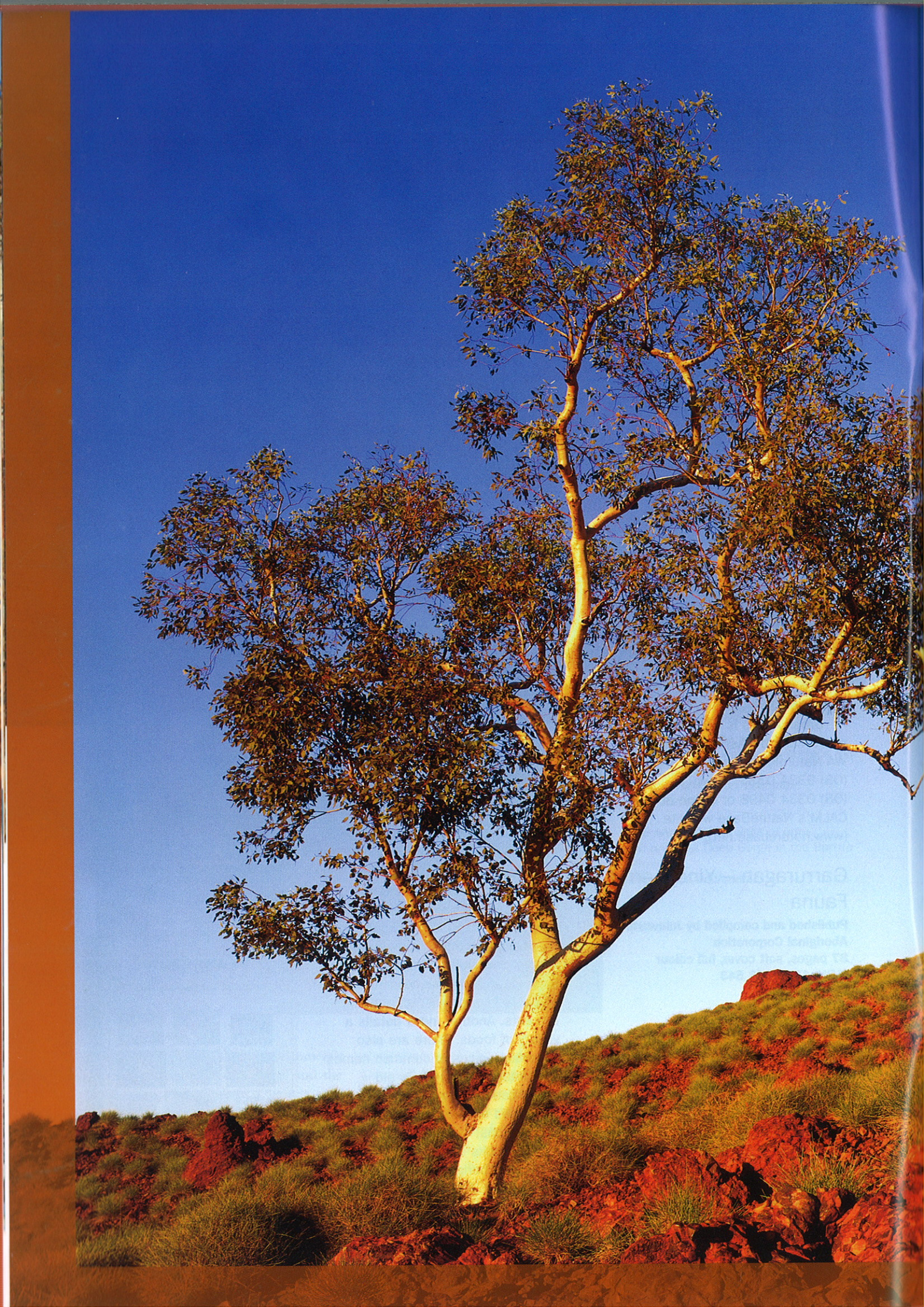
