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hairy harbingers

Wendy Pyper discovers what spiders and grasshoppers can tell us about the health of Australia's savannas.

Peter Marsack, Lochman Transparencies

The sight of a fat, hairy spider scuttling, dangling or lurking nearby, is enough to send most people into spasms of fright. But for Dr Tracey Churchill, from the CSIRO Tropical Ecosystems Research Centre at Darwin, spiders of all shapes and sizes are a professional passion. Her tales of the amazing antics she has observed in her 15 years as an 'arachnologist' highlight their diversity and ecological importance, rather than their ill-founded reputation.

Scientists estimate that there are some 10 000 species of spiders in Australia, of which about 2500 have been described. Only two of these species, the redback and the funnel web, have killed people. As well as being one of the most abundant organisms on the planet, spiders are dominant predators among invertebrates.

As predators, spiders have the potential to be useful indicators of environmental health – in the same way aquatic insects and plants are used to monitor water quality. If a disturbance such as grazing upsets the ecosystem balance, changes in the number and / or types of spiders can indicate that the environment and organisms lower down the food chain are suffering.

'If the spiders are disappearing then there's obviously nothing for them to eat and that could mean there's something wrong in the environment,' Churchill says.

In a project funded by the CRC for the Sustainable Development of Tropical Savannas, Churchill is gathering data on the diversity and abundance of spider species in Australia's northern savannas.

She is building up a picture of the spiders that occur in different parts of the savannas to assist in conservation planning, environmental monitoring, and making decisions to help sustain the productivity of the landscape. 'I'm trying to get a quick and reliable insight into what characterises natural and disturbed spider communities,' Churchill says.

'I ask questions such as what spiders naturally dominate in different areas and what are the patterns of richness. From that basic understanding I can then ask questions about the effects of land disturbance, such as grazing, on spider communities.'

Trapping spiders

Churchill's first task was to understand the composition of savanna spider communities, as no comprehensive surveys had been undertaken. While the savannas extend across the northern third of Australia, Churchill initially focussed on the North Australian Tropical Transect.

The transect was established by CSIRO as one of a series of international transects for the International Global Biosphere program, which looks at global climate change effects. It extends 900 kilometres south of Darwin and has a rainfall gradient (from 1500 mm in the north to 500 mm in the south) across clay, loam and sand soils.

'The goal of the survey was to understand how spider communities vary with the main environmental factors, which up here are rainfall and soil,' Churchill says.

A jumping spider with its prey: a plant hopper nymph. The jumping spider, from the family Salticidae, stalks its prey like a cat, across the vegetation. Jumping spiders live on shrubs and other vegetation and are often caught using sweep nets. They have two large eyes at the front surrounded by six other eyes and many are iridescent in colour. The spiders are only 3–5 mm in size, are harmless to humans and are widely distributed across the continent.

The spiders were collected using pitfall traps, which consisted of 8-cm diameter jars placed in holes in the ground. Fifteen of these traps were arranged in three rows of five, at 10 m intervals, and contained a fluid to kill and preserve the spiders and any other invertebrates unfortunate enough to stumble into them. After a week, Churchill collected the traps and took her spoils back to the lab for identification.

Below: CSIRO arachnologist Dr Tracey Churchill is studying the characteristics of natural and disturbed spider communities

Bottom: Wolf spiders are one of at least three spider families that could be useful environmental indicators in Australia's northern savannas.

Jiri Lochman, Lochman Transparencies

Churchill says pitfall traps collect many of the arachnid inhabitants because much of the savannas consist of a woodland overstorey with an understorey of annual and perennial grasses. However those living above ground can be sampled in other ways, such as with 'sweep nets', which are like butterfly nets.

Since the project's inception in 1996, Churchill has made three collections along the transect, at the end of the wet and dry season, and during the mid-dry. At least three spider families are showing promising distribution trends, which could make them useful as environmental indicators.

