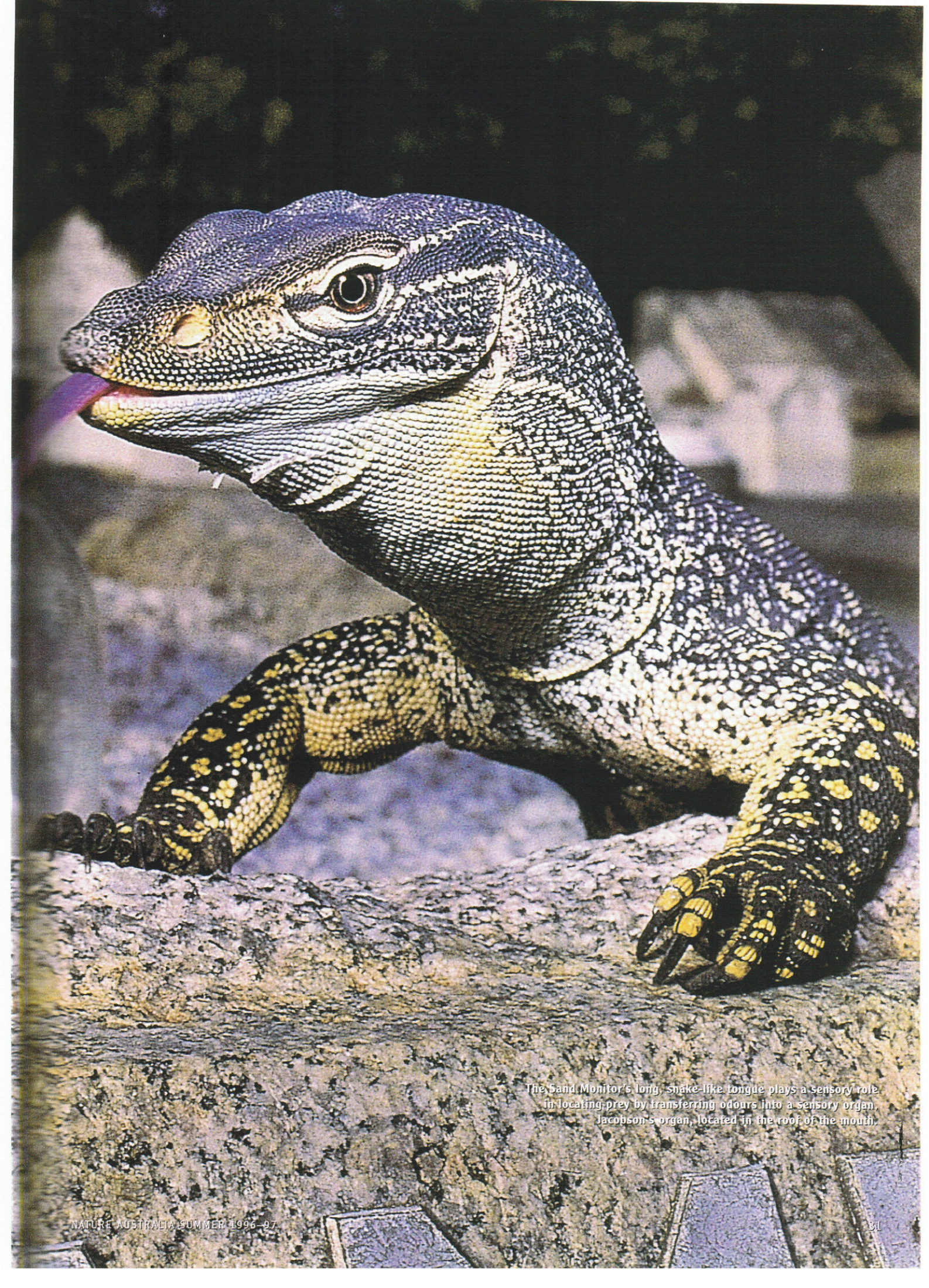




*Grave covers provide excellent vantage points
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areas for potential predators or prey.*

GOANNAS IN THE GRAVEYARD

BY GRAHAM THOMPSON
PHOTOS BY JOHN GREEN



The Sand Monitor's long, snake-like tongue plays a sensory role in locating prey by transferring odours into a sensory organ, Jacobson's organ, located in the roof of the mouth.