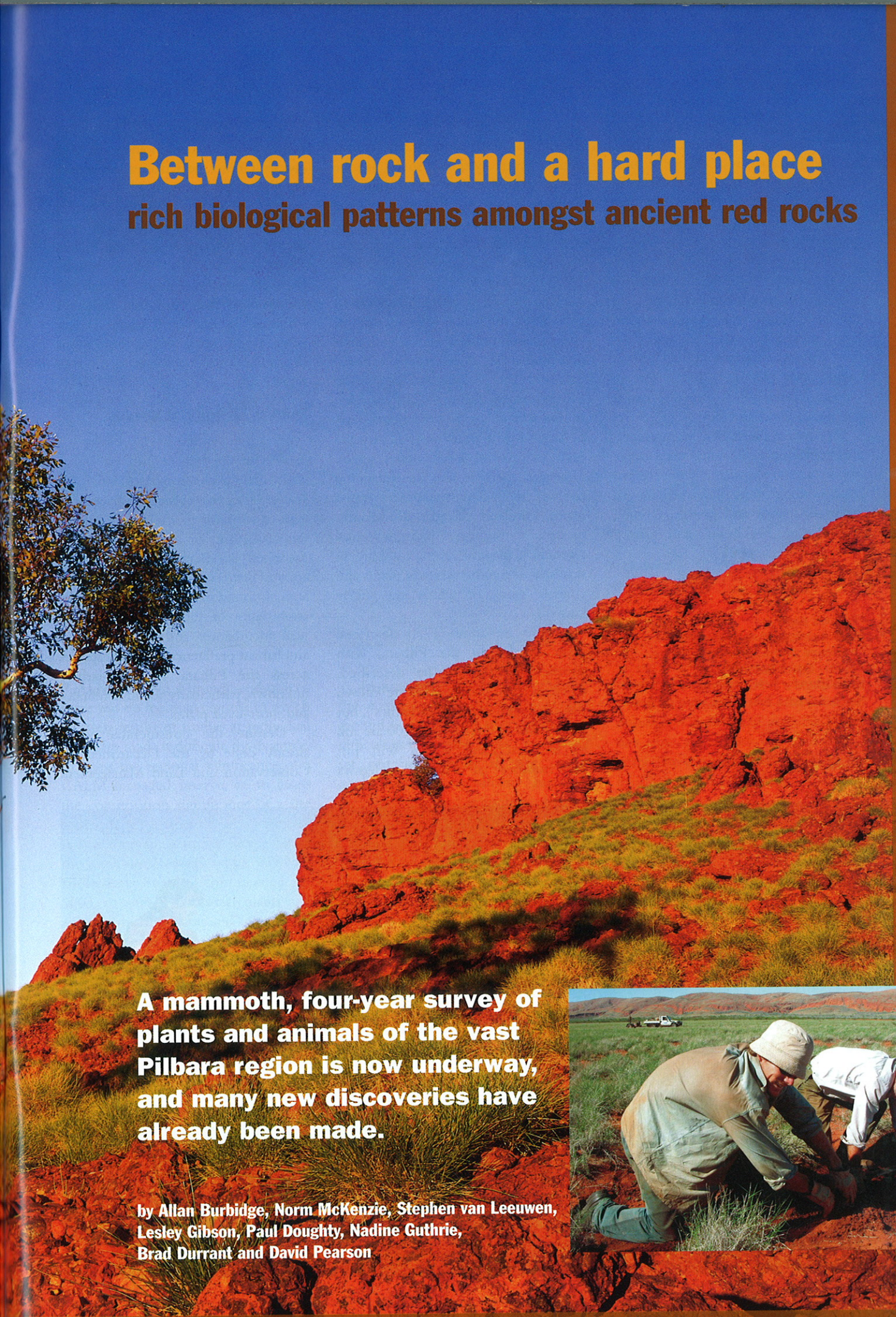


