Zoology Honours 2009: Research Projects

Below are a number of research projects suggested by Animal Biology staff members. This is not the definitive list, and students are encouraged to approach appropriate academic staff within the School of Animal Biology if they have ideas for a research project, or if they want to discuss the possibility of a project within a particular subject area. Staff interests and contact links can be found on the web site [http://www.animals.uwa.edu.au/home/research]. Interested students should contact the Zoology Hons Coordinator [lsimmons@cyllene.uwa.edu.au] for more details.

Conservation genetics: measuring genetic mixing in a translocated population of marine snail

Jason Kennington & Mike Johnson [contact wjk@cyllene.uwa.edu.au]

Translocation is a management tool that is often used to combat the loss of genetic diversity within small and fragmented populations of rare species (Allendorf & Luikart 2006; Frankham et al. 2002). It involves the movement of individuals between populations with the aim of increasing genetic variation within populations by artificially enhancing gene flow (Storfer 1999; Frankham et al. 2002). In support of this concept, several studies have shown that genetic diversity within small and inbred populations can be restored by natural migration and intentional translocation programs (see Frankham 2005). However, relatively few studies have undertaken post-release monitoring of translocated populations to see if the variation introduced by translocation is maintained over many generations. The aim of this project is to examine the extent of genetic mixing in artificial hybrid populations of the intertidal snail Bembicium vittatum, established in 1993 (Parsons 1997). The populations were begun with adults from three widely disjunct sites in Western Australia, the Abrolhos Islands, Penguin Island (500 km south), and Albany (a further 400 km south and east). More than 14 years (8-9 generations) since its inception, the hybrid populations are still extant, providing a chance to study the extent of genetic mixing and the characteristics of recombinant hybrids under field conditions.

The project will carry on from an earlier study using allozymes which suggest the variation introduced by translocation is being maintained and used to adapt to local conditions (Binks et al. 2007), but will involve a much higher density of molecular markers (microsatellites), thereby providing a much better understanding of the extent of genetic mixing and maintenance of variation across the entire genome. A potential added dimension to the project would be to test for associations between molecular markers and ecologically important traits such as growth rate and shell shape which show heritable variation.
differences between the source populations (Parsons 1997). These data will be useful in assessing the impact of selection on genetic variation and for future mapping of these traits. The project will involve a substantial laboratory component and would suit a student with interests in genetics and conservation biology. Extra funding for the project will be provided by an ARC discovery grant held by Jason Kennington and Mike Johnson.

**Background reading**


**Dr. Paco Garcia-Gonzalez (contact pgarcia@cyllene.uwa.edu.au)**

Several projects are available to work on sexual selection and the evolution of polyandry using insects as model systems. Projects may focus on the following aspects:

- Sexual conflict and variation in mating frequencies in natural populations.
- Material and genetic benefits of female multiple mating.
- Maternal effects and paternal effects on offspring phenotype and their consequences for the evolution of female multiple mating.
- Male and female effects on fertilization and paternity success.

For an example see below proposed project on sexual conflict.

**Sexual conflict in *Drosophila melanogaster***

The asymmetry in parental investment between the sexes can lead to females being dragged away from their optimal mating frequency by “manipulative” males. Under this scenario, the conflicting interests between males and females in regard to reproduction may facilitate the evolution of traits that increase the reproductive success of members of one sex at a cost to members of the opposite sex (Arnqvist and Rowe 2005). It has been suggested that sexual conflict promotes sexually antagonistic (rather than mutualistic) coevolution; manipulative reproductive strategies in one sex are countered by the evolution of resistance to such strategies in the other sex (Holland and Rice 1998;
The theory of sexually antagonistic coevolution has been advanced significantly by studies of *Drosophila melanogaster*, where males modify female behaviour and physiology to their own interest (Chapman et al. 1995). The interaction between the sexes in this species results in a decrease in female remating frequency, lifespan, and lifetime progeny production, resulting from the harmful effects of seminal products transferred during copulation (Wolfner 1997). This project will examine the role played by population density in the evolution of sexual conflict in *D. melanogaster*. In addition, it will investigate the consequences of sexual conflict arisen by differences in population densities upon male reproductive success and population fitness.


**Sexual Selection and the behaviour of freshwater fishes**

**Dr Jon Evans**

A number of Honours projects are available. These will focus on sexual selection and the behaviour of freshwater fishes, including guppies (*Poecilia reticulata*), swordtails (*Xiphophorus helleri*) and Australian rainbowfishes. Topics include (but are not necessarily limited to) the following subject areas:

- Mate choice and mating competition
- Sperm competition and cryptic female choice
- The function and evolution of male genitalia

