List of potential research projects for honours and postgraduate students in the Department of Biological Sciences (including Brain, Behaviour & Evolution)

Organised alphabetically by supervisor

Dr. Andrew Allen (9850 9251; E8B217; drew.allen@mq.edu.au)
1. Global biogeography of planktonic foraminifera: relating species abundance to environmental gradients based on population dynamics. (Work being conducted in collaboration with researchers here and in the US on a funded ARC grant.)
2. Effects of global warming on densities and ultrastructures of plant organelles. (Builds on ARC research proposal currently in review. Involves analysis of TEM imagery using stereology techniques. Samples suitable for an honors project have already been prepared.)
3. Effects of global warming on leaf-level nitrogen-phosphorus stoichiometry. (Builds on ARC research proposal currently in review. Involves cultivating plants in growth chambers as well as some laboratory work.)

Dr Leanne Armand (E8C157, x8351, leanne.armand@mq.edu.au)
Honours projects (can be expanded to Masters projects).
1. To be or not to be a sea-ice indicator species: untangling morphometric differences in the diatom *Eucampia antarctica* (in collaboration with Dr A. Leventer, University of Colgate, USA).
2. Diatom diversity and distribution south of Tasmania using state-of-the-art count and imaging technology (FlowCAM).
3. Antarctic sea-ice diatom distribution and diversity off the Adélie Land coast, Antarctica (potential PhD programme can be developed from this project).
4. Fans, fingers, lumps and lace: the effects of oceanographic and geochemical factors on tropical invertebrate morphology (in collaboration with Dr R. Przeslawski, Geoscience Australia).
5. Differentiating pelagic and benthic diatoms in relation to light regime of the seafloor using sea-floor sediments from Jervis Bay (in collaboration Dr. L. Radke, Geosciences Australia).
6. Optimising imaging and counting methods (including dead from living cells and the use of fluorescent dyes) for Open Ocean diatoms on the FlowCAM**.**

Masters projects (can be expanded to PhD level research programme).
7. Natural iron fertilization on the Kerguelen Plateau: phytoplankton community response (may include sea-going mission in Oct-Nov. 2011).
8. Seasonal variation in diatom export to the Kerguelen Plateau (may include sea-going mission in Oct-Nov. 2011).
9. Phytoplankton characterisation and survey of the Jervis Bay region, Eastern Australia**.**
10. Antarctic sea-ice diatom distribution and diversity off the Adélie Land coast, Antarctica.
11. New statistical models in determining palaeo-sea-ice cover from biological and physical data.

A/Prof Brian Atwell (brian.atwell@mq.edu.au 9850 8224)
1. Anaerobic metabolism in rice – a series of potential projects using a range of mutants and transgenic plants to understand how plants tolerate low oxygen environments. Employs techniques of membrane transport, energetics, informatics and gene regulation;

2. Understanding the growth and physiology of Australian wild rice species. This entails studying both stress physiology (flooding, heat, drought and cold stress) at the physiological scale as well as gene regulation of these responses. We have extensive data on growth and development of the canopies of these important native plants on which to build research questions;
3. Climate change biology – we use two native plant systems to understand partitioning of photoassimilates and plant productivity under climate change conditions – eucalypts and weeping grass. We are very well set up to compare behaviour of non-cultivated plants because of a wide range of genetic material. Key aspects include root allocation and wood chemistry;
4. Effect of temperature, drought and elevated CO_2 on hydrocarbon (terpene etc) emissions from leaves. These emissions can act to alter heat trapping by the planet.

These projects are largely part of current or past postgraduate projects and mainly carried out via high-level collaboration with other labs here and abroad.

Dr Andrew Barron (W19F, 9850 1310; andrew.barron@mq.edu.au)
1. The neurobiology of honey bee dance language.
2. The molecular basis of memory: does long term memory change DNA methylation?
3. Learning, risk taking and gambling in bees
4. Gender differences in preferences for 'masculine' and 'feminine' faces in humans (in collaboration with Darren Burke, Newcastle University).