Between rock and a hard place

rich biological patterns amongst ancient red rocks



A mammoth, four-year survey of plants and animals of the vast Pilbara region is now underway, and many new discoveries have already been made.

by Allan Burbidge, Norm McKenzie, Stephen van Leeuwen, Lesley Gibson, Paul Doughty, Nadine Guthrie, Brad Durrant and David Pearson

The Pilbara is awesome. Much of the Pilbara is rock. Many of these rocks formed during the Archean between 2.5 and 3.6 billion years ago, making them some of the oldest rocks on the planet.

Because of its geological history, and the impact of this history on plants and animals that inhabit the area, the Pilbara is considered a natural region both geologically and biologically—the Pilbara biogeographic region corresponds closely with the Pilbara Craton, one of Australia's major geological building blocks.

Separating the ancient stony ridges, abrupt escarpments and steep scree slopes are geologically more recent areas—rolling stony plains of alluvial clays, silts, sands and gravels. Gorges, picturesque rockholes and grassy floodplains occur along intermittently active river systems, such as the Fortescue and Oakover, that drain the uplands. Along the mangrove-fringed western margin of the Pilbara there are extensive coastal flats and floodplains, such as the Roebourne Plains and the De Grey River delta.

The Pilbara is enormous, with an area almost the size of Victoria. Almost everywhere, reddish rocks and soils predominate, as does spinifex (*Triodia*) grassland. The 18 *Triodia* species in the Pilbara range from small rounded hummocks up to 20 centimetres high to large domes more than 1.5 metres high and two or more metres across. However, there is also an intriguing mix of tidal flats, mangroves, open plains, grassland savannas, woodlands, mountain ranges, gorges and temporary tropical rivers, resulting in similarly intriguing mixes of plants and animals, many of which are poorly known.

There are about 1730 described plant species in the Pilbara, with another 350 yet to be described. Currently, 150 plant species are known only from the Pilbara ('endemics'), but it is estimated that another 100 are still to be described, which will put the number of Pilbara endemics somewhere in the vicinity of 250 species. Grasses, peas, daisies and wattles are the most common plant groups, exemplified by the 130 or so wattles recorded in the region. Although most pictorial representations of the Pilbara either capture the iconic white-trunked snappy gum (*Eucalyptus leucophloia*) over spinifex with a turquoise skyline or a tranquil river pool lined with river red gums (*E. camaldulensis*), eucalypts are not well represented.