IF YOU SAW A PERSON WITH A THREE-metre-long fishing rod crawling on hands and knees between the head stones in a metropolitan cemetery, you could be excused for thinking something was seriously amiss. This, however, is the best way I know of catching large goannas in a graveyard. Catching goannas of any size, anywhere, is difficult and requires skill and cunning. These lizards are very wary, cryptic, have good eyesight, can run at great speed and are constantly vigilant against potential dangers.

Twenty-four species of goannas (or monitor lizards, *Varanus* spp.) occur in Australia. Western Australia has 18 species, three of which—Rosenberg's Monitor (*V. rosenbergi*), the Black-headed Monitor (*V. tristis*) and Gould's Goanna or the Sand Monitor (*V. gouldii*)—were apparently common on the Swan River coastal plain prior to settlement. Goannas still occur in the large urban conservation reserves in the Perth metropolitan area or in surrounding bushland but, with the development of roads, houses and formal parklands, sightings are becoming much less frequent. If you are patient though, one place you can usually be guaranteed to see a goanna is in Karrakatta Cemetery. A sample of the 75 or so Sand Monitors that live in this area has been the subject of a four-year study of mine.

Karrakatta Cemetery is located five kilometres west of the central business district of Perth. This 106-hectare site has been used as a burial ground since the late 19th century and, as a consequence, almost all the original vegetation has been removed. Like most cemeteries, graves are arranged in rectangular plots separated by bitumen or gravel roads. Before the cemetery was developed, it contained banksias and eucalypts. Today, some areas have been landscaped with a range of exotic shrubs and trees, while others have been grassed and are surrounded by large and attractive rose gardens.

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Sand Monitors were relatively abundant in the cemetery in the late 1980s, although extremely difficult to find and catch, given their wariness. At the slightest disturbance they retreat to holes that they have dug under the stone grave covers, or into cracks in the slabs that have resulted from soil subsidence. Grave covers provide excellent vantage points from which these metre-long goannas can survey surrounding areas for poten-

tial prey or predators (humans, dogs, cats, raptors). The heat-absorbing, dark grey slabs also provide excellent sites on which to rest early in the morning while the lizards warm up.

Sand Monitors are seasonally active. They emerge from hibernation around late September to early October, having

spent the previous six months in a burrow some 70 or 80 centimetres underground. As you would expect, they are relatively thin, not having eaten since late March. During the first couple of days they remain near their holes, but each day after that they move off in search of food and, presumably, mates.

Sand Monitors exploit visual, olfactory and auditory cues to detect prey. As a goanna approaches a patch of leaves, it

moves its head and neck slowly from side to side, using its snout to shift the leaf litter while flicking its tongue in and out. Like snakes, their very long forked tongue is used to transfer odours into a sensory organ located in the roof of the mouth called the Jacobson's organ. The front feet are used to scratch away the leaves or to dig into the ground for spiders and small skinks, while their pointed snout and sharp teeth are poised for a quick attack. In contrast to other large lizards, which are often herbivorous, most *Varanus* species are active predators. Using a simple stomach-flushing technique I found that the Sand Monitors at Karrakatta Cemetery feed largely on mole crickets (family Gryllotalpidae) with spiders and insect larvae being the next most abundant items on the menu. (No human remains have been found in their diet!)

The number of goanna sightings in Karrakatta Cemetery has decreased in recent years, suggesting that the overall numbers there are in decline. The reason for this is unknown, but it may be due to the clearing of unwanted grasses and leaf litter from between the graves, which reduces the number of inverteb-





Sand Monitors in Karrakatta Cemetery dig their burrows under the broken stone or concrete grave covers on the loose sandy soil. Soil subsidence under these grave covers also provides a warm place where these goannas can locate prey items such as crickets, spiders and cockroaches.

rates available for foraging. The use of herbicide to kill unwanted plants may also directly affect goanna numbers, as a total of five adults have been found dead within one week of spraying operations over the last couple of years.