Please contact me to discuss these or related topics for your Honours project

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**Marine Ecology**

**Dr Robert Black [contact rblack@cyllene.uwa.edu.au]**

1. **Changes in shape in littorine snails**

Chapman's (1994, 1995, 1997) papers on size and shape in littorine snails raise questions about 1) how to measure shape in snails, 2) whether shape changes ontogenetically, 3) whether shape is a plastic character, and 4) how selection influences shape in populations of snails. Unfortunately, these papers do much to confuse these issues. First, Chapman uses a ratio (shell length:aperture length) as a measure of shape without proper concern about the fact that the ratio changes with the shell length. There are plenty of papers dealing with this issue Sundberg (1988) provided an acute commentary on the misuse of ratios (and see Goodin and Johnson (1992) for situations when ratios can be useful); Clarke and Grahame (1999) provide an example of a careful analysis of shape in a littorinid; McQuaid (1996, pp. 239-
242) summarised much of the controversy about shape in littorinids. Second, although Chapman recognised (p. 527) the contribution of differential loss of snails in her 1997 experiment 1 would have on the changes in shape, she seemed to ignore how this process (differential loss of snails according to their shape) (p. 524) could influence her results in experiment 2, where she attributed changes in shape to differences in rate of growth and the influence that has on shape of the snail. Nevertheless, Chapman does recognise the usefulness of her type of experiment in sorting out the mechanisms determining shape and changes in shape in these snails.

The aim of this project is to repeat Chapman's (1997) experiment 2, using local populations of *Nodilittorina unifasciata*, but with adequate protocols to ensure that the contribution of i) selective losses, ii) ontogenetic changes in shape, and iii) plastic changes in shape are differentiated and quantified. Some of the steps in this process would be: 1) analysing the literature about measurement of shape in gastropods in order to find an appropriate way to describe shape and how it might change when snails grow larger, 2) discovering local populations of *Nodilittorina unifasciata* that differ in shape, 3) performing reciprocal transplant experiments using snails from populations with different shape, and manipulating density of snails in order to produce treatments of snails growing at different rates.

**Suggested reading**


2. Exploitation competition between grazers: the details of mechanisms

The pattern of distribution and abundance of the limpets *Siphonaria kurracheensis* and *Collisella onychitis*, described as an intrusive niche on a steep resource gradient (Black 1979), when it is coupled with the experimental investigation of the mechanism involved (Hugo 1985, Black *et al.* 1988) and studies on other similar systems (Schmitt 1985), is one of the very few examples from open marine populations that can be interpreted as having potential for competitive exclusion.

*Siphonaria kurracheensis* (lower left), vacated home-scar (lower middle) *Collisella onychitis* (upper right)

A recent paper by Schmitt (1996) suggests that an area extensive (moves faster) - intensive (digs deeper) trade-off is a common feature of benthic grazer systems, and explains why the particular form of the functions relating 1) equilibrium density of microalgae and density of grazers, 2) growth of grazers and productivity of food, and 3) growth of grazers and density of grazers (his Figures 5, 6, and 7) reveal why the species he studied can coexist. Since all these curves describing the performance of the two species cross, one species has an advantage over the other at low densities or low production of food, but is at a relative disadvantage at higher densities. Schmitt's predictions (pers. comm) for *S. kurracheensis* (moves faster) and *C. onychitis* (digs deeper) are that the forms of the three functions for the two species will not cross over, but that *C. onychitis* will have an advantage over all densities and all food production levels.

The aim of this project is to repeat the kinds of experiments conducted by Schmitt (1996), but using the two species of limpets studied by Black and Hugo, to determine the shape of the three functions listed above. There are features of the experiments which may be improved. Chief among these is to devise a method of measuring primary production of the microalgae directly, in addition to using the standing stock of microalgae as a proxy for production as Schmitt did. The outcome of this study will help determine whether Schmitt's ideas about trade-offs are general and will therefore contribute to our abilities to make predictions about benthic grazing systems.

**Suggested reading**


3. Phenotypic plasticity

The length of feeding legs of barnacles is inversely related to water flow (Arsenault et al. 2001), up to a limit (Li and Denny 2004), exists in two orders of thoracican barnacles and two superfamilies of acorn barnacles (Marchinko and Palmer 2003), and is an environmentally-induced plastic response in both juveniles and adults that can occur after two mouls (Marchinko 2003).

*Balanus amphitrite* or *Balanus variegatus*

The aims of this project are to confirm 1) that local species of barnacles display these phenotypic differences in regimes of differing water flow, 2) that the response is plastic as revealed by transplant experiment, and 3) to test the proposed functional significance of longer legs in calmer water by conducting feeding experiments. *Balanus amphitrite* and *Balanus variegatus* are common in the Swan River Estuary and grow quickly and are amenable to experimental manipulations (Ahmat et al. 1993). *Austromegabalanus nigrescens* occurs in some numbers on some exposed edges of rocky platforms at Rottnest Island (Jones 1993).

*Suggested reading: [photocopies or pdf files of these citations are available from R. Black]*


4. Functional significance of molluscan pedal mucus

Snails go barefoot, but they lubricate their path with mucus secreted from their foot at a substantial metabolic cost (Denny 1980). For marine gastropods there have been many suggested functions of the mucus, both for the snail that produced it (e.g., nutrition, trail-following [Davies and Beckwith 1999]), and for other components of the community (e.g., aid to settlement of other organisms [Holmes 2002, 2005; Holmes et al. 2002]). This project could determine the nature and extent of pedal mucus secreted by common, high intertidal gastropods on local rocky shore (e.g., *Nodilittorina unifasciata*, *Nodilittorina australis* (littorines), *Notoacmaea onychitis* (true limpet), *Siphonaria kurracheensis* (pulmonate limpet)), and experimentally test whether the mucus functions as suggested in the literature.

