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* Dr Richard Major, Australian Museum

Herbivory in urban remnant forests.

Robert Blackburn. *Supervisor:* Dr D Hochuli
School of Biological Sciences, University of Sydney, NSW 2006

As cities grow, they tend to isolate patches of forest leading to biodiversity loss and ecosystem degradation. These fragmented forest patches risk ecological meltdown as they become more susceptible to invasive species, exhibit higher levels of herbivore damage, suffer changes in nutrient cycling, and are released from predatory regulation of herbivores. I used a multi-scale, multi-species survey-based approach to assess herbivory, plant traits, arthropod population composition and predator/herbivore ratios in urban landscapes. In 10 sites along an urban-rural gradient, I found *Angopohora costata*, *Acacia longifolia* and *Banksia serrata* to suffer variable levels of herbivory in different urban contexts. All three species have exhibited different levels of herbivory (*B. serrata* has the least and *A. longifolia* the most), and smaller urban sites (less than 20ha) generally experienced higher rates of herbivory than larger urban sites (greater than 20ha) and larger, continuous reference sites found in National parks.

Every worker for herself: selfish versus altruistic behaviour in a natural hybrid zone.

Michel Holmes. *Supervisors:* A/Professor M Beekman & Professor B Oldroyd
School of Biological Sciences, University of Sydney, NSW 2006

My aim was to understand the mechanisms that keep two subspecies of honeybee, *Apis mellifera capensis* (the Cape bee) and *A. m. scutellata* (the African bee) separate in South Africa. The Cape bee is confined to the southern part of the Western and Eastern Cape, whereas the African bee occurs in the rest of South Africa and the countries to its North. Both subspecies meet and interbreed in a natural hybrid zone. Previous work has suggested that the honeybee hybrid zone is a tension zone in which natural hybrids (products of queens mated with males from both subspecies) have lower fitness than their parental subspecies, thereby ensuring that both subspecies remain separate.

The Cape bee is unique among all *A. mellifera* subspecies, because its workers are capable of thelytoky, the parthenogenetic production of diploid females. The ability to lay female brood without mating has selected for competitiveness among workers for reproductive opportunities. Such competitiveness is absent in the African bee and my prediction therefore was that mixed colonies would suffer from a breakdown in reproductive division of labour ultimately resulting in colony collapse. This reduction in colony-level fitness may be the mechanism that maintains the hybrid zone.

I created mixed colonies by artificially inseminating queens of both subspecies with equal amounts of sperm of both subspecies. I first wanted to determine if sperm of one subspecies would have an advantage over sperm of the other subspecies. I therefore sampled pre-emergent workers from each colony for three months and genotyped them. I further studied the effect of rearing environment on a worker's ability to become reproductively active by transplanting inseminated queens from *scutellata* to *capensis* hives after the first month's brood had been read. Workers raised in these different rearing environments were dissected to check for ovary activation as a measure of reproductive potential, and genotyped to determine their subspecies.

In a final experiment I determined to what extent *capensis* workers choose to produce new queens themselves, or if they prefer the queen's offspring (caste determination in honeybees is environmental rather than genetic, so all diploid brood can be reared as queens). If *capensis* workers prefer their own offspring over the queen's offspring during queen rearing, then in mixed colonies new queens will always be *capensis*, thus changing the colony's composition from mixed to pure *capensis*. The implications of these factors for the maintenance of the hybrid zone will be discussed.

The Indian Myna: Competitive interactions with native birds in the urban environment.

Katharine Lowe. *Supervisors:* Drs C Taylor & R Major*
School of Biological Sciences, University of Sydney, NSW 2006

Urbanisation and introduced species are among the greatest threats to global biodiversity in the modern era. As human development degrades and alters natural habitat it can create an environment favourable to exotic species, which may enhance negative effects on native species that persist within the urban matrix.