To ensure the long-term survival of goannas in Karrakatta Cemetery requires a detailed knowledge of the species' biology. Apart from their diet, this includes information on such things as the size of their activity area, retreats, foraging sites, breeding behaviour and seasonal activity patterns. A series of studies has been undertaken since 1990 to collect data on these topics.

IN THE FIRST STUDY, GOANNAS WERE located early in the morning after they had emerged from their overnight retreats and were basking in the sun on



Karrakatta Cemetery, just five kilometres from Perth's CBD.



The exceedingly wary and generally unapproachable Sand Monitors in Karrakatta Cemetery use their excellent vision and an elevated position to detect the presence of people long before they themselves are observed.

SAND MONITOR

Varanus gouldii

Classification

Family Varanidae. Two recognised subspecies: *V. g. gouldii* (from continental Australia except the arid interior) and *V. g. flavirufus* (arid interior of Australia). Also known as Gould's Goanna.

Identification

Large (up to 1.6 m) terrestrial lizard, with males generally larger than females. Colour pattern and size vary across geographical range. Dorsal pattern a combination of black, brown, yellow and greens making up numerous small circular patterns (ocelli), usually arranged in a transverse band. Dark temporal band extending back from behind eye. Tail laterally compressed, often with a yellow tip.

Habitat and Distribution

Widespread from coastal dunes to forests and sandy deserts. Found throughout most parts of continental Australia, except in the lower half of Vic., extreme southern section of NSW and southern WA.

Behaviour

May dig own burrow, or shelter in hollow logs or burrows of other animals. Will retreat to trees if threatened or to forage. Eats lizards, small mammals and insects.

Reproduction

Breeding occurs during the wet season in northern Australia, and late spring and early summer in southern Australia. Between 4 and 10 eggs laid once a year, either in a burrow or termite mound. Hatching occurs approximately 8–9 months after laying, depending on incubation temperature. Body mass at hatching 15–20 grams.

the grave covers. During this period I found it easiest to stalk them by crawling on my hands and knees between the graves. Once within noosing range, I would gently place the noose over a lizard's head and tighten it. Goannas initially struggled but generally remained calm and made no attempt to bite if held gently but firmly in two hands.

After being weighed, a fine spool of white nylon thread was attached to the base of each lizard's tail. At the point where the goanna was captured, the free end of the thread was tied to a fixed object and the lizard released. I could determine the exact path the animal had taken by following the unravelled nylon thread the following morning. These paths were then recorded onto a plan of Karrakatta Cemetery.

During October and November, goannas weighing less than 600 grams travelled about 180 metres per day, while goannas (usually males) over 600 grams travelled much greater distances,

The slope and east-facing orientation of most of the gravestones in Karrakatta Cemetery provide an ideal basking site for Sand Monitors wanting to rapidly increase their body temperature when they first emerge from their burrows.





To avoid detection, a basking Sand Monitor will often quietly move around a headstone.

possibly in search of a mate. The goannas each effectively foraged over an average area of about 300 square metres each day, focusing on areas that had an accumulation of leaf litter on the ground. The same one or two holes were used for their nightly retreats while foraging in a particular area, but when the available source of prey was diminished, they would move off to a more productive area.