*Collisella onychhitis* (left) after having moved off its home scar (right).

**Suggested reading:** [photocopies or pdf files of citations marked with * available from R. Black]


*Davies, M.S. and Beckwith, P. 1999. Role of mucus trails and trail-following in the behaviour and nutrition of the periwinkle *Littorina littorea*. Marine Ecology Progress Series 179: 247-257.


**Sex and Reproduction**

Prof Leigh Simmons [contact lsimmons@cyllene.uwa.edu.au]

There are a number of projects available in my lab that focus on female reproductive behaviour, the evolution of secondary sexual traits in males, and on sperm competition. Below I outline just two potential projects. Interested students should contact me for details of further projects.
1. Do females have an optimal mating frequency?

Females of many species mate more than once, and with more than a single male, despite the fact that a single mating can provide them sufficient sperm to fertilise their ova. A number of adaptive explanations have been offered to explain polyandry, explanations that invoke immediate benefits to females (e.g. obtaining resources or avoidance of infertile males; for a complete review see (Thornhill & Alcock 1983). Recently it has been suggested that females can gain indirect benefits from mating with more than one male. For example, in European Adders, multiple mating by females reduces the risk of still born young (Madsen et al. 1992), while in sierra dome spiders, multiple mating increases offspring growth (Watson, 1998). Such benefits are best explained by some form of post mating filtering of males and with the existence of genetic incompatibility (Zeh & Zeh 1996; Zeh 1997; Zeh & Zeh 1997). That is, despite outward appearances, not all males in a population are genetically compatible as mates. With no obvious phenotypic cue to mate compatibility, promiscuity may allow females to ensure that their ova are fertilised by sperm carrying compatible genomes.

Multiple mating can also be costly, exposing females to increased risk of predation, disease, and harm from males. Thus, it has been proposed that females may trade the costs and benefits associated with multiple mating, generating an evolved mating frequency that is optimal for female fitness (Arnqvist & Nilsson 2000).

This project is part of a research program examining post mating sexual selection in the Australian Field Cricket, *Teleogryllus oceanicus*. See papers available from www.lwsimmons.org/publications. The work will involve an examination of the fitness consequences for females who copulate with a varying number of males to determine if there is an optimal frequency that maximises fitness. It will also examine female preferences for novel males, to determine if females have an evolved mechanism to ensure mating with multiple partners.

2. Can sexual selection remove deleterious mutations

An enduring problem in sexual selection theory concerns the maintenance of genetic variation for fitness, the so called lek paradox. Theory proposes that fitness variation is maintained predominantly by random mutations in the genome that have negative effects on an organism's viability and reproduction. Male sexual traits often reflect general body condition, which in turn can be negatively impacted by random deleterious mutations. Thus, by choosing males in good condition, females can avoid passing deleterious mutations to offspring, thereby increasing their own fitness. Moreover, by purging deleterious mutations from the population, sexual selection can compensate for the two-fold cost of sexual reproduction. While attractive, this theory has rarely been tested empirically. This project will use our laboratory model, the dung beetle *Onthophagus taurus* to test the notion that sexual selection can remove deleterious mutations and thereby provide indirect genetic benefits to females. The project will involve the experimental induction of mutations using ionizing radiation. The progeny of radiated beetles can be screened to determine the deleterious effects on a variety of fitness traits. Experimental breeding regimes can then be adopted in order to manipulate the intensity of sexual selection, and thus its significance for purging deleterious mutations.


3. The role of the copulatory plug in sperm competition in house mice

(co-supervised with Dr Renée Firman)

Many rodent species bear coagulating glands that produce a secretion after ejaculation to form a compact ‘copulatory plug’ that solidifies, and becomes moulded to the vagina. Several theories have been proposed to account for the evolution of copulatory plugs in mammals. The ‘chastity-enforcement hypothesis’ proposes that copulatory plugs function in the context of sperm competition and prevent subsequent males from inseminating females (Voss 1979, Koprowski 1992). However, multiply sired litters occur in many species that deposit copulatory plugs, including house mice (Firman and Simmons 2008). To date, only a single study of deer mice has investigated the paternity success of males mated to females bearing copulatory plugs, and reported that copulatory plugs had no paternity assurance function (Dewsbury 1988). However, this study was limited; the investigator only used females in post-partum oestrus, when the reproductive tract was expanded from parturition and plugs were easily displaced (Dewsbury 1988).
Honours project will test the chastity-enforcement hypothesis for the evolution of the copulatory plug in house mice. To test the effectiveness of the copulatory plug in preventing subsequent, competitive matings/fertilisations, this project will include behavioural observations and the application of microsatellites for paternity analysis. For a complete and rigorous investigation, it is envisaged that three treatments will be assigned: i. females with plugs during normal oestrus periods; ii. females with plugs during post-partum oestrus periods; and iii. females that have had plugs experimentally removed by the investigator.


