

The knife-edge existence of a native rat

'Man', complained Job, 'is of few days and full of trouble.' Had he not been 'born of a woman', but taken the form of a Northern Territory dusky rat, Job would have felt just as sore a need for comforters, for this animal's brief life is full of environmental adversity.



The Territory dusky rat has fashioned for itself a specialized existence on the low-lying plains that fringe the tidal stretches of the meandering rivers of the Northern Territory, from Daly River in the west to Rose River near the south-western corner of the Gulf of Carpentaria. Many rats must, soon after birth, take refuge from hot, arid conditions as harsh as those of most deserts. Then, a few months later, comes the monsoon: the plains flood and the rats must abandon their dry-season home.

Those that survive these hardships are unlikely to experience them twice, as the term of their natural life generally extends for only one year.

Quite recently, taxonomists were referring to the Territory dusky rat as *Rattus sordidus colletti*, requiring it to share a species with two other subspecies, the plague rat (*villosissimus*) and the Queensland dusky rat, also known as the sugarcane rat (*sordidus*). Now each of these three has risen to the rank of species, and scientists call the Northern Territory form *Rattus colletti*. To the Gunwinggu-speaking peoples of Arnhem Land this animal remains the mulbu.

This rat was the largest caught during the entire study. A researcher is measuring the length of its head.

In all, seven of the world's 100 or so species of *Rattus* may be counted among our native fauna, although, compared with the marsupials, they seem to be relatively new Australians.

Scientists suspect that a small number of immigrants from the islands of Indonesia and Papua New Guinea may have founded the Australian rat dynasties within the last million years. By contrast, those global seafarers, the black and brown rats, came with European man.

The dusky rat takes its name from the dark, sometimes black, hair on its back. Turn it over, and you will often find grey or yellowish fur underneath. When fully grown, a male's head and body together may measure up to about 210 mm, with the tail adding a further 170 mm to the animal's length. Such a male would weigh some 210 g. Females seldom reach quite this size.

Traps and tags

This rat first brought detailed scientific inquiry upon itself by turning up in

abundance in rice plantations. What controlled the animal's numbers? Could the dusky rat's population explode to plague proportions?

From 1972 to 1976, Mr Trevor Redhead of the CSIRO Division of Wildlife Research studied a population of rats living beside the Adelaide River, near Humpty Doo, 55 km south-east of Darwin. His colleague Dr Kent Williams investigated another population at Karpalga — some 150 km to the east, on the plains of the South Alligator River — from 1975 to 1978.

The rats make nests underground in the cracked clay.

In both studies, the scientists laid out grids of traps about once a month. Baits, consisting of small pieces of leather soaked in raw linseed oil, lured rats into the traps, where they remained, uninjured, until the researchers arrived at dawn to weigh, measure, tag, and release them. The tag — a small metal clip attached to one ear and bearing a number — enabled the scientists to identify each individual should it be caught again. The scientists also recorded the sexual maturity of each rat (for example by feeling for foetuses through the skin of pregnant females).

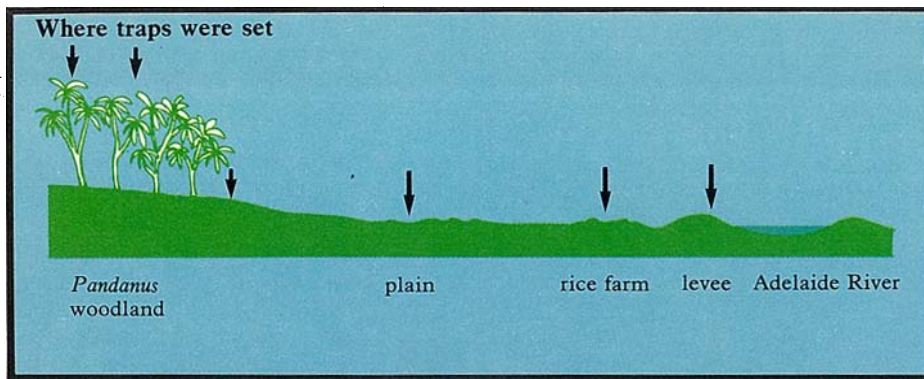
The plains flood

The researchers have found that the Territory dusky rat's life cycle depends very much upon the weather, and therefore varies from year to year — sometimes dramatically. However, a typical sequence of events would be as follows.