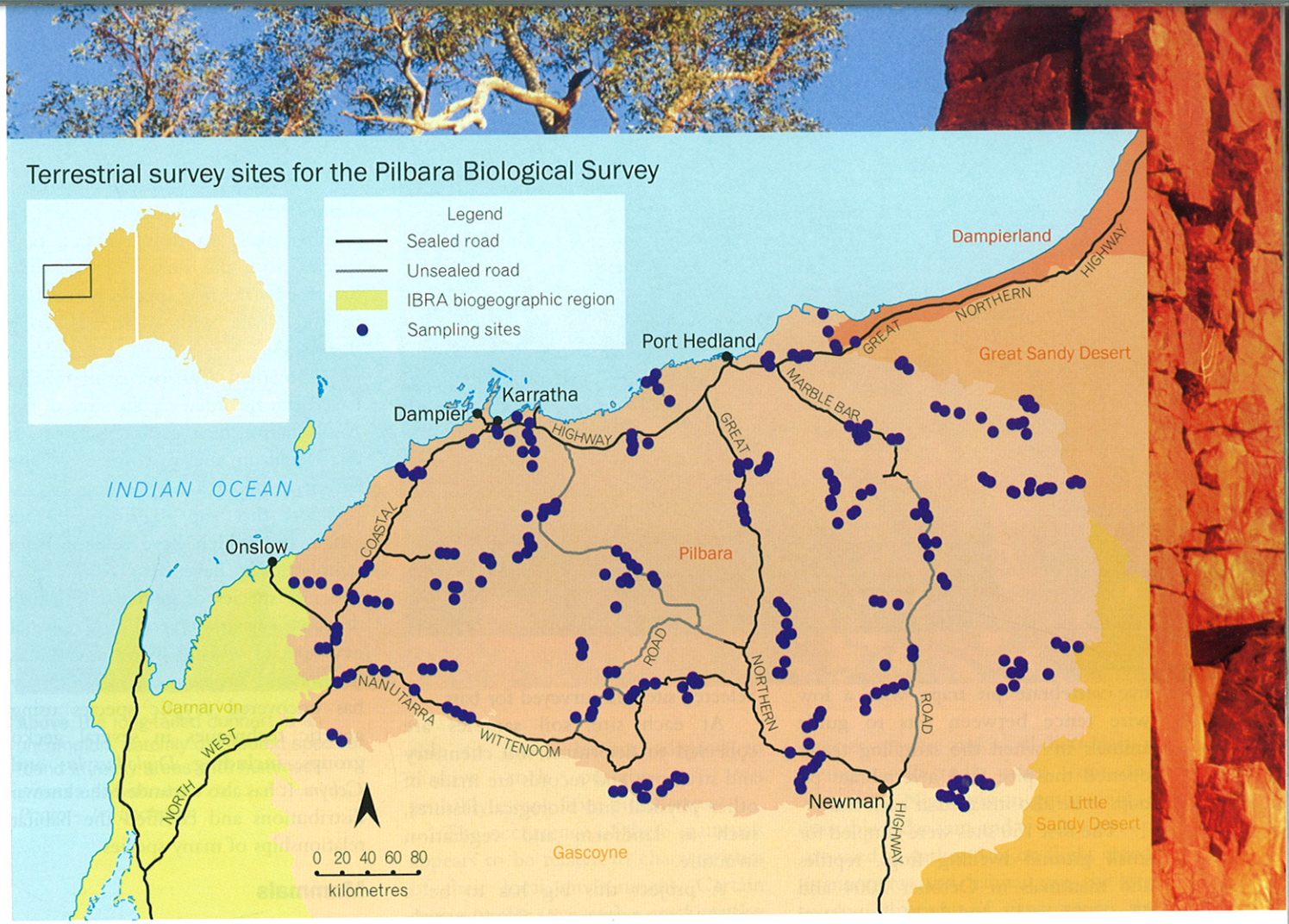
Pilbara Biological Survey

Despite numerous biological surveys in the Pilbara over the years, particularly in the iron-rich Hamersley Range, they have been restricted in area, or confined to a relatively narrow range of plants or animals. They have furnished excellent lists of the rich array of flowering plants and vertebrate animals found in the region. However, assemblages of these species are not well documented and the distribution and habitat preferences of many species across the Pilbara are still largely unknown, particularly for invertebrates and short-lived plants.

Despite the considerable work already done by the Department of Conservation and Land Management

Previous page
Main A snappy gum in the rocky landscape of the Hamersley Range.
Photo – David Bettini
Inset CALM's Tristan Farmer and Tom Smith adjust a drift fence on a pit trap line.
Photo – Jim Rolfe

Below Spinifex.
Photo – Jiri Lochman



(CALM), the WA Museum and others, there was no regional context in which to assess results of studies at individual sites. This made it difficult, for example, to assess the regional significance of a CALM-managed reserve, or to assess the conservation significance of a site proposed for a resource development. It was time for a major survey across the whole region. The Pilbara Biological Survey commenced in 2003, to survey terrestrial plants and animals, wetland plants and animals (see 'Wetlands of the Pilbara' on pages 24-29) and stygofauna (see 'Beasts of the Underworld' on pages 51-55). It is likely to cost about $12 million, funded by the State government (primarily through CALM with assistance from the WA Museum), the Commonwealth government (through the Natural Heritage Trust) and industry, in particular Pilbara Iron, Dampier Salt and Straits Resources.

Major regional surveys already completed in other parts of WA include the Wheatbelt, eastern Goldfields, Nullarbor, Kimberley rainforests and southern Carnarvon Basin (see 'Patterns in nature', *LANDSCOPE*, Summer 1995–96).

In previous surveys of the Pilbara, the rocky nature of much of the ground limited pitfall trapping, due to difficulties in digging holes. This survey set out to sample all the major geological and landform surfaces, including the hard ironstones, granites and basalts.