**Ecological and genetic bases of troglobitic diversity in the Pilbara Western Australia**

**Dr. Terrie Finston (contact tfinston@cyllene.uwa.edu.au)**

The subterranean fauna of the Pilbara includes both groundwater (stygobitic) and soil inhabiting (troglobitic) species. The fauna is dominated by relics, the remnants of extinct surface populations which once occupied the Pilbara when the landscape was more mesic than the present. Aridification during the Tertiary is believed to be responsible for driving surface populations into subterranean refugia, resulting in a diverse fauna, nearly 60% of which is endemic to the Pilbara. The conservation significance of this fauna is a current focus of investigation, and to date has relied on morphological and genetic assessments of biodiversity. However, the ecology of these organisms is poorly studied and further genetic work is required in some groups to aid in understanding population dynamics and species boundaries. Rio Tinto Iron Ore will sponsor a project to investigate some ecological and/or genetic aspects of troglofauna populations. Areas of investigation could include:
1) habitat characterisation with implications for management, by defining appropriate sampling regimes, suitable/potential habitat, and potential for recolonisation after habitat reconstruction
2) genetic studies of population connectivity in groups occupying geographically distinct mesas

Further reading:


Structure and function of mouthparts of *Halosbaena tulki*

Dr Brenton Knott [contact bknott@cyllene.uwa.edu.au]

All described species of the Order Thermosbaenacea (Crustacea: Malacostraca) have been recorded from a variety of stygal habitats, marine, hypersaline, hot springs (48 °C) and freshwater, and their global distribution is consistent with a Tethyan origin.

The one species recorded from Australia, *Halosbaena tulki* Poore & Humphreys, 1992, has been collected from ground waters between Exmouth and the Fortescue River of Western Australia. Gravid thermosbaenacean females brood their fertilized embryos in a dorsal brood pouch. Little is known of the feeding biology of thermosbaenaceans other than the studies of G. Fryer (1965) on the species *Monodella argentarii*, and of Barker (1962) on *Thermosbaena mirabilis* Monod, 1924 that graze on suspended detritus. What is clear is that gravid females of *H. tulki* carry modified mouthparts which constitute a novel system with unknown function. An Honours project that focused on the structure and function of the mouthparts of gravid females of *H. tulki* could use light and electron microscopy to describe the mouthpart structures of gravid and non-gravid females and of males, including the attached muscles. Manton (1977)
provides a sound model to work from. The study could include analysis of the gut contents of gravid and non-gravid specimens. This information would be used to hypothesise on the function and benefits of the mouthparts to the gravid females.

References


Monod, T. 1924. Proceedings of the Linnean Society of London, Session 136, 63


Projects in the Herpetology Lab

Prof Dale Roberts [contact droberts@cyllene.uwa.edu.au]

- conservation biology – threatened frogs species, demography, subdivision, fire, forest management, heading towards biodiversity in farmed habitats.
- history and evolution of the Australian frog fauna. ARC grant with Scott Keogh at ANU evaluating relationships in Myobatrachid frogs – speciation, biogeography, comparative life history evolution, call structure and mating system evolution
- sexual selection and sperm competition in frogs. Mostly with Crinia georgiana but now extending to other species
- Good links to CALM and WA Museum

1. Mate choice copying.

In many animals there is evidence that females copy mate choice of other females (e.g. Widemo 2006). Copying may reduce risks for females that they would otherwise be exposed to with a more extensive sampling of males, or, it might be used by inexperienced females who are developing mate choice criteria. Many mate-choice copying trials have been conducted with fish as females can assess performance of males by the presence of eggs in nests. The frog Crinia georgiana has a polyandrous mating
system (Byrne & Roberts 2004) but about 50% of matings still only involve one male. Many males call from sites with eggs raising the possibility of mate choice copying. This project will investigate the impact of eggs on mating success in *C. georgiana* and whether this species shows mate choice copying.


### 2. Call complexity and male-male competition in pelodyadine frogs

Byrne et al. (2002) showed that in Myobatrachid frogs that as sperm competition risk rose there was also an increase in testis mass. In tree frogs (formerly Hylidae now Pelodyadinae) no such relationship existed. Byrne et al. speculated that something about tree frog mating systems, e.g. call complexity, might reduce the apparent risk of sperm competition. Many Australian tree frogs have multiple call types or complex calls (e.g. Smith & Roberts 2003) and call complexity or the absence of non-calling mating tactics, satellites or sneaks, might account for the result reported by Byrne et al. This project would analyse mating system function in a local tree frog, *Litoria adelaidensis*, including experimental analyses of the role of call variation in male-male and male-female interactions.