During the summer 'wet', the plain gradually floods. Near Humpty Doo the



The boundary between plain and woodland is sharp.



A diagram of Mr Redhead's study area near Humpty Doo. Each arrow marks the site of a grid of traps.

shallower areas remain inundated for 3 months, and the lower ground for up to twice this time.

As the soil becomes waterlogged, many of the rats move to the levee banks and the edges of the plain. They shelter by day among grass tussocks and clumps of fallen sedge, emerging by night to forage in the shallow water. Some dig burrows in soft soil above the level of the water. At this time of year the bases of grass stems or sedges make up most of the diet.

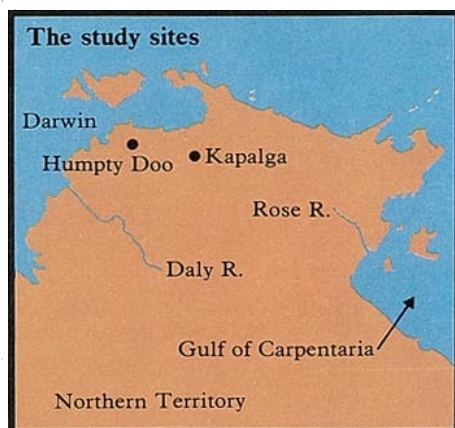
Other rats retreat to the woodland on higher ground bordering the plain, feeding on the ground and hiding by day among logs and tree roots.

The rat population declines during the wet season, but scientists have not yet identified specific causes.

In April or May, the dry season begins and the water subsides on the plain. As if impatient to return, the rats leave their summer quarters as soon as the soil is sufficiently dry.

Natural burrows

Cracks, on average about 10 cm wide, soon appear in the baking clay, and the rats accept these as natural burrows, sheltering there from the hot sun and coming out at night to feed on the grasses and sedges



The Division of Wildlife Research studied Territory dusky rats near Humpty Doo and at Kapalga.

growing on the plain. In the same way that many small mammals that live in deserts burrow underground to escape the hot, dry atmosphere, so dusky rats find conditions more congenial in the clay crevices.

In the middle of one afternoon in the dry season, Dr Williams recorded a shade temperature of 36°C just above the surface of the plain, but 60 cm below ground in a large crack the thermometer read only 29°C. And the relative humidity, although a mere 35% above ground, turned out to be 75% in the crevice. Clearly rats reduce their physiological stress — and particularly the loss of precious water — by spending the daytime in a subterranean microclimate.

The cracks offer more comfortable living at night, too. Early in the dry season overnight temperatures may drop to 8°C, and scientists have found trapped rats stiff and inert when the air temperature was about 20°C. These rats, whose body temperatures had dropped well below their normal 38°C — in one case to only 24°C — recovered as their body temperatures rose.

A Kapalga trap site on the edge of the plain at the end of the wet season. Introduced weeds make up most of the lush vegetation in the foreground.



In the crevices, however, the temperature remains almost constant throughout the day, standing at about 25°C at that time of year.

Breeding begins soon after the rats return to the plain, where they make nests underground in the cracked clay. Mr Redhead found that 65% of all pregnancies occurred in April. Gestation lasts about 21 days, and after only 3 more weeks the young can already fend for themselves. In a favourable season, the females are ready to breed within a remarkably short time — at the age of only 4–5 weeks.

