnel and backfill as they go, so that there is little sign of their passage. In a sense, these bizarre little animals seem to move a little elbow room with them as they push and dig by means of the nose and front legs, while the back legs push sand behind the body.

Marsupial moles lack functional eyes. The flattened head has a large area of exposed, leathery skin around the nostrils that forms a hard shield. The chest and shoulders have well-developed bony support, which, along with the nasal shield, absorbs the brunt of constant ramming through the soil. The ears have a simple opening, which is partly hidden under the fur, and most of the body is covered in silky cream to orange fur. The tail is small, marked with rings and terminates in a horny knob.

To enable propulsion through the sand, the marsupial mole's forelimbs have undergone considerable changes and have become efficient 'shovels'. Over evolutionary time, the forelimbs have rotated and extensive musculature has developed to enable moles to strongly force sand back past the body. Two digits on each forelimb have massive claws, reminiscent of the blades of earth-moving machinery, which cut away at the sand and shovel it backwards as the mole advances. Other claws on the hands are much reduced in size. Despite being awkward-looking and relatively slow-moving on the surface, moles are able to disappear speedily into the sand and then dig rapidly away, eluding efforts to dig them up.

Marsupial mole dreaming

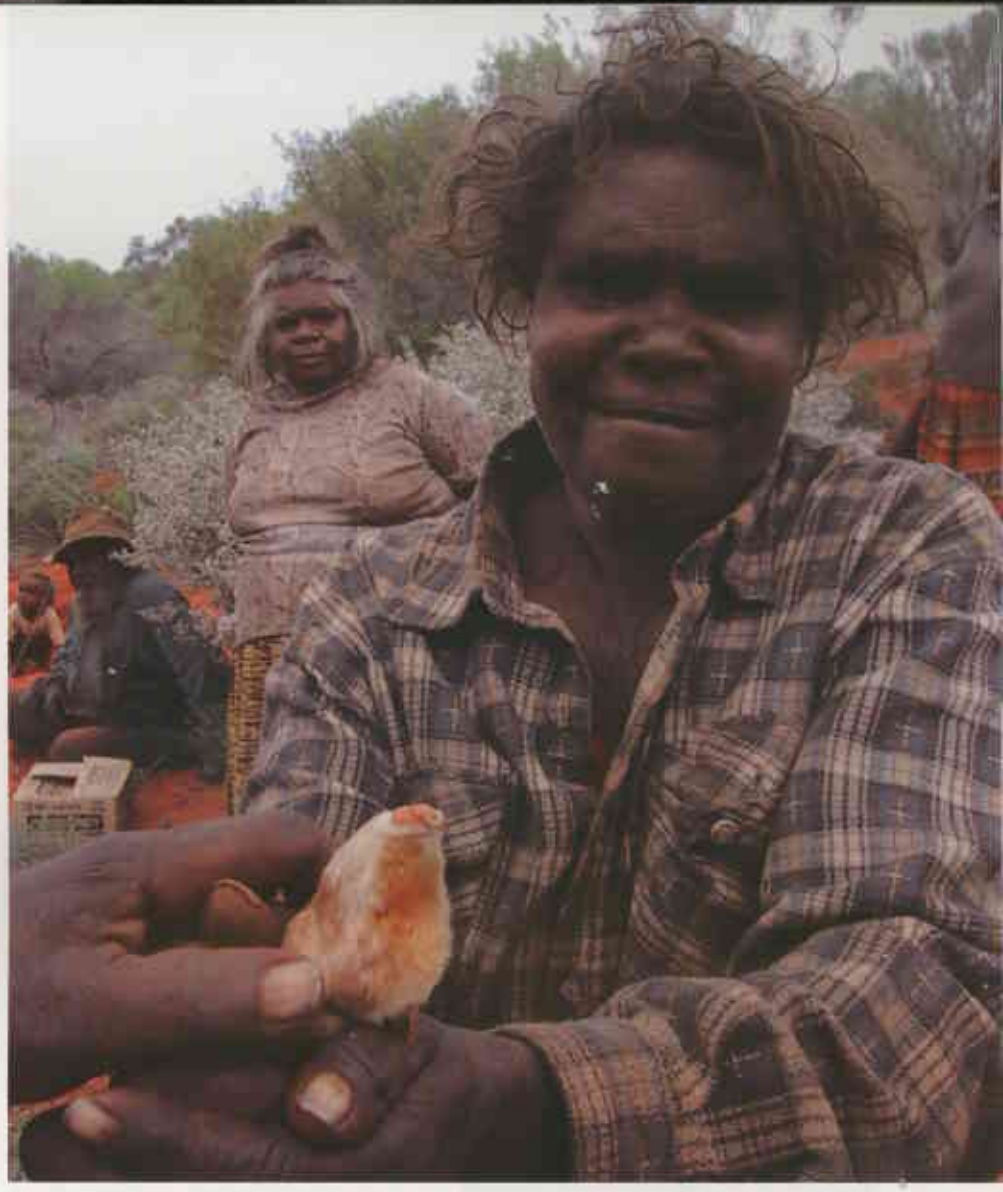
Desert Aboriginal people have long known about marsupial moles, because of their habit of occasionally surfacing and moving above ground. These surface forays leave distinctive tracks, typically starting with a circular hole only a few centimetres deep (where the animal has been unable to backfill), and ending in a neat pile of sand about 10 centimetres across. In between these is a sinuous belly drag bordered by