**Cryptic species of the amphipod *Austrochiltonia***

**Dr Brenton Knott [contact bknott@cyllene.uwa.edu.au]**

Ceinid amphipods, genus *Austrochiltonia*, occur widely in surface habitats of southwestern Australia. Two species have been described from surface waters in southeastern Australia and Tasmania and originally placed in the family Hyalellidae but later transferred to the family Ceinidae. Typically one species is identified in Western Australian samples, *Austrochiltonia subtenuis* (Sayce, 1902), a species also recorded from southeastern Australia and with a restricted distribution in Tasmania.
Most attention on amphipod systematics in Australia has focused on the crangonyctids which have ancient Gondwanic connections and which display considerable diversity in both surface and subterranean habitats. Ceinid amphipods may be a more recent coloniser of the Australian landmass and although they, too, have invaded the underground, the real extent of their variation in Australia is yet to be assessed. The suspicion is that their greatest diversity occurs in Western Australia, from salt lakes to coastal lakes of the Swan Coastal Plain.

Hence, there is considerable scope for an Honours project focusing on the local forms, from morphological and/or genetic perspectives, with field studies included. Local populations are readily available for a student to use to begin to understand the morphology of the beast and to develop genetic primers (sensu Hillis et al. 1996), as well as develop some substantive knowledge of the likely methodologies that may yield hypotheses relating to factors controlling distribution of species. Armed with such insights, field studies could be used to collect samples from a number of sites to answer the question: Is there more than one valid species of Austrochiltonia in Western Australia?

References

Temporal genetic variation in the intertidal snail *Bembicium vittatum*

Mike Johnson & Jason Kennington [contact msj@cyllene.uwa.edu.au]

Analysis of variation of genetic traits over time can provide valuable information about stability of genetic structure, effective population size, and contrasting effects of selection on different traits (e.g., Lessios *et al.* 1994, Tessier & Bernatchez 1999, Palm *et al.* 2003). Most studies, however, examine temporal variation over only a short period of time, even though longer term comparisons allow much more powerful analyses.

The intertidal snail *Bembicium vittatum* offers a chance to examine temporal genetic changes of molecular and morphological traits over a twenty-year period, representing more than a dozen generations. This species lacks planktonic larvae, and is highly genetically subdivided in the Abrolhos Islands, in ways that reflect patterns of connectivity among populations (Johnson & Black 1991, 1996, 1998). In addition, populations differ in their sizes and degree of isolation, and hence in their potential for bottlenecks. Variation of allozyme loci was examined in 1987, 1992 and 1997, and samples for the same sites are available from 2007. Thus, analysis of allozymes in the 2007 samples, combined with comparisons with the previous years, will provide tests of stability of patterns of genetic subdivision, and specific comparisons among populations with different characteristics.

These populations also differ in shell shape and colour, which are adapted to local conditions (Johnson & Black 2000, 2007). Quantification of temporal variation in these morphological traits will allow testing of the expectation that they should be less affected by fluctuation in population sizes, and hence are likely to differ from the allozymes in their amounts and patterns of temporal variation (e.g., Binks *et al.* 2007).

This project will involve analysis of allozymes and shell traits in populations of *B. vittatum*, to quantify temporal variation, as a test of effects of population characteristics and type of trait on genetic structure. The extent and complexity of the data provide rewarding possibilities for a student willing to take on in-depth analyses.

**Background reading**


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**Metabolic Ecology of the Mulgara, Dasycercus cristicauda**

**Jane Prince [contact  jprince@cyllene.uwa.edu.au]**

The distribution and abundance of the mulgara is highly variable in space and time (Masters 2003, 2005). Mulgaras are well known to move through the landscape, disappearing and re-appearing at the same location over many years. There have been several hypotheses as to why this occurs. One of these relates to the quality and availability of spinifex cover (*Triodia* spp) (e.g. Masters et al. 2003, Letnic & Dickman 2005), implying that spinifex needs to be burnt regularly to regenerate suitable habitat. Another hypothesis concerns the availability of food: mulgaras may literally eat themselves out of house and home and then have to abandon the area until the larder is re-stocked.

If food does become limiting, it is most likely to be during winter when there are fewer prey active. Interestingly, there are many more diggings evident during winter than at any other time of year and this may be because mulgaras are forced to dig for food during winter nights when it is too cool for invertebrates and geckos to be active.

This project will examine the metabolic needs of mulgaras during winter and relate that to the caloric content of key prey items. Data on distribution and abundance of those prey items will be available from pit-trapping records at sites with different fire histories recorded as part of the Mt Keith Biodiversity Project, however, some additional data on
the abundance of targeted prey items and the distribution of mulgara diggings will be required.

This project will involve field work on site at Mt Keith Operations and laboratory work either at Mt Keith (if facilities are available) or at UWA. Travel to and from the site and accommodation and meals on-site will be funded by BHP Billiton. All health and safety requirements for mine-site access will have to be observed including drug and alcohol tests, a zero tolerance to drug and alcohol in the workplace and various training requirements. Animal ethics approval is already in place for this project, however it will be necessary for the student to complete a PAWES course.

The project will be supervised by Professor Phil Withers, Dr Jane Prince and Mr Roy Teale (Biota Environmental Sciences).