Dr Kate Barry (9850 8208; E8A174; kate.barry@mq.edu.au)
1. Costs of sexual cannibalism in praying mantids
- do aggressive females remain unmated?
- are males likely to mate multiple times? If not, is cannibalism less costly for males than previously thought?
2. Male mating strategies in sexually cannibalistic mantids
- male approach behaviour: what are the circumstances under which males will act on information regarding the likelihood of female aggression and subsequently reject dangerous females?
- ejaculate expenditure: do cannibalised males increase their ejaculate expenditure (sperm and/or accessory gland products) given the lack of future mating opportunities?
3. Comprehensive field studies of cannibalistic mantids
- how does the data compiled in semi-natural studies compare to field data?

Dr Linda Beaumont (linda.beaumont@mq.edu.au 9850 8157)
1. Temperature-sensitive species: What is the probability of extreme daily temperatures being exceeded throughout the 21st century?
2. Australian migratory birds: How may interactions between climate change and future land use projections impact on their distributions?
3. Global meta-analysis of changes to the timing of bird migration: What species have undergone the strongest changes and why?
4. Vegetation of the Wet Tropics: Projecting changes in distribution, richness and functional traits

5. Numerous projects particularly suited to GIS users

Dr Melanie Bishop (melanie.bishop@mq.edu.au, E8C 159 [inside Climate Risk Centre], 9850 4075)

1. Ecological restoration in a changing climate
2. Impacts of climate warming on bioturbation by a benthic bulldozer
3. Assessing top down control of benthic community structure by hunter-gatherers
4. Impacts of oyster farming on wild oyster populations
5. Impacts of an invasive crab on commercially important bivalve
6. Can acid sulfate acidification of estuaries inform future impacts of CO2 acidification? (with A/Prof Raftos)
7. Why does leaf litter mixing have non-additive effects on decomposition rate?
8. Other mutually agreed-upon projects focusing on coastal systems.

Dr. Glenn Brock (9850 8335, E8A 322; glenn.brock@mq.edu.au)

1. Ecospace utilisation and trophic structure of early Cambrian benthic communities from South Australia
2. Exceptional preservation, taphonomy and biodiversity of faunas from the Middle Cambrian Monastery Creek Phosphorite, Western QLD
3. Early Cambrian Reef-Mound architecture, Druid Range, Arrowie Basin, South Australia
4. Molluscan Evolution and Biofacies from the Lower Cambrian of South Australia
5. Abundance, Diversity and Biostratigraphy of SSF and trilobite assemblages from the Lower Cambrian Moorowie Formation, Mt Chambers, NE Flinders Ranges
6. Faunas, Biodiversity and Palaeoecology of the Lower Cambrian Kulpara Limestone, Curramulka Quarry, Yorke Peninsula
7. Holocene Foraminiferal Assemblages as proxy for Monitoring Reef Health from the Central Great Barrier Reef (*external funding dependent*)
8. Investigation of Salt Marsh and Estuarine Foraminfera in applied palaeontology (numerous potential projects)
9. Taphofacies Analysis and Depositional Environments of the Silverdale Formation (Silurian) at Hatton's Corner, Yass Basin, NSW
10. Subsurface biostratigraphy and chemostratigraphy of Cambrian faunas from South Australia and/or Central Australia
11. Faunal Turnover and Isotope Statigraphy from the Lower-Middle Cambrian Chandler Limestone & Giles Creek Dolostone, Amadeus Basin, Northern Territory
12. Ordovician faunas from the Emanuel Formation, Canning Basin Western Australia (*external funding dependent*)
13. Biogeography and biofacies of Silicified Brachiopods from the Middle Ordovician Haedon Formation, New England Fold Belt, NSW
14. Middle Cambrian phosphatic brachiopods from Black Mountain, western Queensland.
15. Epibionts in the fossil record – what do they tell us about ancient palaeocommunities
16. Any projects related to the Australian fossil record considered.

Dr Culum Brown (culum.brown@mq.edu.au; 9850 6292)

1. Learning & memory in fishes.
2. Cerebral lateralisation ("handedness") & dual processing in fishes.
3. Environmental enrichment and brain development/plasticity in fishes.
4. Social networks and social transmission of information in fishes.
5. Boldness-shyness traits in fishes; repeatability of personality testing.
6. Native/exotic interactions in fishes.
7. Population genetics in Australian, Panamanian and Indian fishes
8. Prey and predator recognition in hatchery-reared fishes
9. Microhabitat characteristics of roosting locations in grey headed flying foxes
10. Climate modelling for flying foxes
11. Any Behavioural Ecology or Fishy Projects considered.