Previous page
Main Marsupial mole.
Photo – D Reif/Nature focus
Inset Marsupial mole tracks.
Photo – Joe Benshemesh

Left The northern marsupial mole.
Photo – Andrew Burbidge

Above Distinctive track left by a marsupial mole shuffling along the surface.

Right Traditional owner Mary Pan, from Anangu-Pitjantjatjara lands, holding one of the few itjaritjari people have ever seen. Traditional owners have played an integral role in recent itjaritjari research, working hard and enthusiastically as part of the successful research team.
Photos – Joe Benshemesh



paddle-like impressions of feet and a small continuous groove left by the tail. Marsupial moles were not important food for Aboriginal people, presumably because of their small size and low encounter rates. However, they are important in Aboriginal mythology and their blindness and tunnelling habit feature in several Tjukurrpa (Dreaming) stories about their exploits.

In an attempt to clarify their distribution and abundance in desert areas of WA, the Department of Conservation and Land Management carried out a study with the assistance of Jan Turner, an anthropologist with the Ngaanyatjarra Council. Observations of moles by Aboriginal people were collected throughout the Great Victoria and Gibson deserts, greatly extending their known distribution. Aboriginal people saw moles most often in winter and after rain, which appeared to force moles to the surface due to waterlogging. Ngaanyatjarra people refer to marsupial moles as itjarri itjarri or itjarrutju, and they feel affection and sympathy for the 'old blind ones'.

A *LANDSCOPE* Expedition to Queen Victoria Spring Nature Reserve in 1996 located a dead mole in the most serendipitous fashion. After initially stepping over what looked like a dingo dropping, closer examination revealed a large pair of claws on the foreleg. This find extended the range of marsupial moles more than 450 kilometres further south than previously known, to the southernmost part of the Great Victoria Desert in WA.

Anatomy

The initial discovery of the marsupial mole generated much excitement in the scientific community and intense debate about the mole's relationship to other mammals. Much of what is known about the anatomy of the moles is based on dissection of Museum specimens, many collected in the late 1880s and early 1900s. Despite the lack of sophisticated equipment, Stirling (1888 and 1891), Wilson (1894), Gadow (1892) and Sweet (1904) were able to document and publish many of the remarkable features of the species. Even so, the existence of a pouch (marsupium) was not initially noticed and they were grouped with the monotremes (such as the echidna and platypus).

Over subsequent years, marsupial moles were shuffled from one mammalian group to another, eventually being placed in their own family (Notoryctidae; derived from the Greek words *notos* meaning 'south wind' and *oryktes* meaning 'one who digs' thus 'southern digger') with links to the polyprotodont marsupials (such as bandicoots). Recent work by Mark Westerman, using modern genetic techniques, found that marsupial moles were so different from other marsupial families that they warranted their own Order, indicating that moles have been evolving independently of other marsupials for a long period. Marsupial moles have external features and habits similar to the golden mole of Africa, but have evolved from entirely different ancestors, providing a fabulous example of convergent evolution.