The introduced Indian Myna (*Acridotheres tristis*) is commonly believed, due to anecdotal reports in the media, to have a substantial impact on native species through competition and aggressive behaviour. However, the paucity of scientific evidence on the issue leaves us unable to draw accurate conclusions nor devise appropriate management strategies.

I aimed to investigate hypotheses that the Indian Myna aggressively displaces native birds and out-competes them at food and nest resources, and to establish important baseline data on how the Indian Myna uses the urban environment and relates to other species.

First, I determined the frequency and nature of interactions between all species present in a range of urban habitats. The Indian Myna was not the most aggressive species, responsible for less than 8% of interspecific aggressive encounters; not significantly different from the expected level when compared to all other species.

Second, I assessed the species occupancy of natural tree hollows, and surveyed nest site selection by Indian Mynas. Assuming equal competitive ability between all species, Indian Mynas claimed significantly fewer tree hollows than expected. Where there was a choice between habitat types, Indian Mynas nested in the more highly modified environment, and in artificial structures rather than in vegetation.

Finally, I observed Indian Myna interactions during foraging of two target native competitors (Magpie Lark and Willie Wagtail). Despite regularly sharing feeding grounds, and foraging in close proximity, the Indian Myna did not significantly interfere with feeding activities.

The results suggest that in the specific area chosen Indian Mynas are not nearly as aggressive as presumed, and have little or no impact on resource use by native bird species in the urban matrix. Further research over wider geographical and temporal scales, including Indian Myna removal experiments, is necessary to support these conclusions.

- Dr Richard Major, Australian Museum

Teaching Northern Quolls (*Dasyurus hallucatus*) to avoid cane toads improves survival in a toad colonised world

Stephanie O'Donnell. Supervisors: Professor R Shine & Dr J Webb
School of Biological Sciences, University of Sydney, NSW 2006

In a world desperate for novel approaches to reduce the detrimental impacts of invasive species on native ecosystems, it is surprising that any method that could solve this conservation crisis would be overlooked. However, conditioned taste aversion (CTA) is one such tool that has been given little attention in recent literature. CTA occurs when an animal associates the taste of a particular food with the feeling of illness experienced after ingestion, after which the individual will avoid eating food with that taste again. This process can be exploited for wildlife management because it is possible to deliberately induce CTA in individuals by offering food treated with an undetectable illness-inducing chemical, such as Thiabendazole. Although CTA has been used to control predation, the method has never been used to protect native predators from a toxic invasive species. The highly toxic cane toad, *Bufo marinus*, has devastated populations of native predators including the northern quoll, *Dasyurus hallucatus*. These predators readily eat cane toads but have no defence against their toxins (reflecting a lack of exposure to toad toxins over evolutionary time) so will usually die when they attack and eat large toads. CTA could be used to teach quolls and other predators to avoid cane toads, thereby enhancing the probability of predator survival as the toad continues its invasion across northern Australia. My project explored the potential of CTA as a tool to conserve quolls by first determining whether it was possible to teach quolls to avoid cane toads as prey, then comparing the survival of trained and untrained individuals after reintroduction into a toad colonised environment. CTA proved to be an effective way of increasing quoll survival. Training made quolls more likely to reject a live toad in a controlled situation. Training and sex both influenced survival rates after release. The next step must be to determine an effective dose rate to maximise the longevity of the aversion. The final step will be baiting trials in wild populations of native predators in areas where cane toads are soon to invade.

Molecular ecological methods for studying herbivore diets: Multiplex microsphere arrays and flow cytometry

Tamara Pulpitel. *Supervisors:* Dr G Sword & Professor S Simpson
School of Biological Sciences, University of Sydney, NSW 2006

Dietary analysis is fundamental in attempting to understand processes common to all animals. Knowledge of individual diet patterns commonly provides insight into community structure, life history and trophic level interactions. Traditional approaches to diet identification have included direct observation, microscopic classification of gut or faecal material and stable isotope analysis. Whilst effective, the precision of these methods is often lost particularly when trying to identify a blend of food items consumed by dietary generalists. This project attempted to develop a DNA –based molecular technique in which diagnostic oligonucleotides were designed to screen DNA from unknown faecal samples. With novel technologies such as multiplex microsphere arrays and flow cytometry we may soon have a non-invasive and efficient means of accurately identifying complex diet mixtures at our disposal.