Prof Ken Cheng (W21A 2; 9850-8613; ken.cheng@mq.edu.au)

1. learning and cognition in free flying honeybees (on campus)
2. navigation, foraging, and learning in red honey ants (field experiments in Alice Springs)

Prof Mark Connor (9114 4030, mark.connor@mq.edu.au, ASAM)

1. Investigating novel drug targets on calcium channels and TRP channels using cell-based assays of intracellular calcium concentration.
2. Investigating agonist biased opioid receptor signalling.
3. Investigating G protein-coupled receptors for novel endocannabinoid compounds.

Dr Jennifer Cornish (jennifer.cornish@mq.edu.au; 9850 9467)

Projects into the neurobiology of drug addiction (cocaine, methamphetamine 'ice') and related disorders (psychosis, anxiety, depression, memory impairments) using techniques in:

1. Neuropharmacology/physiology
2. Behavioural Pharmacology/physiology
3. Cardiovascular Pharmacology/physiology (with Assoc Prof Ann Goodchild)
4. Proteomic analysis of brain areas (with Assoc Prof Paul Haynes)

Assoc. Prof. Jenny Donald (9850 8161; E8C211; jenny.donald@mq.edu.au)

1. Projects in human molecular genetics. Contact Jenny for availability.

Prof. Michael Gillings (9850 8199, E8A271;michael.gillings@mq.edu.au)

The EMMA laboratory focuses on genetic diversity and its role in evolution. Current projects cross the breadth of living things, from microorganisms to vertebrates. Research programs use molecular methods to assess DNA diversity, and involve collaborations with a range of other staff members. Students will receive a thorough grounding in the natural history of their chosen organisms, and will investigate various questions using PCR, DNA sequencing and bioinformatics.

Current Projects include:

- Origins of antibiotic resistance and the role of integrons in Bacterial genome evolution
- Next generation sequence analysis of microbial communities in Nullabor caves
- Development of rapid methods to assess DNA methylation
- Genetic diversity and dispersal of the invasive fish *Gambusia holbrooki*

- Species complexes in Australian Rainbowfish
- Identification of plant roots with molecular forensics
- Integrons and antibiotic resistance genes in wild animals

Assoc. Prof. Ann Goodchild (98123550; ann.goodchild@ mq.edu.au) and Dr Natasha Kumar (9850 4027; natasha.kumar@mq.edu.au)
Systems and signalling group- The Australian School of Advanced Medicine
1. Do closely related relatives of somatostatin alter breathing and blood pressure in the ventral brainstem?
2. What is the chemical code of sympathetic neurons that regulate the release of noradrenaline and arenaline from the adrenal medulla?
3. Where does the somatostatin that stops breathing come from in the brain and at which receptors does it act?

Alternative projects are also available.
No knowledge is assumed and no experience is required.

Professor Sandy Harrison (98504258; E8C270; sandy.harrison@mq.edu.au)
1. Changes in biodiversity in response to climate change over the past 21,000 years across eastern Australia
2. Mapping Australian vegetation types using surface pollen samples as a basis for improving reconstructions of past vegetation changes
3. How did fire in Australia respond to rapid climate changes during the last glacial?
4. How well do climate models reproduce changes in the strength of the Australian monsoon?
5. How well do climate models reproduce past changes in ENSO variability as reflected in Australian regional climates?

Assoc. Prof. Mariella Herberstein (9850 6276; E8B 111; marie.herberstein@mq.edu.au)
1. Any behavioural/ecological project on insects and spiders
2. Any project relating to parasites in and the behaviour, ecology and evolution of *Kosciuscola* grasshoppers in the Australian alpine region (with Dr Michelle Power & Kate Umbers)

and in association with…
Aaron Harmer (E8A295; 9850 6279; aharmer@bio.mq.edu.au)
1. Biomechanical properties of spider orb-webs.

Interested students will conduct fieldwork and laboratory experiments in a cross-disciplinary project incorporating aspects of both spider behaviour and the physics of spider silks.