References


Demography and habitat use of co-occurring species of cowries in sanctuary zones within the Ningaloo Marine Park

Jane Prince [contact jprince@cyllene.uwa.edu.au]

The newly created protected areas within the Ningaloo Marine Park include many of the intertidal platforms and sand flats inhabited by species of cowries (Cypraea spp : Mollusca Gastropoda Cypraeidae). By their nature of producing a high lustre shell surface, cowries attract the interest of shell collectors, and their occurrence in the readily accessible intertidal areas makes them a prime target for exploitation. The Department of Environment and Conservation regards cowries as a high priority for management within these sanctuary areas and initially is interested to know about their distribution and abundance on both a large (marine park) and small (within site) scale, and recruitment patterns (based on current demography). A recent survey of the intertidal areas within the park revealed that cowries were not well represented by standard sampling and that
targeted sampling methods would be required to understand their distribution and abundance.

This project would fall under the WAMSI Node 3 project being conducted by Associate Professor Bob Black, Professor Mike Johnson and Dr Jane Prince (Animal Biology UWA), Dr Anne Brearley (Plant Biology, UWA) and Dr Alan Kendrick (DEC, Regional Ecologist, Exmouth) and it is anticipated that some or all of those persons would form the supervisory panel. The student would be expected to accompany the research team on trips to the Ningaloo Marine Park, working in parallel to the more general survey. Additional trips to the area may be required.

The student would devise ways of sampling these species to answer general questions about demography and habitat use. Analysis of the data will require the use of a number of statistical methods, including multivariate analysis of assemblage structure and habitat variables. Comparisons of present distribution and abundance with historical museum records would form the basis of recommendations to DEC as to the requirements for future management of those areas identified as important for the species involved.

Ants as indicators of ecosystem functioning

Jane Prince [contact jprince@cyllene.uwa.edu.au]

Ants represent a taxonomically diverse and numerically abundant component of terrestrial ecosystems. They are also highly responsive to human impact (Folgarait 1998) and so are potentially useful as indicators of anthropogenic changes to ecosystem functioning. Ants can be assigned to different feeding guilds or functional groups and these have been shown to respond differently to changes in the environment (Hoffman and Anderson 2003, Underwood and Fisher 2006). In the case of fire, changes in the availability of food items have been shown to alter the competitive abilities of different
Much of the research on ants has been carried out in temperate forest ecosystems. The Mt Keith Biodiversity Project provides an opportunity to examine the change in composition of the ant fauna with time after fire in an arid rangeland environment. This project requires field trips to the mine site in April and/or July 2009.

References

Settlement of marine invertebrates on intertidal rock platforms at Rottnest Island

Jane Prince [contact jprince@cyllene.uwa.edu.au]

Assemblages of macroinvertebrates on intertidal rock platforms at Rottnest Island show clear patterns of distribution and abundance that to some extent mirror the environmental conditions on the rock platforms. Are these patterns a result of differential delivery of planktonic larvae around the island, or is larval supply more even and the patterns a result of post-settlement mortality?
This project will employ settlement devices to measure settlement rates on different platforms around the island, and compare the composition of newly settled invertebrate assemblages with the resident populations. In particular, settlement in the newly established as sanctuary zones will be compared with non-protected areas.

Linking community structure to habitat variables at sites inside and outside sanctuary zones in the Ningaloo Marine Park

Jane Prince [contact jprince@cyllene.uwa.edu.au]

Sanctuary or no-take zones represent an opportunity to assess the impact of fishing or other exploitation on standing stocks of key indicator species. However it requires that conditions are equivalent outside and outside the reserves, which is seldom the case. This project aims to identify the key environmental factors that are driving difference between assemblages over and above the effects of exploitation.
This project is funded by a WAMSI grant to Bob Black, Mike Johnson, Anne Brearley and Jane Prince and would require field trips in February and July 2009.

Terrestrial invertebrates of granite outcrops: biodiversity and conservation status

Adjunct Professor Barbera Main [contact bymain@cyllene.uwa.edu.au]

Research area: spider taxonomy/ecology/conservation

Granite outcrops are a notable feature of the southern WA landscape. Aquatic invertebrates are reasonably well documented (Bayly 1997) as are most of the plants (Hopper et al. 1997). However there is a dearth of knowledge on terrestrial invertebrates (Main 1997; Withes and Edwards 1997). Nevertheless endemicity of a few species (eg. arachnids is indicated (Main 1997). Main (2000) lists the major groups of terrestrial arachnids characteristic of of granite outcrops. Although there are several popular books and articles on granite outcrops (see Main 1997) there has been (a) no comprehensive survey of the invertebrate fauna of ANY rock (b) no study of the primary biological attributes which enable invertebrates to live on the outcrops or bordering apron region (c) the impact of man-induced disturbances on the long-term persistence of invertebrates.

In the framework of a comprehensive survey on a selection of rocks (representing various levels of anthropogenic disturbance) in forest and/or dryer areas the question can be posed whether the theory of island biogeography is applicable for conservation management.

Alternatively a case study on the biology of one or several species might point to resolution of the conservation status of the invertebrate fauna of an outcrop.