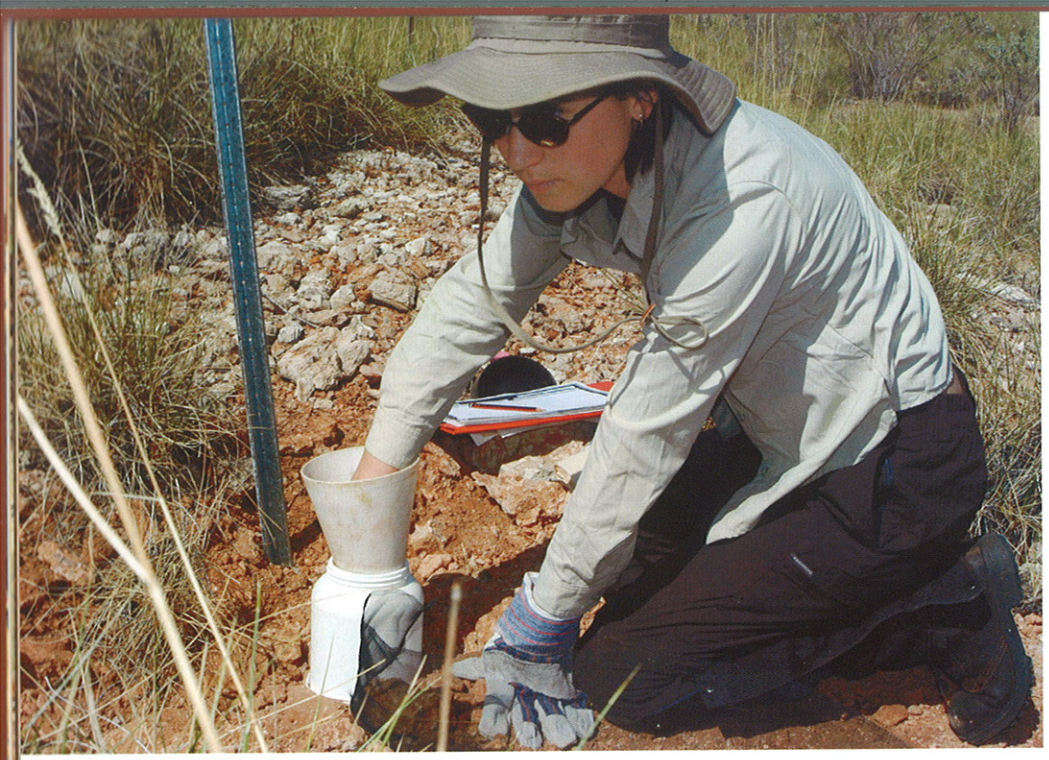
As well as uncovering new information about plants, reptiles, frogs, birds, mammals, spiders, scorpions, beetles and aquatic invertebrates, the survey will allow the development of a framework to guide sustainable land-use and conservation planning in the Pilbara; help to assess the region's conservation reserve system; improve environmental impact assessments; and verify information about distribution of threatened species and ecological communities.

On the ground

The sheer size of the Pilbara biogeographic region—19 million hectares—provides a huge challenge in establishing sampling sites, undertaking sampling and detecting biogeographic trends (the way plants and animals are distributed in relation to climatic, geological, historical and biotic characteristics of the landscape). Because of this, and the limited number of skilled staff available at any one time, the survey will take several years. The terrestrial component began in 2003 and aims to report by mid-2007.

Three hundred sampling sites across the Pilbara (map) were selected to represent the major geological formations and landform types, encompassing a cross-section of soils, climate and vegetation types. The sites are on pastoral leases, in national parks including Karijini and Millstream-Chichester (Miliyana), on recently-acquired pastoral leases, newly-created conservation parks, Aboriginal lands and unallocated Crown land. Many are on mining tenements and some are adjacent to active mining operations. Extra sites, including hilltops and other locations, are also being sampled for plants.