Dr Roger Hiller (9850 8148; E8A 208; roger.hiller@mq.edu.au)
1. Molecular biology of the main intrinsic LHC from a Dinoflagellate

- involves algal culture, phage library screening, DNA sequencing and RT-PCR.

Dr Grant Hose (E8C153; 9850-6296; grant.hose@mq.edu.au)
1. Tolerance and resilience of groundwater ecosystems to disturbance
2. Testing the biodiversity-ecosystem function relationship in groundwaters
3. Using metagenomics to assess pollution impacts in freshwaters
4. Response of stream invertebrate communities to environmental change

Dr Darrell Kemp (E8A-275; 9850-8355; darrell.kemp@mq.edu.au)
Lab- and field-based projects involving animal behaviour, breeding experiments, quantitative and molecular genetics, spectrometry (colour measurement) and electron microscopy. Specific projects could be embedded within the following themes (plus similar ones):
1. The evolution of sexual signal traits and behaviours in brightly coloured tropical freshwater fish (particular interest in the evolution of ultraviolet colour signals);
2. The evolution and genetics of colouration and signaling behaviour in butterflies, bugs, other insects;
3. The evolutionary dynamics of interactions between insect hosts and bacterial endosymbionts; particularly 'male killing' or 'feminizing' Wolbachia in butterflies;
4. The occurrence and cause of sex-ratio biases (deviations from 50:50 males:females) in Australian butterfly populations;
5. Adaptive potential in tropical and temperate butterfly populations, particularly as it pertains to the ability of populations/species to evolve under changing climate scenarios.

Dr. Matthew Kosnik (9850 7248; E8A330; matthew.kosnik@mq.edu.au)
1. Gradients in molluscan diversity and predation intensity on the east Australian coast.
2. Experiments investigating the depth and rate of bioturbation in Great Barrier Reef lagoons (or other soft-sediments).
3. Topics investigating macrobentic ecology in soft-sediments, especially those organisms with mineralised skeletal elements.
4. Palaeontology of Australian molluscan faunas.

Dr Caroline Lehmann (98506279; E8C274; caroline.lehmann@mq.edu.au)
1) What is the relationship between fire, rainfall and rainfall variability in North Australia?
2) What is the fire regime of Spinifex grasslands across Australia, and how does this relate to that of savanna systems?

These projects are GIS based using MODIS and Landsat satellite data.

Students are welcome to propose questions they find interesting about fire-vegetation-climate interactions.

Assoc. Prof. Michelle Leishman (E8A170; 9850 9180; michelle.leishman@mq.edu.au; http://www.bio.mq.edu.au/dept/centres/pirel/index.html)
Any projects in plant ecology, especially invasion and restoration ecology, including…
1. responses of exotic and native plants to additional CO_2
2. competitive interactions between exotic and native plants under different resource conditions
3. impacts of invasive plants
4. quantifying the effectiveness of bioretention of nutrients in urban stormwater design
5. volatile emissions from plants grown under high CO_2 – with **Dr Belinda Medlyn** and **Dr Ian Jamie**
6. the smell of invasive success: comparative analyses of plant scents produced by invasive plants - with **Dr Ian Jamie**

Dr Joshua Madin (E8B 216; 9850- 8667; joshua.madin@mq.edu.au)

1. Any questions that focus on coral reef ecology, ecological biomechanics, or ecological informatics
2. Modeling relationships between reef fish swimming ability and hydrodynamic gradients (coral reef fishes)
3. Optimal branching architecture of plants over environmental gradients (plant biomechanics)
4. Developing a knowledge model for the ecological and environmental sciences (ecological informatics)

Dr Simon McMullan (Australian School of Advanced Medicine; 9812- 3552; simon.mcmullan@asam.mq.edu.au)

1. How do cardiovascular control neurons communicate with each other to optimally distribute blood through the body?

ALSO CONTACT SIMON IF YOU ARE INTERESTED IN ANY PROJECTS WITHIN THE AUSTRALIAN SCHOOL OF ADVANCED MEDICINE

Dr Belinda Medlyn (E8C209; 9850 8897; belinda.medlyn@mq.edu.au)

A range of projects related to climate change impacts on forests

- interactions between rising CO_2, drought and temperature, using large-scale field experiments in western Sydney
- water relations of Eucalyptus trees under current and future atmospheric CO_2 concentrations
- investigating plant mortality under drought conditions (with Dr Melanie Zeppel)