Above Typical Great Victoria Desert sand-dune country inhabited by marsupial moles. *Photo – David Pearson*

Left A line of mounds where the marsupial mole has nearly surfaced numerous times. *Photo – Joe Benshemesh*

Ecology

Very little is known about the ecology of marsupial moles, in part because they are so difficult to keep in captivity. The longest captive record is just 10 weeks, but most die within a month. The reason for this is unclear, but stress and our poor understanding of these animals' requirements are probably involved. Until recently, our knowledge of their ecology has been limited to what can be gleaned from Museum specimens and a range of observers, including Aboriginal people, who have encountered the animals. For example, we know from specimens that the female reproductive system is similar to that of other marsupials, and that females may have up to two young at a time (they only have two teats), even though young have only been recorded twice. We also know that the testes of the male are situated between the skin and the abdominal wall—a most unusual position for a marsupial. Presumably, this is another adaptation for their underground lifestyle, where there is no cooling advantage in having an external scrotum, but which may offer some protective benefits as well as reducing drag. But nothing else is known about the reproduction. There are so many puzzling questions, such as how moles find each other to mate in all that sand.

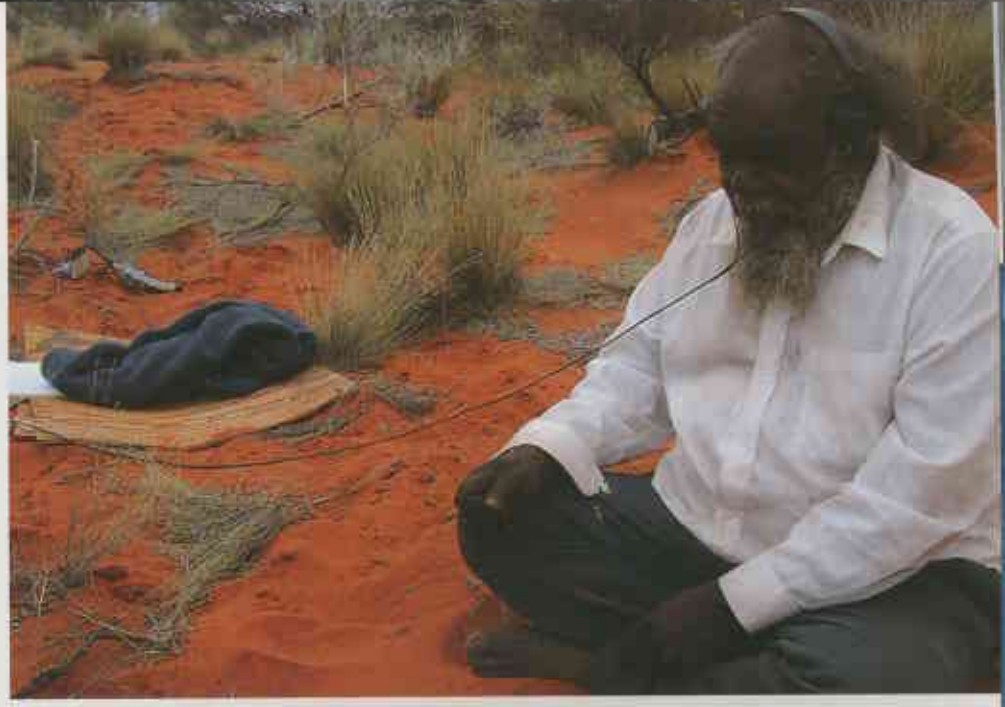
Museum specimens have also provided almost all of the available information on the diet of marsupial moles. Most of the diet consists of ants (particularly their eggs), termites and beetles, with occasional traces of spiders, grasshoppers and seeds. In captivity, moles have eaten the larvae of a variety of beetles, moths and other invertebrates, centipedes, spiders and even geckoes.