Establishing the pit traps took a team of five to six people, led by CALM Senior Technical Officer Jim Rolfe, about five months in mid-2003 and mid-2005, using shovels, crowbars, drills and, often, blasting the hard rock to create holes for pit traps. At each site, they installed two 50-metre rows of



five vertebrate pit traps, with a low wire fence between pits to guide animals in when the sampling teams opened the pits. Five invertebrate pit traps were also installed at each site.

The first 150 sites were sampled for small ground-dwelling frogs, reptiles and mammals in October 2004 and May 2005, and sampling of the second set of 150 sites began in September 2005. In each sampling period, four teams—usually consisting of three to four zoologists—each take responsibility for sampling 35 to 40 quadrats. Each quadrat is trapped for seven days and nights, in each of two seasons. Ground vertebrates are identified and released, or kept as voucher specimens for reference and further study at the WA Museum. Each site is surveyed for birds, and any breeding noted. Terrestrial invertebrates are trapped in pits at the same sites. Selected sites are surveyed for bats.

At each site, soil samples are collected to determine soil chemistry and structure, and records are made of other physical and biological features, such as landform and vegetation structure.

A project this big has to be a collaborative venture. So far, 40 people have been directly involved in fieldwork for the terrestrial zoology component of the project. Most are CALM staff or consultants, some are from the WA Museum, and eight have been volunteers. In addition, about a dozen experts from other institutions have helped to identify specimens, particularly invertebrates.

Frogs and reptiles

Nine frogs and more than 120 reptiles are known from the Pilbara. Lizards are exceptionally diverse, with more than 20 endemic species, a number likely to double when new species from the survey are formally described. One frog species is endemic to the Pilbara, with another awaiting description.

More than 100 species of reptiles have been recorded on the sites so far. A distinctive new gecko species was discovered in the first week of the survey in an area of the large rocky boulders that cap so many Pilbara ranges but which have seldom been sampled. We have also found two endemic species of pebble-mimicking dragons (*Tympanocryptis*) and several new species of sand-swimming skinks (*Lerista* and *Eremiascincus*). The survey has uncovered cryptic species using genetic techniques in several gecko groups, including *Diplodactylus* and *Gehyra*. It has also expanded the known distributions and clarified the habitat relationships of many species.

Mammals

Mammal bones from sinkholes and caves are being identified by Alex Baynes of the WA Museum, to document the Pilbara's original mammal fauna. At least 57 species were originally present, of which 11 are now extinct in the region—information that is important for reintroduction programs. Three others—the water rat, pale field-rat and western chestnut mouse—persist only on the region's islands. Most of the regionally extinct species are either small macropods, such as the boodie, or large rodents, such as the long-tailed hopping-mouse.

We have so far recorded 17 small mammal species in the Pilbara (excluding bats): nine carnivorous

Above left Clare Stevenson, from the WA Museum, checks a pit trap for small vertebrates.
Photo – Allan Burbidge

Left Botanist Greg Keighery records plants collected by Sue Patrick and Margaret Langley from a terrestrial biodiversity site on a red sand dune in the Cane River Conservation Park in the south-western Pilbara.
Photo – Stephen van Leeuwen

Above The long-tailed dunnart is an uncommon, patchily distributed species found in rocky areas with hummock grasses and shrubs.
Photo – Jiri Lochman

marsupials (dasyurids) and eight rodents (seven native species and the introduced house mouse). The western pebble-mound mouse (*Pseudomys chapmani*) is now largely restricted to the Pilbara. The first indication that a pebble-mound mouse may be in the area is a distinctive mound of small pebbles, which it gathers to form a nest.

Dasyurids include three species endemic to the Pilbara: the commonly caught Pilbara ningaui (*Ningaui timealeyi*), a false antechinus (*Pseudantechinus roryi*) and at least one undescribed planigale species. Ningauis and planigales can be confused, but their behaviour is a first clue: the ferocity of the planigales contrasts with the tranquillity of the ningaui. Another dasyurid, the little red kaluta (*Dasykaluta rosamondae*), resembles a little red bear and behaves like one as well. It is best to be attentive when handling one of these! Its distribution extends just beyond the Pilbara. The long-tailed dunnart (*Sminthopsis longicaudata*), a striking-looking animal, is rarely caught but perhaps its patchy distribution is to blame. Two false antechinus species (*Pseudantechinus roryi* and *P. woolleyae*) previously recorded in the Pilbara also appear scarce, but are able to jump—having adapted to massive rock outcrops—so can probably escape from pitfall traps.