For example, the Zodariidae or ant-eating spiders typically occur in drier habitats where they exploit ant and possibly termite prey. In Churchill's study, they were common on sandy soils (fast draining) in high rainfall areas, but became the dominant spider type on clay (slow draining), loam and sandy soils as rainfall decreased.

'The Zodariidae have really evolved and adapted to fill niches in the dry country, particularly within the semi-arid perennial grasslands,' Churchill says.

The burrowing Lycosidae (wolf spider), in contrast, dominated on clay soils in high rainfall areas, but dropped off rapidly as rainfall decreased.

'Decreasing rainfall would make the soil harder, which may be less favourable to burrowing,' Churchill says.

And the 2–3 mm Oonopidae, which have a hard 'toffee-like' carapace and hunt termites in the leaf litter, tend to favour clay soils in areas of intermediate rainfall.

Land-use disturbance

Once trends such as these have been established, the next step is to see if they are disrupted by land-use disturbances. As grazing is the dominant land use in the savannas, Churchill has been investigating responses in spider communities along gradients of grazing intensity. These gradients can extend more than 9 km in locations throughout western New South Wales and Queensland, the Northern Territory and central Western Australia.

Along the semi-arid gradients on the Mitchell grasslands of the Barkly Tablelands, in Queensland, Churchill has found the Zodariidae to be the dominant spider type. However the number of Zodariidae drop significantly the closer they get to an artificial water source, where cattle congregate.

'This response is reasonably clear cut: the closer you get to the high impact zones, the less Zodariidae there are, while in the less disturbed areas you get more Zodariidae,' Churchill says. 'So they could be used as an indicator because they show a clear response to disturbance and because they are abundant and easily sampled.'

These early results showed that even at family level, spiders have the potential to be useful indicators of environmental change. Churchill also identifies spiders to species level, to see if they provide any further information.

'It depends on where you are biogeographically, as to whether you'll receive more information at species level,' Churchill says. 'If a trend is driven by one species, then it may be better to zoom in on that species so you get less error in your data. So we need to compare the information we get at both levels to see if species identification is worth the extra effort.'

As there is an expectation that land use in the savannas will become increasingly diversified, with pastoralism, mixed agriculture, tourism, conservation, mining and aboriginal land uses, strategies to maintain biodiversity and environmental health will be crucial. The invertebrates we love to fear could form an integral part of these strategies.

Seeking trends amid a web of spiders

THE Tropical Savannas CRC is in partnership with the Parks and Wildlife Commission of the Northern Territory and other state and territory government departments. This gives it access to spiders collected as part of wider biodiversity surveys.

These collections will help Tracey Churchill understand the impacts of a broad range of environmental changes on the savanna's spider fauna, such as tree clearing in central Queensland, sulfur plumes from the Mt Isa mine and military training in North Queensland. The impacts of fire also need to be investigated and spiders from a large CSIRO fire experiment at Kakadu are under the microscope. The spiders from all these projects also fill a significant gap in our knowledge of Australian spiders by revealing biogeographic trends across the continent's north.

Sampling the road to nowhere

THE drive down the North Australian Tropical Transect from Darwin to Kalkarindji, just south of Katherine, is long and hard. But twice a year, research assistant Gus Wanganeen and a posse of scientists make the trip in the name of invertebrate research.

The 800-km drive to Kalkarindji takes about 12 hours, with a stop at the pub in 'the 'middle of nowhere'. On arrival at camp – a small caravan with cooking facilities – the group settles into swags under the cover of mosquito nets.

Sunrise brings the promise of a day setting pitfall traps along the sample site. Wanganeen digs two lines of 15 holes with an auger while a colleague inserts the traps (glass jars) and fills them with a deadly mixture of propylene glycol, water and alcohol. 'It's easy work but it's labour intensive, depending on the soil type,' Wanganeen says.