One remarkable species of spider previously identified as a lycosid (Main 1976, 2000 (see figs.)) but now recognised as taxonomically belonging elsewhere is of particular ecological and conservation interest. It has developed a flattened morphology & laterigrade legs (associated with living under granite slabs) which is similar to the body form of huntsman spiders (family Sparassidae) & lycosid-like eye arrangement. Restricted to the microhabitat of exfoliated slabs or flakes on a group of granite outcrops in the mid & south eastern wheatbelt it presents a complex of biogeographic, taxonomic, genetic, physiological, general biological (eg. life history peculiarities) and behavioural phenomena. Furthermore it faces anthropogenic intrusions plus habitat invasion by feral animals including pigs.

Introductory references

Phenology of males of the mygalomorph spider *Chenistonia tepperi* Hogg (family: Nemesiidae) and the biological implications

[This is a (museum) collection-based project involving an extrapolated biological solution]

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*Chenistonia tepperi* is a spectacular golden-brown, relatively large mygalomorph spider (body length varying up to about 3 or more cm) and with long legs (see Plate 11 and Fig. 18a, Main 1976, 1984). Spiders construct burrows (at least 25 - 30 cm long with open entrances i.e. there is no trapdoor) in sandy or loamy soil. The taxonomic status is not clear in that several species may currently be included under the one name of a “superspecies” ranging from the southern Flinders Ranges in South Australia to the west coast of Western Australia. (See also general references on biology in Main 1964, 1981 and 1976, 1984).

Mygalomorph females are mostly long lived taking many (?) years to mature. They remain in the same burrow throughout life and reproduce iteroparously. Wandering males search actively for female burrows where mating takes place. Males of some species may mate with more than one female but do not persist beyond the one season. Eggs and brood are incubated in a female burrow until the spiderlings disperse.

The reproductive phenology is unusual in that males of the “species” are found throughout the year whereas most mygalomorph species have a restricted “wandering” (or “running”) time associated with a particular season. Wandering of all mygalomorph males is associated with humid conditions, generally before rain. Records suggest that wandering periodicity (of *C. tepperi*) has a geographic pattern (for example summer in the Goldfields, winter in the wheatbelt, throughout the year along the south coast). What then are the environmental factors determining the phenology?

The project would involve (a) analysis of Western Australian Museum data base records and BYM’s collection records for geographic localities and dates of collection (b) morphological examination (and analysis of a selection of characters) of individual specimens to assess variability (particularly size as indicated by carapace length).

Several theoretical aspects are posed. Does the data suggest incipient sympatric/allopatric speciation? OR clinal variability of morphology/phenology in relation to geographic distribution patterns and environmental parameters? AND what are the implications for female reproductive biology and dispersion of spiderlings?
The project requires (a) meticulous care and responsibility in handling collections (hundreds of individually curated specimens) (b) application of scholarship in analysing records re associating historical seasonal (meteorological) data, collection times, distribution data etc (c) staying power with the tedious morphometrics (d) imagination in interpretation (its not an “easy option”).

Can you do it?

References

And various papers on request.

Immunocompetence of Western Australian Honeybees

Dr Boris Baer & Prof Leigh W Simmons [contact bcbaer@cyllene.uwa.edu.au]

Honeybees (*Apis mellifera*) are vital for 90% of worldwide crop pollination such as fruits, vegetables, cattle feed, nuts, seeds, cotton etc. However, the global importance of honeybees for ecosystems and human food production has been overshadowed in the last few years by devastating declines in both feral and managed populations, especially in Europe and in Northern America, mostly caused by spreading parasites and pathogens. To counter the worldwide losses of bees and to protect the honeybee from further parasitic infections, more detailed studies on the honeybee immune system and its interaction with parasites is urgently needed.

The study proposed aims to provide first insights into the immune system of Western Australian honeybees, for example by comparing the immune system of feral bees with those currently bred by Western Australian beekeepers. The efficiency of the honeybee immune defence can be measured in several ways, for example as encapsulation response or by measuring the activity of specific proteins that are involved in immune defence. Apart from quantifying immunocompetence among Western Australian honeybees, honeybees can also be infected artificially, either with real parasites or with bacterial cell wall fragments in order to initiate a immune response. This allows us to quantify the bees potential to counter possible infections. Finally, artificial insemination techniques allows controlled breeding designs with bees, offering the possibility of estimating heritabilities of immune
characteristics, and artificial selection for bees with increased or decreased immunity for further experiments.

The study will be done in close collaboration with Western Australian bee keepers and the ARC Centre of Excellence for Plant Energy Biology. The latter will allow extending the study of honeybee immunocompetence to a molecular, proteomic level.

Sperm use in honeybee queens

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Apart from being used for honey production, honeybees are the worldwide most important species for crop pollination. However, we currently face a dramatic and global decline of honeybee populations with severe expected consequences for agricultural yields. To counter the dramatic losses of honeybee colonies, detailed studies of honeybee reproduction and fertility will ultimately allow us to optimize breeding, compensate the current losses. Honeybee reproduction is quite spectacular, as queens only mate at the beginning of their life, during one or very few mating flights. Afterwards they are able to store millions of sperm for years, and use them in very economic ways to fertilize millions of eggs. We have very little information how social insect queens are able to keep sperm alive for years, how active sperm remain during storage, and how queens are able to economize their use of sperm during egg fertilization. This project will start to investigate the economy of sperm use in the honeybee *Apis mellifera* by estimating the number of sperm that queens use to fertilize their eggs. To do this, freshly laid eggs will be collected from beehives, fluorescence dyed and inspected with a fluorescence microscope to determine the number of sperm found on each egg. Further experiments are possible to compare sperm use in queens that differ in age, mating frequency or fecundity.

