Meet the parasites

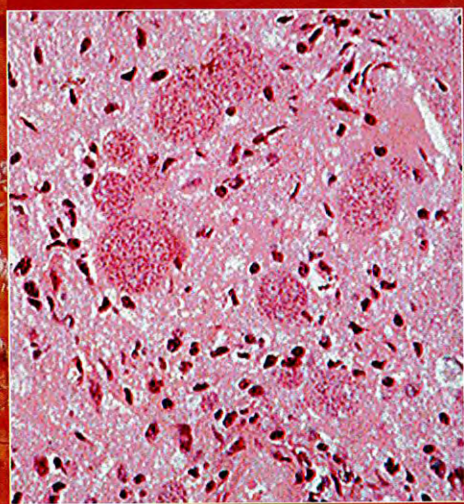
Scientists are shedding new light on the little-known world of the parasite and determining the impact these unseen creatures are having on our wildlife.

by Andrew Smith, Alan Lymbery and Andrew Thompson

In a world where fast responses and peak physical condition are prerequisites for a long and healthy life, factors that even marginally impact on the ability for fight or flight can have dramatic consequences. In this context, parasitic infections that cause illness in wildlife are as important to understand in terms of their impact on survival as those that result directly in high mortality rates. Indeed, anecdotal evidence and historical research have implicated parasites such as *Toxoplasma* and *Trypanosoma* species as causing die-offs in the past but this has never been fully investigated or quantified. Furthermore, other parasites, such as *Echinococcus* and *Leishmania* species, can threaten human health and present an economic threat to livestock production.

Overall, the diversity of parasites associated with native wildlife in Australia remains poorly understood, and is further complicated by the fact that non-native parasites, often introduced with non-native vertebrate hosts such as cats and dogs, can become established in native animals with unpredictable consequences. Most of what is known is based on information collected opportunistically from various sources and relates largely to the parasitic worms that are easily visible by examination of carcases and by using light microscopy techniques. It is now possible to employ non-invasive and technologically advanced techniques such as Polymerase Chain Reaction (PCR) and genetic analysis to identify parasites that cannot otherwise be detected.

Scientists are using these techniques to more fully understand the diversity and effect of parasites in native fauna, and to distinguish between native and exotic species. A collaborative venture between the Department of Environment and Conservation's (DEC's) Science Division and the Parasitology Group at Murdoch University, funded primarily by the Australian Research Council, has been established with the specific aim of surveying a range of wildlife species for the presence and diversity of parasitic infections.



Above Releasing a boodie on Faure Island in Shark Bay after taking samples to study for parasitic infections.
Photo – Andrew Smith

Inset *Toxoplasma* in the brain of a wallaby that died from the infection.
Photo – Murdoch University

Target species and locations

By using DEC's existing and extensive infrastructure for wildlife monitoring and translocations programs, it has been possible to obtain samples from an otherwise unattainable diversity of wildlife species, including the woylie (*Bettongia penicillata*), boodie (*Bettongia lesueur*), chuditch (*Dasyurus geoffroii*), brushtail possum (*Trichosurus vulpecula*), golden bandicoot (*Isoodon auratus*), western barred bandicoot (*Perameles bougainville*), bilby (*Macrotis lagotis*), banded hare-wallaby (*Lagostrophus fasciatus*), water rat (*Hydromys chrysogaster*), spectacled hare-wallaby (*Lagorchestes conspicillatus*), western chestnut mouse (*Pseudomys nanus*), rock wallaby (*Petrogale lateralis*), spinifex hopping mouse (*Notomys alexis*), *Planigale* sp; Shark Bay mouse (*Pseudomys fieldi*), bush rat (*Rattus fuscipes*), ash grey mouse (*Pseudomys albocinereus*), dibbler (*Parantechinus apicalis*) and quenda (*Isoodon obesulus*). Furthermore, some species occur across different environmental gradients, such as both offshore islands and temperate mainland sites, which make it possible to look for variations in parasite prevalence and species composition that may be attributable to climatic effects or the make-up of sympatric, or mixed, communities. So far, blood and scat samples have been collected from animals in Fitzgerald River National Park, the Upper Warren Region east of Manjimup, Lake Magenta Nature Reserve, Julimar Conservation Park, Francois Peron National Park and Boyagin Nature Reserve. Samples have also been obtained from Faure Island and Karakamia Wildlife Sanctuary, though a collaboration with the Australian Wildlife Conservancy, (AWC) as well as from Barrow Island Nature Reserve, and Thistle Island in South Australia, though networking with the South Australian Department of Environment and Heritage.