‘Success and susceptibility’: Predator-prey interactions between the native jade perch, *Scortum barcoo*, and the invasive mosquitofish, *Gambusia holbrooki*.

Amelia Reid. *Supervisors:* Dr A Ward & A/Professor F Seebacher
School of Biological Sciences, University of Sydney, NSW 2006

Predation has significant impacts on evolutionary and ecological processes. It has created an evolutionary ‘arms-race’ between predator and prey animals and is a key feature governing ecological communities by influencing prey densities and dynamics. Predation can have direct effects on prey species through consumption, and indirect effects through the costs of employing antipredator strategies. Determining what factors influence the effect of predation can lead to a greater understanding of how predation impacts upon evolutionary and ecological processes. My project aims to examine the predator-prey interaction between *Scortum barcoo* (jade perch) and *Gambusia holbrooki* by determining how experience and hunting strategies of predators and the behaviour, swimming capacity and shoaling composition of prey, influence predator capture success and prey susceptibility to predation. To determine if experience with prey improves predator hunting efficiency, jade perch were fed a diet of either live *Gambusia* (‘experienced’), freshly-killed *Gambusia* or cichlid pellets (‘naïve’ groups). ‘Experienced’ perch caught significantly more *Gambusia* than ‘naïve’ perch. There was no significant difference in the amount of capture attempts made by perch between treatments, suggesting that experience with live prey increases hunting efficiency, but does not affect the motivation of perch or their ability to recognise prey. Persistence, that is, more attacks made per minute, increased the capture success rate of *Gambusia* by perch. There was no significant difference in the number of either unsuccessful or successful attacks made by perch when they hunted alone, in a pair or in a group of three. To examine if behavioural phenotype influences susceptibility to predation, an assay measuring a *Gambusia*’s tendency to explore a new environment was performed. Individuals that explored more were not significantly more susceptible to predation than individuals that explore less. To examine if flight response influences susceptibility to predation, the sustained swimming speed (U_{crit}) and fast-start response of *Gambusia* were quantified. The slower a *Gambusia*’s fast-start response, the more susceptible it was to predation. No significant relationship was found between sustained swimming speed and susceptibility to predation. My project illustrates that predator experience, persistence in hunting and prey fast-start response influence predator capture success and prey susceptibility to predation.

The thermal ecology of flat rock spiders (*Hemicloea major*)

Francesca van den Berg. *Supervisors:* Dr D Hochuli & Professor M Thompson
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Temperature is one of the fundamental drivers of ectotherm physiology and behaviour. The temperatures that are experienced can therefore affect an ectotherm's ability to capture prey, escape from prey and assimilate and use energy. I investigated the thermal biology and physiological consequences of seasonal acclimation of *Hemicloea major* in the laboratory and relate these to field microhabitat observations.

I acclimated *H. major* spiders to spring and summer thermal regimes and then tested their ability to capture prey at different temperatures. Spiders showed an increased latency to strike and prey capture success at 30degrees. I used a non-linear thermal gradient to determine their mean selected temperatures. My results show that spiders disproportionately select temperatures around 30-35°C. Summer acclimated spiders selected higher mean temperatures than spring acclimated spiders. No spider was found to have a temperature above 45 degrees. I determined the critical thermal maximum spiders from the field to be 48.5 degrees.

My study shows that temperature is an important factor in the ecology of *H. major*. *H. major* can acclimate to spring and summer thermal regimes which affects their selected temperature and ability to capture prey at different temperatures. This is important as it allows them to show high site occupancy to particular rocks even though the thermal profiles of these rocks change seasonally.