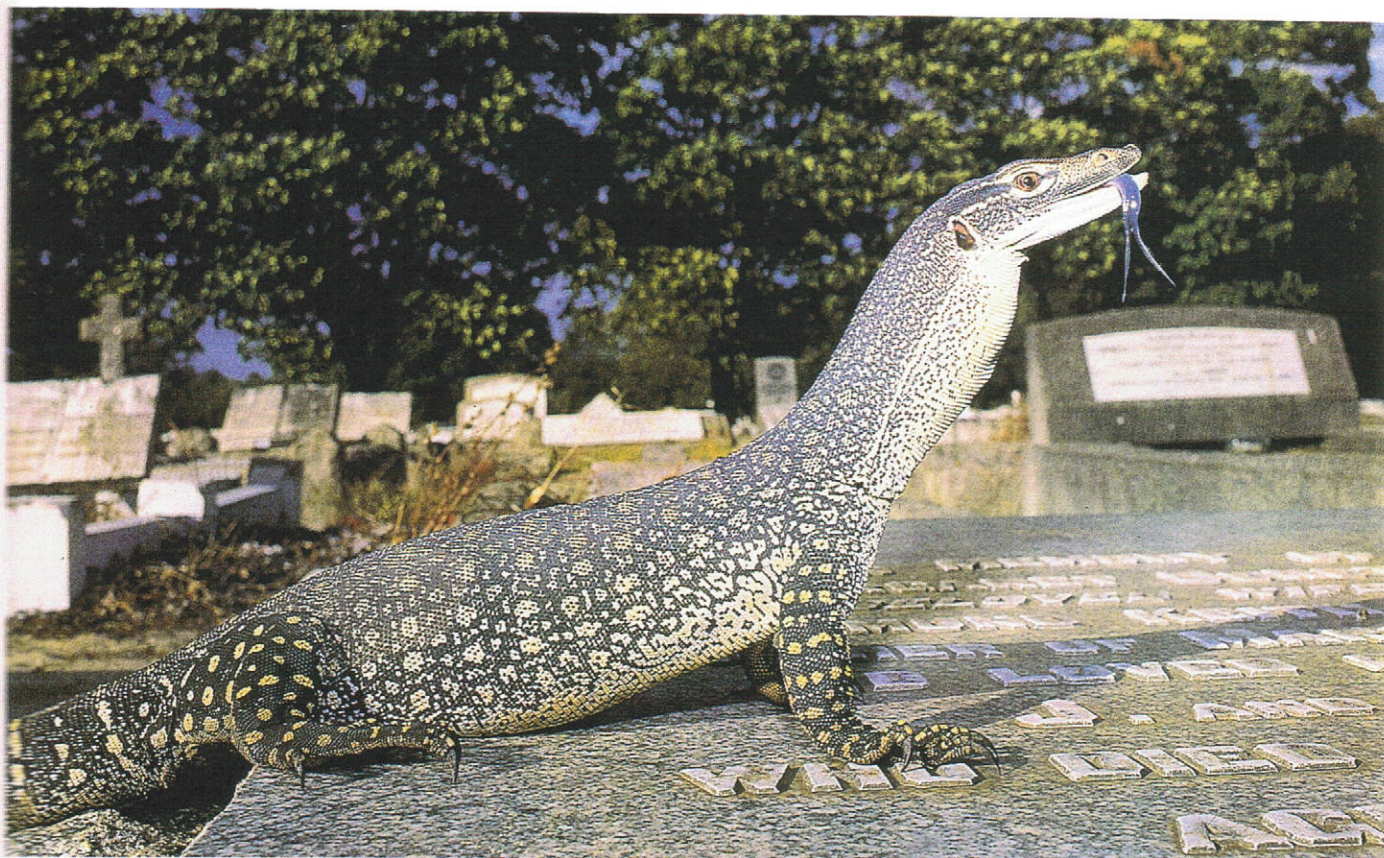
Because their foraging areas changed every couple of days, it was important to establish the total size of the area over which the goannas foraged in a particu-

lar season. By attaching a miniature radio-transmitter to the side of each goanna's tail just behind the back legs, I was able to monitor the goannas' locations on a daily basis. From this information I could estimate the total area occupied or visited over an entire season.

Four males with an average body mass of about 600 grams had activity areas of approximately 19 hectares, while six females with an average body mass of about 370 grams had activity areas of just two hectares. The difference between the size of activity areas may be related to either the sex or size of these goannas, or it could be a combination of both. The two largest males had activity areas of approximately 32 hectares. On a couple of days, these large males travelled much greater distances than had been recorded during previous weeks of monitoring. This behaviour was probably associated with searching for mates, although females were never seen. During the spring-summer breeding season at Karrakatta Cemetery, male Sand Monitors follow scent trails released by females and probably venture well outside their normal activity area. Males also used a larger number of burrows than females during the breeding season, which is probably associated with their larger activity areas. Activity areas overlapped and goannas were recorded retreating to overnight burrows previously used by other goannas. On no occasion, however, did two goannas use the same burrow overnight, although other researchers have found Rosenberg's Monitors sharing a burrow.