Once the traps are set, the group heads for Kidman Springs, about four hours drive north of Kalkarindji. After setting up camp, there's time for a few beers and a chat around the campfire before hitting the sack. In the wide, flat, open country the night-sky is spectacular, but the temperature can plummet. 'During the day the average temperature is about 32°C, although it's cooler in the dry season. But at night it can get down to 10°C,' Wanganeen says.

The following day is a repeat of the previous: set traps and head north. The next stop is a pastoral property at Willeroo, about 200 km north of Kidman Springs, then home to Darwin for the weekend.

Come Monday, Wanganeen is on the road again, to pick up the traps. This time though, he stops at Annaburroo, a pastoral property where other members of the invertebrate research group at Tropical Ecosystems Research Centre are collecting specimens. He will also stop at the Douglas Daly research station, which is run by the Department of Primary Industry (Fisheries), to collect more specimens.

Once all the traps have been recovered from Kalkarindji, Kidman Springs and Willeroo, Wanganeen heads back to Darwin, where the catch is sorted. He makes two such field trips a year, in the dry season during October/November and at the end of the wet season in April/May.


Campsite at Mount Sanford Station.


Litter sampling.


Sweep sampling.

Consulting the grasshoppers

Pioneering research into the grasshopper fauna of northern Australia has shown the insects could be used as indicators of environmental health.

According to insect ecologist, Dr Alan Andersen, from the CSIRO Tropical Ecosystems Research Centre in Darwin, grasshoppers are a dominant group of herbivorous insects in grassy ecosystems worldwide.

In the tropical savannas of central and northern Australia, grasshoppers are thought to play a greater grazing role than all the native mammals combined. Their voracious appetite for all things botanical, however, makes them vulnerable to environmental disturbance, particularly when it involves the grass layer.

This vulnerability can help conservationists and land managers assess the health of an environment disturbed by grazing, mining or fire. But first, key information is required on the structure of grasshopper communities or 'assemblages' and their response to disturbance, to distinguish natural assemblage variation from human induced ones.

'We need baseline information on what to expect in the absence of disturbance,' Andersen says. 'Then we can look at how disturbance alters that.'

Function over form

To understand the structure of natural grasshopper assemblages, Andersen and his colleagues recorded the species, relative abundances and habitat preferences of grasshoppers in Kakadu National Park.

They identified 161 grasshopper species, which they then classified into different 'functional' groups depending on the grasshoppers' diet and specific habitat requirements.

The functional groups identified included 'grass-eating', 'broadleaf-eating', 'algae-eating' and 'open ground dwelling' grasshoppers.

A book born in **childhood**

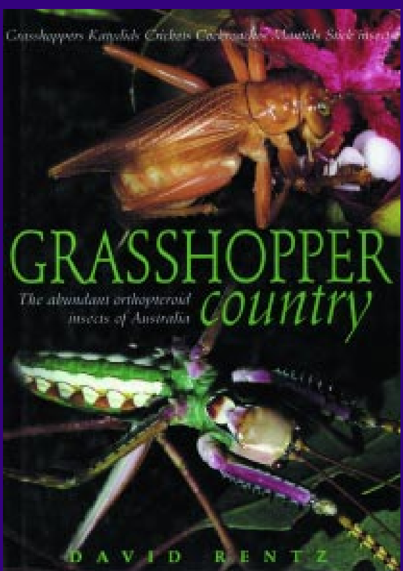
DR DAVID RENTZ, curator of Orthopteroid Insects at CSIRO Entomology's Australian National Insect Collection in Canberra, has been studying grasshoppers since the age of six.

Fifty years on, his life's work has been documented in a comprehensive and beautifully illustrated book *'Grasshopper Country. The Abundant Orthopteroid Insects of Australia'.*

The book covers all orthopteroid insects, which include grasshoppers, crickets, katydids, cockroaches, mantids and stick insects. It caters for general and experienced readers and provides identification keys, taxonomic details, illustrations of anatomical characteristics and photographs and electron micrographs of the insects, taken by Rentz in the field and laboratory.