In captivity, Territory dusky rats produce litters of nine or more young (mothers have 12 teats) and can breed in any month of the year. In the wild, weather conditions usually restrict breeding to relatively short periods. Furthermore, a female can come on heat just after giving birth to young; this *post-partum* oestrus enables her to bear a litter while she is still suckling the previous one.

When you consider all these features together — the large litters, short gener-

The same site 6 months later. The ground is littered with dry *Pandanus* fronds.



Living in a permanent wet season: the water rat

Another native rodent — and, like the dusky rat, a member of the family Muridae — to have been accused of committing an economic nuisance is the water rat.

If Kenneth Grahame had set 'The Wind in the Willows' in Australia, Rat would have been modelled on *Hydromys chrysogaster*, and if the author had farmed in one of the irrigation areas of New South Wales or northern Victoria, Ratty might have turned his practical nature a little more to undermining his neighbours' livelihoods and less to the moral reform of Toad. For this *Hydromys* species sometimes digs holes in levee banks and around water wheels, upsetting the flow in irrigation systems.

The water rat and platypus are the two native mammals to have specialized in fresh-water life. The rat lives in lakes and rivers throughout the less arid parts of Australia, in New Guinea, and on many offshore islands. It generally looks dark brown above and pale — often orange — below, but both size and colour vary.

In order to learn more of its habits and help answer the question whether the species should be designated a pest, Mrs Penny Olsen (at the time Penny Wool-lard), Mr Wim Vestjens, and Mr Leckie MacLean, of the CSIRO Division of Wildlife Research, began studying a population at Griffith, N.S.W., in 1970.

They caught more than 300 rats in open wire boxes equipped with a treadle that closed the door behind an animal once it was inside. Fish bones, sardines, and the viscera of ducks obtained during the shooting season all made good bait. For a close study of the rats' breeding biology, Mrs Olsen also kept some animals captive in Canberra.

The scientists particularly wanted to find out what water rats eat. *H. chrysogaster* has tidy table manners, discarding most of the indigestible (and therefore identifiable) parts of its meals, and so making a researcher's work difficult. However, the CSIRO team was able to conclude that fish rank highest as a regular major source of food.

This will come as no surprise to those anglers who have netted fish only to lose them again to a hungry water rat. Near Griffith the main fish eaten turned out to be goldfish, mosquito fish, and English perch — all introduced species, thriving in the local waterways. Insects contribute strongly to the diet, too, especially in spring.

Occasionally a water rat will take a bird;

A water rat.



a well-grown rat is the heaviest of all native rodents, and the size of a small adult cat. The scientists found feathers in 8% of the stomachs they examined. Duck-shooters, like fishermen, from time to time lose their game to a rat, and the animal has been known to kill quite large birds for itself, including musk duck.

Crustaceans, such as yabbies, and spiders also featured in the list, along with mussels, frogs, and the occasional mammal. Cannibalism, the researchers say, cannot be ruled out.

Because plant remains, particularly woody items, linger undigested for a relatively long time in the gut, they may seem misleadingly common in the diet, but the study team did establish beyond doubt that the water rat is not the total carnivore it has sometimes been made out to be. In winter, particularly, or when alternative foods are scarce, the rats include a few plants in their diet. The only species the researchers could identify was the water fern *Azolla fuliculoides*.

Comparing different seasons and different years, the scientists concluded that this rat shows great adaptability. It quickly exploits a transient flush of insects, and will even concentrate on house mice during a plague. It has been known to raid poultry runs and to help itself to fish offal from a cannery. And that predilection for hunting introduced fish when native fish abound must reflect a taste acquired comparatively recently.

The water rat breeds at a more leisurely pace than the dusky rat. In her 5-year study of captive specimens, Mrs Olsen found that females bore, on average, just over three young in a litter, and produced

about two and a half litters each year. Nearly 90% of all births came during the period September–March.

In captivity, the young mature when they are 4–8 months old; the females can breed for three seasons, until they are about 3½ years old.