Dr Sham Nair (9850 9686; E8C 246; sham.nair@mq.edu.au)

1. Comparative genomics of sea urchin immunology
2. Molecular analysis of a hypervariable immune gene family in sea urchins
3. Gene expression analysis of physiological stress in pearl oysters

Dr David Nipperess (E8B105; 9850 6950; david.nipperess@mq.edu.au)

1. Do phylogenetically diverse plant communities support more insect species than less diverse communities?
2. Australian and global hotspots for mammalian phylogenetic diversity
3. Rapid biodiversity assessment of invertebrates - combining parataxonomy with DNA barcoding
4. Bird diversity in riparian zones in suburban and rural landscapes - what is the effect of the landscape matrix?

Dr Ross Peacock (9850 8297; ross.peacock@mq.edu.au)

1. Understanding the significance of climate variability and climate change for the adaptive management of NSW world heritage rainforests (jointly with NPWS).
2. Investigating the effects of fire in infrequently burnt montane rainforests through the study of regeneration traits and the application of a control burn (jointly with NPWS).

3. Development of biodiversity surrogates and structural indices for monitoring change in forest condition in northern NSW (with Dr Chris McElhinny ANU and the NSW Office of Environment and Heritage).
4. Antagonisms in the survival of rainforest seedlings; the role of ground fauna activity, climate variability and seedling traits (jointly with NPWS).
5. Palaeoclimate modelling of long term rainforest dynamics and rainfall patterns using dendrochronology and stable isotope wood chemistry (with Assoc. Prof. Ian Goodwin and NPWS)

Dr Michelle Power (E8A324; 9850 6974; michelle.power@mq.edu.au)
1. Diversity and evolution of parasites of marsupials
2. Microbial profiling for conservation of Australian sea lions (with Prof. Rob Harcourt GSE)
3. Epidemiology of Giardia in humans in NSW

Dr Michelle Power & Prof. Michael Gillings
1. The impacts of human sewage on the Antarctic environment: spatial and temporal distribution of antibiotic resistance genes from human microbes.

Professor Colin Prentice (E8C269; 9850-4227; colin.prentice@mq.edu.au)
1. Mapping climate futures: how climate change will alter biogeographic patterns
2. What controls fire? Analysis of global data on fire (from satellites), climate, and human activities.
3. What can we learn from changes in the stable isotope composition of methane in ice cores?
4. Quantifying the natural cycle of NHx (ammonium and ammonia) in the atmosphere and biosphere.
5. Influence of slope and aspect on photosynthesis and transpiration at different latitudes. [Would suit a mathematically inclined student.]
6. The effect of low CO_2 during ice ages on the world distribution of forests and savannas.
7. Using plant traits to infer past climate changes.
8. Testing a new stomatal conductance model using stable carbon isotope data.
9. Global analysis of leaf phenology using satellite observations.
10. Climate change and bioclimate change – what's the difference? [Would suit a moderately mathematically inclined student.]

Assoc. Prof. David Raftos (9850 8402; E8C 245; david.raftos@mq.edu.au)
1. QX disease in Sydney Rock oysters
2. Disease control in abalone
3. Hypervariable defence proteins from sea urchins
4. Effects of environmental stress on protein expression in oysters and sea urchins
5. Environmental proteomics in marine invertebrates
6. Evolution of the immune system: Identification of the cellular components that provide invertebrate cells with their molecular concept of individuality
7. Genetic control of fertilisation success in oysters

Dr K-Lynn Smith (9850 9233; W21C 1; klynn.smith@mq.edu.au)

1) *Animal communication: What's in a scream?*

Animals often produce alarm signals in the presence of a predator, which presumably increases the survival chances of mates and kin. Some animals produce a complex array of sounds instead of just a simple sound. What information is encoded in the different sounds (e.g. type of predator, speed of approach)? How do other animals interpret the sounds and react?

Objectives:

- Use new tag sensor technology to record all alarm calling behaviour.

- Use high-definition video cameras to monitor females and males responses to calls as well as the events that elicit different call types.

- Analyse sounds using Raven software and compare with predator characteristics and conspecific responses.