Accompanying the book is the CD-ROM, *Sounds of Australian Orthopteroid Insects*, containing calls from 99 species of crickets and katydids.

The book and CD package is published by University of New South Wales Press in association with CSIRO Publishing and is available from bookstores for $79.95. Rentz is now working on a field guide to grasshoppers which is due to be published in 2002.



'Functional groups are groupings of species based on their ecological behaviour rather than their taxonomic position,' Andersen says.

'They allow you to compare assemblages of grasshopper species from one place to another, even if they don't have the same species in common. Then if you find a functional group that acts as an indicator, you can use it to monitor environmental health anywhere in Australia.'

To identify which grasshopper species or functional groups could act as environmental indicators, Andersen and his team sampled grasshoppers at 27 sites around the Ranger uranium mine. The study sites were distributed amongst three habitat types in relation to disturbance; natural, disturbed and waste rock.

The natural sites were relatively undisturbed by human activity and represented the range of savanna habitats occurring in the region. Disturbed sites were affected by disturbances indirectly related to mining activity, such as the construction of roads and clearing of bush. Waste rock sites included variously revegetated 10 to 12-year-old sites at the mine's waste rock dump.

Grasshoppers were surveyed inside 50 by 50-metre plots at each site during the mid-wet season, when they were most active.

'We found that in terms of the number of species at each site, there was not much difference. But when we looked at the types of species at each site, there were significant differences,' Andersen says.

At the natural sites, three grasshopper species were consistently identified and shown by statistical analysis to be reliable indicators of undisturbed habitat. According to grasshopper expert, Dr David Rentz, from CSIRO Entomology, *Goniaea vocans* (slender gumleaf grasshopper) lives on eucalypt leaves. *Tolgadia infirma* is a species restricted to grassy areas of the Northern Territory and *Zebratula flavonigra* (zebra grasshopper) is a tropical grasshopper, which feeds on broad-leafed herbaceous plants.

Disturbed habitats were characterised by one species, *Gastrimargus musicus* – a 'yellow winged locust' – while waste rock sites were home to *Acrida conica* (giant green slantface), a common grasshopper found in parks and lawns and *Bermiella acuta*, characteristic of creekline habitats. While *B. acuta* normally perches on grasses and sedges beside water courses, the poorly drained waste rock sites, containing persistent pools of water, provided a new, suitable environment.

As well as these species, the 'ground-dwelling' functional group of grasshoppers was found to be a significant indicator of undisturbed habitat. This functional group may now be used as an indicator of disturbance anywhere in Australia.

Andersen says now that the bioindicator potential of grasshoppers has been confirmed at Kakadu, the next step is to extend the study to the rest of Australia. Grasshoppers have been collected at sites along the North Australian Tropical Transect, an imaginary line extending from the tropics to the desert and spanning three main soil types and various rainfall levels.

'We've sampled grasshoppers at these sites to give us an idea of how they change with rainfall and soil. This will give us a broad overview of how grasshopper assemblages change naturally in northern Australia,' Andersen says.

The research team has also collected grasshoppers from areas disturbed by fire and grazing cattle and will conduct indicator analyses to identify a broader range of species or functional groups that could be used as to monitor environmental health in other parts of Australia.

Abstract: Spiders and grasshoppers have been shown to be potential indicators of environmental health. In two separate projects at the CSIRO Tropical Ecosystems Research Centre in Darwin, Dr Tracey Churchill and Dr Alan Andersen gathered data on the diversity, abundance and ecology of these arachnids and insects respectively, in natural and disturbed habitats. This information allowed them to compare the composition of spider and grasshopper communities in each environment and identify families, species or groups that characterised each. These 'bioindicators' will aid conservation planning and help land managers assess and monitor the health of environments affected by grazing, mining, tourism, agriculture or fire.

Keywords: spiders, wildlife surveys, population distribution, land use, northern savannas, grasshoppers, locusts, wildlife surveys, population distribution, Kakadu National Park, NT.