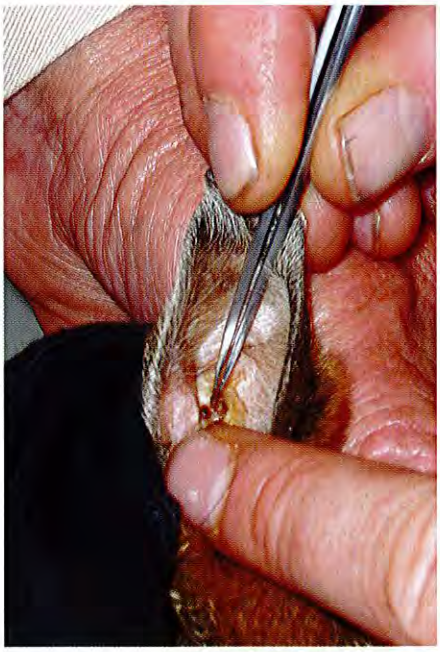
Above Animals from Fitzgerald River National Park have been tested for parasite infection.
Photo – Andrew Smith

Left Checking a bandicoot for ectoparasites on Barrow Island.
Photo – Andrew Thompson

Below left Collecting scat samples in the field.
Photo – Andrew Smith

Rangelands translocations

One of the key components of the project is DEC's translocation of several native species to Lorna Glen as part of the Rangelands Restoration Project (see 'Into the wild: restoring rangelands fauna' on page 52). The Lorna Glen project work aims to restore native mammal diversity and vegetation conditions on an ex-pastoral lease approximately 160 kilometres north-east of Wiluna in the arid zone. Before the first translocation, DEC scientist Dave Algar and technical officer Mike Onus worked intensively to reduce the prevalence of feral cats in the region to a predetermined density considered low enough to allow animals to become established. To date, the project has resulted in the translocation of brushtail possums (*Trichosurus vulpecula*), bilbies (*Macrotis lagotis*) and mala (*Lagorchestes hirstus*), and the implementation of cat control measures, which have reduced the number of cats to less than five per 100 kilometres of transect surveys. Although the mala translocation has



Above Collecting ectoparasites from a spectacled hare-wallaby.
Photo – Andrew Smith

Above right Spectacled hare-wallaby.
Photo – Jiri Lochman

Right and far right Newly discovered tick species.
Photos – Halina Burmej

not been successful due to predation by feral cats and native predators, brushtail possums and bilbies continue to do well. On a monitoring trip in December 2008, DEC technical officer Judy Dunlop reported several previously unrecorded bilbies—bilbies that had either been brought to Lorna Glen as pouch young, or had been conceived and raised at Lorna Glen. All the trapped female bilbies had large pouch young indicating successful post-translocation recruitment. In addition, brushtail possums have been breeding well and have established in the woodland areas along the wetlands and creek lines. The parasite project has resulted in samples being taken from bilbies and possums both pre- and post-translocation as well as at regular follow-up intervals. This helps determine whether the probability of survival and reproductive success is influenced by any parasitic infection in individuals before translocation, as well as whether there is any significant pattern in parasite acquisition following translocation to a new environment.

The parasites

The field sites that are visited were chosen specifically to give a broad geographical representation as well as the opportunity to sample species from different habitats. When in the field, blood and scat samples are collected by Murdoch scientists or graduate students who accompany DEC staff on their trapping rounds. Blood samples are usually collected from the lateral caudal vein that runs alongside the base of the tail on larger macropods such as the boodie and woylie, whereas the marginal ear vein is used on most other species.

Only a small amount of blood is needed as all haemoparasite work is conducted using PCR-based methods in the laboratories at Murdoch. Animal ethics approval has been obtained for these procedures. The scat samples are collected into two separate vials, one containing 10 per cent formalin solution and the other a 70 per cent alcohol solution. The former samples are investigated by light microscopy, whereas the latter samples are suitable for genetic analysis when information on species and strain type is required. The sampling techniques employed here are favoured for their minimal impact on the animals' well-being, and for the vast amount of information that can be generated from such small samples. The usual range of animal statistics are also recorded including age, gender, reproductive status and body condition, with the intention of later analysing the data in conjunction with infection status.

Considerable effort has been put into collecting ectoparasites (fleas, ticks, mites and lice) from as many different hosts and locations as possible as it is thought that they may hold the key to the transmission of other parasites, including the trypanosomes (blood parasites). In addition, very little is known of the diversity of ectoparasites in their own right, with a noticeable lack of relevant or up-to-date information in scientific literature. To address this, doctoral student

Left Western barred bandicoot.
Photo – Jiri Lochman

Below left Possum under anesthetic while testing for parasites.
Photo – Andrew Smith

Halina Burmej has been collecting and cataloguing 'ectos' and is developing a valuable resource from which existing data, such as host-parasite associations and geographical distribution, can be updated. In addition, Halina is describing a new tick species found on a woylie and establishing a series of protocols for investigating micro-parasites and other pathogens directly associated with ectoparasites.