And is the species a pest? Mrs Olsen thinks that both the numbers of water rats and the damage they do are probably over-estimated. Trapping has always revealed smaller populations than local farmers suspected. People sometimes count holes in banks, but do not always distinguish between those made by water rats and those excavated by yabbies or even foxes.

Outside irrigation areas, water rats barely seem to impinge on man's economy, and the species is protected in all States, although farmers can obtain licences to take it where it becomes a pest.

Water rats have even been turned to good economic account. During World War II, when imported furs were scarce, their skins were made up into coats, and from time to time people have suggested farming the rats like minks. The Tasmanian Department of Agriculture is exploring both the economic and the practical feasibility of such farming.

The ecology of the eastern water rat *Hydromys chrysogaster* at Griffith, N.S.W.: food and feeding habits. Penny Wool-lard, W.J.M. Vestjens, and L. Mac-Lean. *Australian Wildlife Research*, 1978, 5, 59–73.

Reproductive biology and development of the water rat *Hydromys chrysogaster* in captivity. Penny D. Olsen. *Australian Wildlife Research*, 1982, 9 (in press).

Soil cracks shelter the rats

	above ground (°C)	in soil crevice (°C)
just before dawn	19.9	24.7
mid afternoon	35.0	24.7

ation time, and 'rapid-fire' production of young — you can easily understand how a dusky rat population may explode when the environmental conditions are just right.

Mr Redhead has found that, as the dry season progresses, the rats rely more and more on sedge corms for their food and water. In January, during the wet season, these corms make up some 40% of the diet, but by October the proportion has risen to 85%. Rats eat insects in all seasons, too.

The dry season brings its own particular stresses, although these are not yet fully understood. Typically, rats abandon the edges of the plain a month or two into the 'dry', often concentrating in shallow depressions in the centre of the plain. Above the ground, their food plants gradually wither in the relentless heat, although the underground corms remain juicy for some time to come.

By now, the days of the parental generation of rats are clearly numbered. Growth

Temperatures recorded at Kapalga early in the dry season.

slows, the rats lose weight, their fur thins and becomes dry, and ticks increasingly infest their skin. By the end of the dry season those rats that colonized the plain after the floods retreated have died, leaving the new generation to continue the species' precarious existence. Few individuals live for more than a year.

Responding to the weather

As the seasons vary, so the rats respond. They may start bearing young earlier in the year or prolong their breeding season as environmental conditions permit. In some years the population expands at a dramatic rate, reaching a peak several times higher than that of most years. At other times the numbers 'crash' and very few rats turn up in the traps.

Mr Redhead witnessed both an explosion and a crash of a population in the second year of his study. He found only moderate numbers of rats when he began

trapping in 1972, but the following year breeding started earlier than usual, probably thanks to a mild wet season that caused particularly minor flooding.

Rats returned to the plain before their normal date, and some of the females became pregnant as early as March.

Already off to a good start, the population received a further fillip from two atypical falls of rain during the normally dry season: 29 mm at the end of June and 28 mm in September. Mr Redhead points out that at Darwin, where the climate is very much the same as at Humpty Doo, June rain as heavy as this comes, on average, only once in 100 years, and such September gaugings only one year in five. The combination is therefore rare!

The rains encourage a good flush of grass, and the rats responded by extending their breeding season. However, the parental females took no part in this phase of the population explosion; having recolonized the plain and produced their litters they suffered the normal high mortality. Young, swiftly maturing rats, born early that same season, pushed up the population by exploiting the unusually favourable conditions and bearing litters of their own.

A similar rapid rise in population occurred at Kapalga in 1978, following a mild wet season and some dry-season rain. Dr Williams estimated that the density of

If a long 'wet' is followed by a harsh dry season, the rat may become very rare over most of its range for years.



rats rose from 18 animals per hectare in May to 230 in August; over those 3 months the population doubled every 17 days.