The occurrence of these mammals appears to be related to characteristics of their local environment. Certain species prefer areas with a cracking clay surface: the Lakeland Downs mouse (*Leggadina lakedownensis*) and striped-face dunnart (*Sminthopsis macroura*) shelter in the deep cracks. Some, such as the common rock-rat (*Zyzomys argurus*), shelter in rocky outcrops. Others, like the ningaui, seem to turn up almost everywhere. Clues to the habitat preferences of some species come from their external anatomy. Rock-dwelling species either have striated footpads (long-tailed dunnart), or large, soft footpads (common rock-rat). In contrast, some species adapted to sandy surfaces, such as the lesser hairy-footed dunnart (*Sminthopsis youngsoni*), have hairy pads that act like running spikes. In the final analysis, we aim to further expose relationships between species occurrences and habitat attributes, including the influence of climate, then use this information to predict where else in the Pilbara these species may be present.

Bats are being surveyed at more than 50 sites, with 17 bat species known from the Pilbara. The two flying-foxes are by far the largest. The others are microbats, which use high frequency calls to avoid obstacles and locate prey during their night-time forays. These search-mode calls are species-specific and a call dictionary is being collected using minidisc recorders. Night vision equipment, a portable radar gun and a video camera are used to gather data on flight speed, manoeuvres and habitat use, the first ecological study of structure in the region's bat fauna.

We have found that Pilbara microbat communities fall into four ecological types: interceptors that catch their flying prey during a direct high-speed pass, such as the white-striped bat; agile species that can out-turn their prey in open habitats (common sheath-tailed bat) or in cluttered air-spaces (orange leaf-nosed bat); ambushers that wait on a perch then accelerate to overtake prey that flies past or pounce on prey that walks past (greater long-eared bat and ghost bat); and slow, but manoeuvrable, gleaners that take prey from vegetation or the ground (lesser long-eared bat and Arnhem Land long-eared bat). Not all of these occur at any one site. Some species are restricted to the region's mangrove communities, others live close to riverine situations, while one is only present in the region in winter.

Birds

The Pilbara is home to about 250 non-oceanic bird species, and is especially rich in birds adapted to arid areas. Pilbara birds don't seem to have as close a relationship to the ground surface as the mammals, but vegetation

Above The dangerously venomous Pilbara death adder.
Photo – Ron Johnstone

Left The painted finch feeds and breeds in rocky areas with spinifex.
Photo – Jiri Lochman

structure is important. For example, singing bushlarks are common on grassy plains on a range of soils. River systems, especially where there are river red gums and cadjeputs, have the greatest number of bird species—they are like elongated oases in a desert of rocks and spinifex. Some species, including peaceful doves, blue-winged kookaburras, black-tailed treecreepers, star finches and Torresian crows, are more or less confined to these areas. Others, such as spinifex pigeons and painted finches, are typically found among spinifex on rocky slopes, but come in to pools to drink. Still others, such as the spinifexbird and striated grasswren, are normally only found in dense, healthy stands of spinifex.

Creeping crawlies

It is already clear that many new species of terrestrial or aquatic invertebrates will be discovered as a result of the survey, and many species are likely to be confined to the Pilbara.

Twelve months of sampling invertebrates at the first 150 sites has produced about 100,000 individual specimens. These need to be sorted into major taxonomic groups in CALM's terrestrial invertebrate survey laboratory. Some of these groups, particularly beetles and spiders, are then identified with input from the WA Museum and other specialist organisations, such as the Australian National Insect Collection in Canberra. Other groups, such as wasps, are sent directly to specialists in other organisations.