The goannas at Karrakatta Cemetery appeared to have a good 'mental map' of their activity area. If, for example, they were swooped on by a Rainbow Bee-eater (*Merops ornatus*) trying to protect its foraging site or nest hole dug into the sand, the goannas invariably took the shortest unobstructed route to a safe burrow. Similarly, goannas returned regularly to specific foraging sites used on previous days that, in some cases, were hundreds of metres from their burrow.

DURING SUMMER 1993-1994 MY colleagues and I followed two goannas over a period of six weeks to record their daily patterns of behaviour. Goannas emerged in the morning, generally between 6 and 9 a.m., poking their heads out from under a grave cover for a while before bringing their whole bodies out into the sun. They would then climb onto a grave cover, absorbing heat from the sun and from the dark coloured slab, to increase their body temperature from around 15° C when they were in their burrow to about 37° C. This would normally take between 15 and 30 minutes depending on the ambient temperature. Sand Monitors have a maximum body temperature of around 44° C, but they



Sand Monitors show early signs of annoyance by inflating their neck (gular pouch) and abdomen and hissing. This is often followed by side-swipes of the tail, an erect posture or aggressive lunges with their mouth open.

probably cannot sustain this temperature for an extended period. After warming up, they would move off in search of prey.

These goannas like to maintain their body temperature within a narrow band of about 36–39° C. To do this they use a number of behavioural strategies. When initially warming up in the morning or after a period in the shade, they will flatten their bodies and direct the largest surface area toward the sun, while remaining ever vigilant. On days when ambient temperatures are in the high 20s, grave covers can be over 40° C and surface soil temperature in the high 30s. To avoid overheating, goannas will often shift their foraging areas from full sunlight to filtered sunlight or shaded areas. In the hottest part of summer, many goannas are active only in the early morning and late afternoon, retreating to burrows during the heat of the day. These goannas are not active at night.

The goannas displayed a number of interesting body postures. The most common was the vigilant posture, characterised by a motionless body, the abdomen in a prone position, and with head and neck held high. The head is slowly turned to obtain a clear view of the surrounding area. If the view is obstructed, they stand erect, balancing

on their hind limbs and tail. Goannas also wag their tail like a dog. On one occasion when a Sand Monitor was seen wagging its tail, it was busy chasing a small skink in a patch of grass; on another occasion, a goanna approached to within about three metres of an observer, wagged its tail a couple of times and moved off to forage. The purpose of this tail wagging is unknown.

Many species of goanna also engage in a combat ritual. Male Sand Monitors have been observed wrestling while standing belly to belly on their hind limbs, using their tail as a prop, and with forelimbs wrapped around their opponent. These struggles can last for many minutes with their sharp teeth occasionally cutting through the skin of their opponent during the fight. The purpose of these combat rituals is probably to defend territories or determine access to females. However, although I have observed goannas at Karrakatta Cemetery over four summers and have talked to many gardeners who work the area, no-one has ever seen any combat ritual at this locality.

General maintenance of the grave sites, and maintenance of the goanna population at Karrakatta Cemetery, could be seen as a conflict of interest for the management staff at the cemetery. On the one hand, people that visit the graves expect the grounds to be kept neat and tidy, with the soil around them raked and removed of weeds. However, goannas do not fare well in such a situation since they require a certain amount of shelter and leaf litter for successful

foraging. A compromise has been adopted, whereby low-growing native shrubs (such as bottlebrushes) are being planted in a number of areas and the leaf litter underneath them is allowed to accumulate. The shrubs, while being an attractive addition to the cemetery, provide shelter for the goannas, and the leaf litter provides extra foraging sites. Also, there are plans to minimise the weed-spraying program in those areas most frequently used by goannas, and to erect signs explaining to the public why leaf litter and weeds have been allowed to accumulate. With sensible and sensitive planning, based on the information obtained from the studies at Karrakatta Cemetery, managers will not only be enhancing the aesthetics of the cemetery but they will also be helping to maintain a very special population of goannas. ■

Further Reading

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