In these crowded conditions, the rats' behaviour changes, and some move about during the daytime, uttering high-pitched squeaks.

Territory dusky rats are eaten by such predators as water pythons and the occasional death adder, and when exceptional numbers of black-shouldered kites hover over the plain you know the rat population has reached plague dimensions. Then the rats may do considerable damage to any nearby crops and even to the electrical wiring of buildings when they abandon the plains as the rains begin.

A Northern Territory dusky rat.



In the dry season, the clay of the flood plain cracks.



One of the Kapalga traps in late September 1978. Territory dusky rats nest underground in these natural crevices.

The end of a plague

For as long as the favourable seasons continue, the rats will remain abundant, but sooner or later their environment will impose one of its periodic constraints, and then the plague ends.

Mr Redhead did not have to wait long to see this happen. The plague year of 1973 ended with record-breaking rains, and few rats survived that wet season to recolonize the plain in 1974. These bred as usual at the end of the wet season.

But then on the night of December 4, more than 250 mm of rain swamped the plains as cyclone Selma passed by. Three weeks later, the notorious cyclone Tracy brought further heavy downpours. People saw hundreds of drowned rats, and all this rain may well have reduced the population in less direct ways as well.

After this severe reversal in their fortunes, the rats remained scarce for several years until 1978. In general, deep or prolonged flooding during the wet season re-

duces the population, and if a long 'wet' is followed by a harsh dry season, the Territory dusky rat may become exceedingly rare over most of its range for some years.

The contrast between good times and bad in the rats' environment shows strikingly in the rates at which not only the population but the rats themselves grow. From his measurements of trapped animals, Mr Redhead calculated that, on average, a male of 120 mm grew in length four times as fast in the favourable conditions of 1973 as a similar male the following year, when the rats had their backs to the ecological wall.

Weight measurements, too, tell a striking story: a 60-g male in August 1973 was putting on weight at the rate of 1% each day, but its 1974 counterpart could manage only 0.1%.

It is less easy to explain another of Mr Redhead's observations — the shifting sex ratio. When the population at Humpty Doo was expanding, females outnumbered

males, but periods of dwindling numbers saw a surfeit of males. These relations held in both wet and dry seasons. It will be interesting to see whether this is always true, or applies only to the particular area under study.

The ups and downs of Territory dusky rat numbers do not resemble the rhythmic cycles of some small mammals in the Northern Hemisphere — the lemming in Norway and Canada, for example — but follow inevitably from the irregular variations in the monsoonal climate.

A population may explode when the environmental conditions are just right.

Mr Redhead believes that the survival of the species may well depend upon those few individuals that spend the wet season in the woodlands rather than on the larger numbers on the levees, because, if the river is already swollen by heavy rain, a high tide may flood the levees.

How, then, can we sum up the ecology of the dusky rat? In a climate of unpredictable extremes, the rat lives on something of a knife-edge. In order to make the most of good times while they last, the dusky rat has evolved prolific powers of reproduction, giving it the highest productivity of all the Australian species of *Rattus*.

Like its close relatives the sugar-cane rat (*R. sordidus*) and the plague rat (*R. villosissimus*), the Territory dusky rat is an opportunist, taking advantage of all-too-brief favourable conditions to build up the population rapidly, probably increasing genetic diversity and maximizing the chances that some individuals will survive the next lean spell.

At Kapalga the work goes on. Under Dr Michael Ridpath, members of the Division are investigating aspects of the ecology of the district, and no doubt this study will throw further light on the dusky rat's position in its community.

John Seymour

More about the topic

On the demography of *Rattus sordidus colletti* in monsoonal Australia. T.D. Redhead. *Australian Journal of Ecology*, 1979, 4, 115–36.

The elusive plague rat. *Ecos* No. 14, 1977, 10–13.

Killing cane rats. *Rural Research* No. 114, 1982, 29–30.