A kakarratul (northern marsupial mole) recently caught by Aboriginal people near Punmu community was sent to Philip Withers and Graham Thompson, physiologists at The University of Western Australia. They found that the body temperature of the mole was low (averaging around 30.8° C) relative to other marsupials and also ranged widely while in captivity (22 to 31°C). Its ability to tolerate a low and fluctuating body temperature may allow the mole to reduce its energy consumption (since fewer resources are spent keeping the body temperature elevated). This has been interpreted as either an adaptation to avoid overheating in the moist microhabitat of the soil or perhaps to cope with relatively scarce resources in the soil profile.

During the last three years, Joe Benshemesh has been working with Aboriginal people and Earthwatch volunteers in the Anangu-Pitjantjatjara lands of South Australia to try to learn about the ecology of itjaritjari in the field. Using a blend of traditional techniques such as tracking, high-tech surveillance equipment and good old shovelling, this work has been remarkably successful. New methods have been developed to reveal the backfilled tunnels of the animals, and this has provided much-needed techniques for survey and for piecing together the subterranean life of marsupial moles.

The results have been surprising. For example, in the same areas in which we would walk tens of kilometres to find a single marsupial mole track on the surface, we have found the equivalent of tens of kilometres of their backfilled tunnels per hectare underground. This is partly due to the fact that their underground signs may last for years compared with only days for surface tracks, but it's also a reflection of these animals' fossorial habits and that they surface only rarely. Indeed, exactly why marsupial moles surface at all is a puzzle, given the vulnerability of these blind and slow-moving animals to a host of potential predators. Understanding the threat posed by introduced predators, such as foxes, is particularly important and depends on why, and how often, itjaritjari surface. Traditional tracking skills have been invaluable in finding signs of moles on the surface and in interpreting the behaviour of the individuals that made them.

These techniques rely on signs the moles leave behind and provide a boon for answering many questions about their distribution, habitat preferences



Right Walalkara Indigenous Protected Area Ranger Robin Kankanpakantja listens to the sound of a marsupial mole burrowing through the sand.
Photo – Joe Benshemesh

Below right Southern marsupial mole eating a gecko.
Photo – Mike Gillam

and general ecology. But without being able to observe individuals in their natural environment, it is difficult to deduce much about their behaviour or to estimate population sizes. A means of observing animals going about their daily lives is therefore essential, and we have been developing ways of detecting and 'observing' itjaritjari using geophones (vibration detectors used in seismic and surveillance work).

Fortunately, itjaritjari make very distinctive tunnelling sounds and, with a grid of geophones, it is possible to count the number of individuals underneath the surface, and track the animals as they go about their normal activities underground. Although we have listened to the geophone grids for many hours and detected some itjaritjari, only a computer is able to listen long enough to collect systematic information and plot the animal's locations. To do this, George Jung (Geoscience, Monash University) has developed a sophisticated system that will be trialed in the field this year. While we may have to wait a while for an itjaritjari to wander into our study area, we are confident that when this happens a wealth of information on the habits and ranging behaviour of these strange little animals will be obtained.

The successes in the Anangu-Pitjantjatjara lands have been largely due to the collaborative spirit of the work, and finding a site at which the animals still occur in reasonable numbers. But we don't know how representative this is of the vast areas in which the two species of marsupial moles are thought to occur. There is an urgent need for surveys throughout this range, and any sightings should be carefully reported.

Mole patrol

A 'Mole Patrol' kit encourages people travelling through desert areas to watch out for moles and their distinctive tracks and to report any sightings (see 'Bush Telegraph', *LANDSCOPE*, Summer 2002–3). The information packs, which contain photos of the moles and their distinctive tracks, are mailed to observers in the hope that further sightings can be made of this elusive inhabitant of the desert. If you would like further information, please contact the Mole Patrol on (08) 8952 1541 or by email (tsnnt@ozemail.com.au).

So next time you are out in the desert, especially if it's wet, watch out for the shuffling tracks of the marsupial mole. You just might be lucky enough to see one of the most bizarre and interesting Australian mammals.

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