Parasite types

The project has investigated several parasites so far. The trypanosomes have been of particular interest as several species are known to be pathogenic in humans and animals, particularly when a parasite encounters a new host. An interesting example is that from Christmas Island, where, about 100 years ago, an introduced trypanosome species (*Trypanosoma lewisi*) was implicated in the extinction of a native rat (*Rattus macleari*). The exotic trypanosome was introduced onto the island by ship rats (*R. rattus*) and their fleas when they escaped from cargo ships arriving from Europe.

Trypanosomes, which are small extra-cellular protozoans, are responsible for various human diseases such as sleeping sickness and Chagas disease, and Surra in cattle. A major concern regarding trypanosomes in Australia is the introduction of an exotic species that becomes established in native wildlife with potentially devastating results.

Toxoplasma gondii is a parasite most commonly associated with cats. It is relatively widespread and is believed to affect animals in a variety of ways, for example, by making infected rats more susceptible to predation by reducing caution or increasing inquisitiveness, thus perpetuating the parasite's life cycle. Due to its association with cats, it has traditionally been thought of as having been introduced into Australia by humans who brought infected cats with them as pets. However, work by doctoral students Nevi Parmeswaran and Shuting Pan is beginning to question this assumption as genetic analysis of samples obtained by this project suggest that, among the known strains that occur worldwide, there appear to be unique strains circulating within Australian wildlife.

The work is still at the preliminary stage and it is too early to say for certain whether the Australian strain, or genotype, pre-dates the arrival of humans and cats, but the work is certain to shed light on trypanosome in Australia as we know it.

Our native wildlife also harbour a diversity of enteric protozoan parasites including *Eimeria*, *Giardia*, *Cryptosporidium* and *Blastocystis*. Some of these, such as *Giardia*, are well known parasites in humans and domestic animals and cause a variety of gastrointestinal disorders as well as impacting on production. The use of molecular tools has allowed scientists to discover that native mammals may be infected with human and domestic animal strains of these parasites as well as their own novel strains. But we have yet to determine the pathogenic significance of these parasites in wildlife, and the role of wildlife as potential reservoirs of human pathogens.

Parasites and threatened species

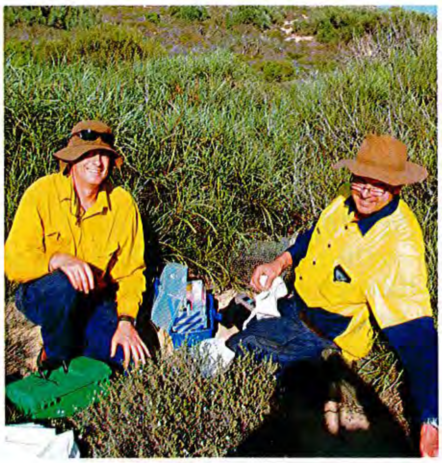
Early in the collaboration between DEC and Murdoch University, an investigation was carried out into blood parasites of the woylie to ascertain whether or not there was a causal link between infection and the observed rapid decline in woylie numbers in the Upper Warren Region (see 'Down but not out: solving the mystery of the woylie population crash', *LANDSCOPE*, Winter 2008). A novel *Trypanosoma* species was found, and genetic analysis suggested that it was most likely to have been associated with the woylie for a long time, or was at least more similar to other trypanosomes from Australian animals than trypanosomes from other parts of the world. Furthermore, two additional factors of interest soon emerged: firstly the prevalence of trypanosome infection, or the number of animals within the population that were infected, was much higher in the Upper Warren Region where the woylie was in serious decline in comparison to a stable woylie population within the AWC-managed Karakamia Sanctuary near Perth. Secondly *Toxoplasma gondii* was also present within the Upper Warren Region and completely absent from the Karakamia population. However, correlation does not imply causation, and much work needs to be done to understand the decline of the woylie. However, the presence of the two parasites together warrants further investigation and indicates the importance of establishing baseline health data for threatened species.

Lessons learned and future work

Overall, the project offers the opportunity to gain new information on animal parasites and a better understanding, through extrapolation, of which parasites may pose a threat in the future. For example, the recent discovery of a novel form of *Leishmania* in kangaroos suggests that there is a competent sandfly vector capable of transmitting the parasite within Australia, and that kangaroos and the as yet unidentified vector may act as a reservoir should the human form of *Leishmania* inadvertently be introduced into the country. There are lessons to be learned, and protecting Australia from the introduction of parasites that can readily become established is critical. The introduction into Australia of the tapeworm parasite *Echinococcus granulosus* in sheep during the 1700s has resulted in its establishment within a dingo-macropod cycle, where it has serious negative impacts on the fitness of several wildlife species and causes a potentially fatal disease (hydatid disease) in humans. Vigilance is paramount in matters of biosecurity, as is an understanding of natural host–parasite associations. The more extensive our knowledge, the better prepared we are to make decisions regarding novel parasites and the risks posed to animals involved in captive breeding and translocation programs throughout the State.

Right Water rats have undergone testing for parasites.
Photo – Jiri Lochman

Below Working in the field.
Photo – Andrew Smith



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