What you'll learn how to do for all projects: Experimental design (library research, test set-up), behavioural observations (outdoors and in the lab), statistical analysis, preparing paper(s) for publication

2) *Teaching behaviour in animals*

Learning can accomplished in several ways, either through tiral and error, by imitating others or by gaining information from a teacher. This project will determine if hens teach their chicks which food are appropriate to eat.

Objectives:

- Use high-definition video cameras to observe female preference for different food types.

Test chicks' responses to their mother's behaviour to determine if chicks learn which foods are edible from their mother.

3) Can chickens use human directed cues to find hidden objects? Some animals, like horses and dogs, can use human cues in a cooperative setting to get food. While others, like chimpanzees, do better if it is a competitive interaction. This could be a product of the type of social organization in which the animals live.

Objectives:

- Test is chickens can follow gaze or pointing to hidden food

Determine if birds are better in cooperative or competitive settings

4) Animal cognition: If you can't beat 'em, outsmart 'em.

Subordinate males are prevented from mating with females by the stronger alpha male so, in order to reproduce, the subordinates must employ sneaky tactics to fool the alpha and attract the females.

Objectives:

- Use brand new tag sensor technology to record all behavioural vocal interactions between group members, particularly tracking subordinate behaviour. Use high-definition video cameras to monitor females and males responses to calls.

Map male behaviour onto mating success

Dr Adam Stow (9850 6292; E8A269; adam.stow@mq.edu.au)

1. Relationships between the evolution of sociality, reduction of genetic variability and production of antimicrobial compounds in arthropods
2. Rapid methods for detecting antimicrobial compounds from insects
3. Going with the crowd - the ecology of sociality in thrips
4. Teddybear's Picnic - population structuring of teddybear bees and their bugs
5. Taxonomy and parentage analysis of Cunningham's Skinks species complex

A/Prof Phil Taylor (9850 1311; W19F; phil.taylor@mq.edu.au)

1. **'Arachnopsychology': Navigation, learning, memory and problem-solving in jumping spiders** (co-supervised by Phil Taylor, Ken Cheng and Tina Peckmezian). Jumping spiders have extraordinary visual ability and complex behaviour, and here we are interested in the cognitive abilities that underpin their behavioural abilities.

2. **Interspecific communication in jumping spiders** (co-supervised by Phil Taylor & Rowan McGinley). Studies of jumping spider interactions have focussed on their sophisticated visual intraspecific communication. But how do they communicate to negotiate territorial disputes with other species of jumping spider that they encounter in their wanderings?

3. **Sexual inhibition in Servaea vestita jumping spiders** (co-supervised by Phil Taylor & Vivian Mendez)**.** After mating, female jumping spiders are highly unreceptive to subsequent courtship. Although this has been widely reported, there has been very little experimental investigation of this central element of sexual selection. A wide range of experimental options are available.

Prof Mark Westoby (E8C 161; 9850 8196; mark.westoby@mq.edu.au, http://www.bio.mq.edu.au/ecology/westoby/mark.htm)

1. Twig design and twig breakage compared across species (a mixture of biomechanical measurements in the lab with comparisons of actual breakage rates in the field)
2. Mechanics of breakage of grass stems in relation to the persistence of grass fuels for bushfires (again a matter of comparing across species in the field, but with rigorous biomechanical measurements using the Universal Testing Machine)
3. Anatomy of woody stems in relation to hydraulics and breakage risk (emphasis on quantitative microscopy technique, but the question is about large-scale patterns in the nature of stemwood across different species)
4. Modeling natural selection on plant strategies under rising CO2 (for students with interests in mathematical modelling)

Dr Anne Wignall (anne.wignall@mq.edu.au, E8A 281, 9850 8586)
1. How does male courtship change with mating status in spiders?
2. How do spiders identify vibrations in their webs (i.e., what characterises prey, mates, predators).

Dr Ian Wright (E8C210; 9850-4228; ian.wright@mq.edu.au; www.bio.mq.edu.au/~iwright/wright.htm)
Projects focusing on plant ecology or ecophysiology, including
1. Glasshouse seedling study: Quantifying relationships between "functional" traits of NT savanna species and seedling growth rate (and adult growth rates)
2. Microscopy study: using leaf traits of fossil species for paleo-ecological reconstruction.