Just sorting this material into major groups has taken about five person years, and we still need to identify the great majority of these animals to species level. A broad range of groups has been caught, including ants, land snails, millipedes, mites, centipedes, pseudoscorpions, mantids, grasshoppers, crickets and termites. These groups, by virtue of their general ground-dwelling habit and fairly low mobility and dispersal capabilities can show highly localised distribution and specific habitat preferences across the Pilbara.

Because the mammoth task of sorting and identifying specimens is not yet complete, we have not yet been able to analyse any data, but there are some interesting preliminary results. The native bee and wasp fauna is highly diverse, with many groups parasitising other insects, spiders and even other wasps! Families represented include bees, stinging wasps, spider

Above left A new species of wasp from Millstream-Chichester National Park.
Photo – Nicholas Stevens

Top An undescribed weevil species found during the biological survey.
Photo – Rolf Oberpreiler

Above Allan Burbidge checks a pit trap.
Photo – Allan Burbidge

wasps, mud-dauber wasps and magnificent metallic wasps.

More than 35 families are represented in the rich and diverse assemblage of beetles. So far, we have identified the weevils, ground beetles, pie dish beetles and dung beetles (more than 30 species in 12 genera). Several species of dung beetles previously considered rare or restricted in distribution have been found at several localities in large numbers. Many new forms of ground beetles, including charismatic tiger beetles, are turning up regularly. So far, we have identified six species of tiger beetles and at least 80 species of other ground beetles. Many are small and cryptic, with highly restricted ranges within the survey area. Some are only otherwise known from widely disparate localities in the Northern Territory or desert regions of north-east South Australia.

Bugs, slaters, cockroaches and scorpions are yet to be examined in detail, but seem to be diverse across the region if not particularly rich at any one site. Various species also appear to have restricted ranges.

We expect ground-dwelling spiders to comprise 20 to 25 families, with around 250 to 300 species, about half the richness of the Wheatbelt. Jumping spiders (Salticidae) and ant-eating spiders (Zodariidae) have dominated previous surveys, comprising around a third of all spider species recorded. The Pilbara survey is following the same pattern, with at least one of these two families being represented at every site, commonly by more than two species. Other common families include miturgids (large burrowing spiders), lamponids (which include the white-tailed spider), wolf spiders and oonopids (very small, orange spiders). Local endemism amongst spiders seems to be lower than in previous surveys, with around 15 to 20 per cent of species appearing to be restricted to a local area (compared to 30 per cent in the Wheatbelt). Most species seem to be widespread throughout the Pilbara but many of these are likely be endemic to the region.

Because there has been so little invertebrate collecting in the Pilbara in the past, large numbers of species across all of the groups examined cannot be easily identified, and most of them will be unknown to science. This makes the process very exciting but also especially time consuming. Many taxonomic issues need to be ironed out before this huge dataset can be analysed.

Next steps

The survey is also recording plants and vegetation communities of the Pilbara, but results from this extensive program are still some way off due to a rainless summer last year. Nevertheless, the botanical survey team has recorded numerous new populations of Priority flora and species new to the Pilbara and Western Australia, including at least one wattle from the east Pilbara. The team has also extended the known ranges of many other species.

Botanical and zoological sampling will continue until spring 2006. After this, there will be many hours of work sorting and identifying specimens, followed by analysing and interpreting data. By mid-2007, a diverse set of scientific publications will have been prepared, with work underway to further distil the enormous amount of information into a form that can be understood and used by anyone with responsibilities or an interest in land management in the Pilbara. For years to come, the information and specimens collected through the survey will provide researchers at CALM, the WA Museum, and other institutions around Australia with material to further investigate the taxonomy, systematics, ecology and biogeography of the Pilbara plants and animals.

Allan Burbidge, Norm McKenzie, Lesley Gibson, Nadine Guthrie, Brad Durrant and David Pearson are all zoologists based at CALM's Wildlife Research Centre, Woodvale. Stephen van Leeuwen is a CALM botanist based at Karratha. Paul Doughty is Curator of Herpetology at the WA Museum.