Literature

Establishing salinity thresholds of freshwater macroinvertebrates

Dr Andrew Storey [contact  awstorey@cyllene.uwa.edu.au]

The impact of salinity on the aquatic fauna of creeks and wetlands of south-western Australia is well documented (Bunn & Davies, 1992, Halse et al. 2003, 2004; Pinder et al., 2004, 2005), with many examples of highly degraded systems with depauperate faunas. Past studies have estimated salinity thresholds of aquatic macroinvertebrates based on observations of what is present and assumptions of what has been lost, giving rise to broad, generic thresholds. However, ecotoxicity tests to determine more precise salinity thresholds of aquatic invertebrates have yet to be performed. It is likely that concentrations in our more salinised landscapes far exceed critical thresholds of the more sensitive aquatic macroinvertebrates.

The jarrah forest, on the Darling Range contains many freshwater streams, and is a stronghold for species of aquatic invertebrates regarded sensitive to salinity. These systems are in a relatively high rainfall area and presumed safe from salinisation. However, there are concerns regarding bauxite mining by Alcoa World Alumina in the ‘Intermediate Rainfall Zone’ (IRZ) of the jarrah forest. Ground waters in the IRZ have slightly elevated salinities, and clearing and subsequent mining may result in rising ground water levels, leading to increased salinities in some streams. It is not known if groundwater salinity is sufficiently elevated as to adversely affect stream fauna.

This project will establish salinity thresholds of a range of stream macroinvertebrate species (i.e. mayflies, stoneflies, caddisflies) suspected to be sensitive to salinity. Acute tests will establish concentrations at which mortality occurs. Chronic tests will establish sub-lethal concentrations. Tests will be performed using a Multispecies Freshwater Biomonitor (MFB). The MFB detects responses in individual animals by measuring changes in behaviour (i.e. gill ventilation rates, general locomotion) using electrical impedance. The results of this project will provide salinity thresholds for a range of stream macroinvertebrate species, and indicate level of risk from rising groundwater levels associated with mining. This project is supported by Alcoa World Alumina Australia, as part of their broader studies of the impacts of mining in the IRZ.

References


What are the sex ratios of marine turtles hatching at western Australian rookeries?

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The sex of marine turtles is determined by the temperature experienced during development in a terrestrial nest, with warmer incubation temperatures producing females. Several species of marine turtle are endangered, and there is concern that global climate change is altering nesting behaviour (e.g. females nesting earlier) and increasing nest temperatures, both of which will act synergistically to alter population sex ratios. Three species of marine turtles (loggerhead, Caretta caretta, green, Chelonia mydas and hawksbill turtles Eretmochelys imbricata) nest at a variety of rookeries in the Ningaloo and Shark Bay regions of Western Australia. These rookeries have been subject to long-term monitoring of nesting and hatching, but the sex ratio of hatchlings is unknown because hatchlings cannot be sexed externally. This project would develop a spatially-explicit modelling approach to estimate the sex ratios of hatchings at western Australian rookeries, using climatic, topographic and physiological data that are already available. Sex ratio estimates could be validated by the use of sex steroid assays of amniotic fluid remaining in eggshells. The project would ideally suit a student who has volunteered, or plans to volunteer over the 2008/9 summer for the turtle monitoring program based at Exmouth (see http://www.ningalooturtles.org.au/). Other useful skills would be experience with GIS software and an aptitude for mathematics. Please contact Dr Nicki Mitchell to learn more about the project (njm@cyllene.uwa.edu.au or 6488 4510)

Key references


steroid concentrations in chorioallantoic/amniotic fluid. General and Comparative Endocrinology 99, 204-10.

Population genetics of the New Zealand fur seal in Western Australia

Dr Oliver Berry (UWA/CSIRO), Dr Jason Kennington (UWA), Dr Richard Campbell (DOF/DEC) [contact ofb@cyllene.uwa.edu.au]

The New Zealand fur seal underwent an extreme population reduction during the commercial harvesting era of the 18-20th centuries. Recovery of this population in Australia has been slow but in recent times, the abundance in Western Australia has more than doubled and the species is also undergoing a range expansion. The use of molecular tools to investigate the patterns of population genetics and the ecological patterns in recolonisation would greatly assist wildlife managers and provide some important information on the biological principles of population recovery. This project would investigate the patterns of population structure via the use of mtDNA sequence patterns from a collection of approximately 200 existing samples taken from newborn pups from ten individual breeding colonies. Further sampling will take place from individuals from the newly established breeding colonies and haulout areas in the new range to look at patterns of expansion. There may be the opportunity to conduct some fieldwork in relation to additional sampling to augment the existing collection. There will be some in kind/financial support provided through the Departments of Fisheries (DOF) and Environment and Conservation (DEC).