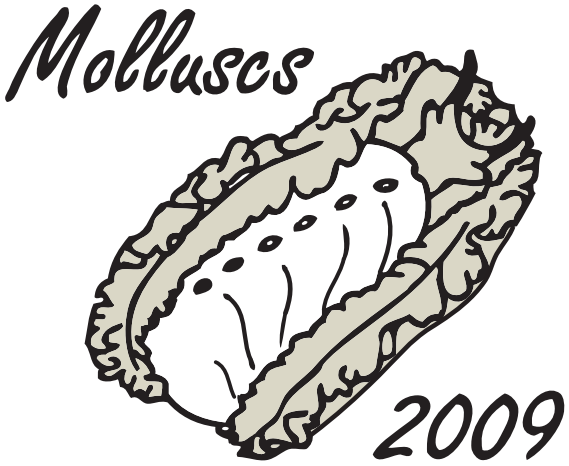
Malacological Society of Australasia

Triennial Conference

Molluscs 2009

Program and Abstracts



25-27 November 2009

Emmanuel College

The University of Queensland

St Lucia, Queensland

Australia

Requests for this book should be made to:

Malacological Society of Australia
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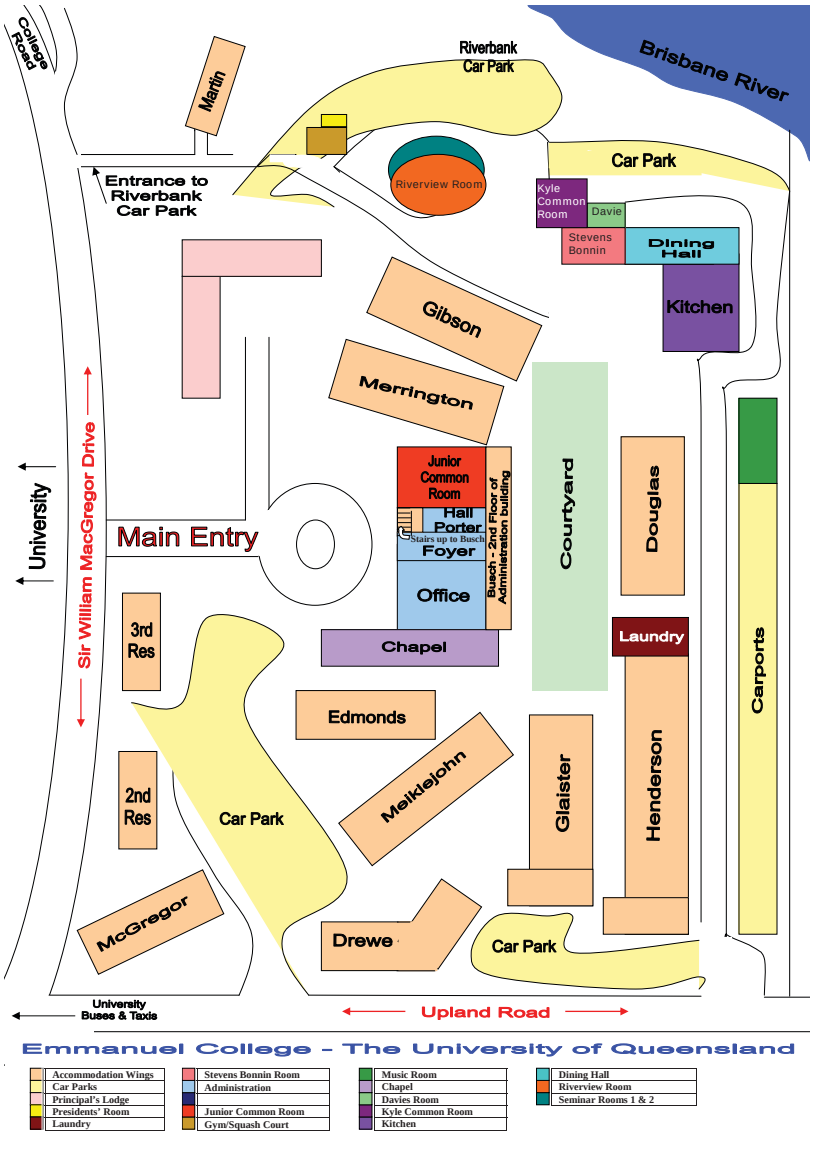
CONTENTS & VENUE MAP

Molluscs 2009
Conference Rooms

Riverview Room
Kyle Common Room,
Stevens Bonnin Room
Seminar Rooms



LOCAL INFORMATION

Emergency - Police, Ambulance, Fire - 000

For on-campus incidents call The University of Queensland Security on (07) 3365 3333

Visitor Information Centre

The Brisbane Visitor Information Centre is located on Queen Street Mall in the Brisbane CBD. This accredited visitor information centre offers a one stop shop for travel information including maps, brochures, and itineraries. Phone: 07 3006 6200.

Bus, Ferry & Train

TransLink call centre: 131230
Public Transport Information: http://www.translink.com.au/

Transport Information Centre

Visit the centre for information and advice about public transport in Brisbane.
It is located at the King George Square station, Ann Street concourse.

Open	Monday - Friday: 8am - 6pm	Saturday: 9am - 5pm
	Sunday and public holidays: closed	

Taxis: Yellow Cabs: 131924; Black & White Taxis: 133222

Food and Shopping

Breakfast is provided for those with accommodation booked at Emmanuel College, and lunch is provided for all conference participants. However dinner is only provided on the Thursday evening (conference dinner). There are numerous options for dining close to the conference venue. Dinner can be ordered at the College by arrangement earlier in the day.

On Campus (see campus map opposite)

Wordsmiths – The Writer's Café next to the University Bookshop serves coffee and light food in a garden setting. It is also a venue for literary launches and readings. Opening hours are 7am-5pm Monday to Thursday; 7am-4pm Friday and 8am-3pm weekends.

The **University of Queensland Club** is located on Staff House Road and overlooks the University gardens, lakes and fountains. Conference goers who live more than 17 kilometers from the club can sign in as visitors, otherwise they will have to be accompanied by a member to be signed in as guests. The club is open Wednesday to Friday from 5-7pm for dinner (downstairs in the Char Grill), and the Coffee Shop is open for breakfast from Monday to Friday from 7.30-9.30am.

The Pizza Café outside the Schonell Theatre is licensed and offers a wide range of interesting pizzas. It is open for dinner Monday to Friday, 11am-9pm, 12 noon-8pm Saturday, and 12 noon-4pm Sunday. Ph (07) 3377 2239.

Off Campus (see map opposite)

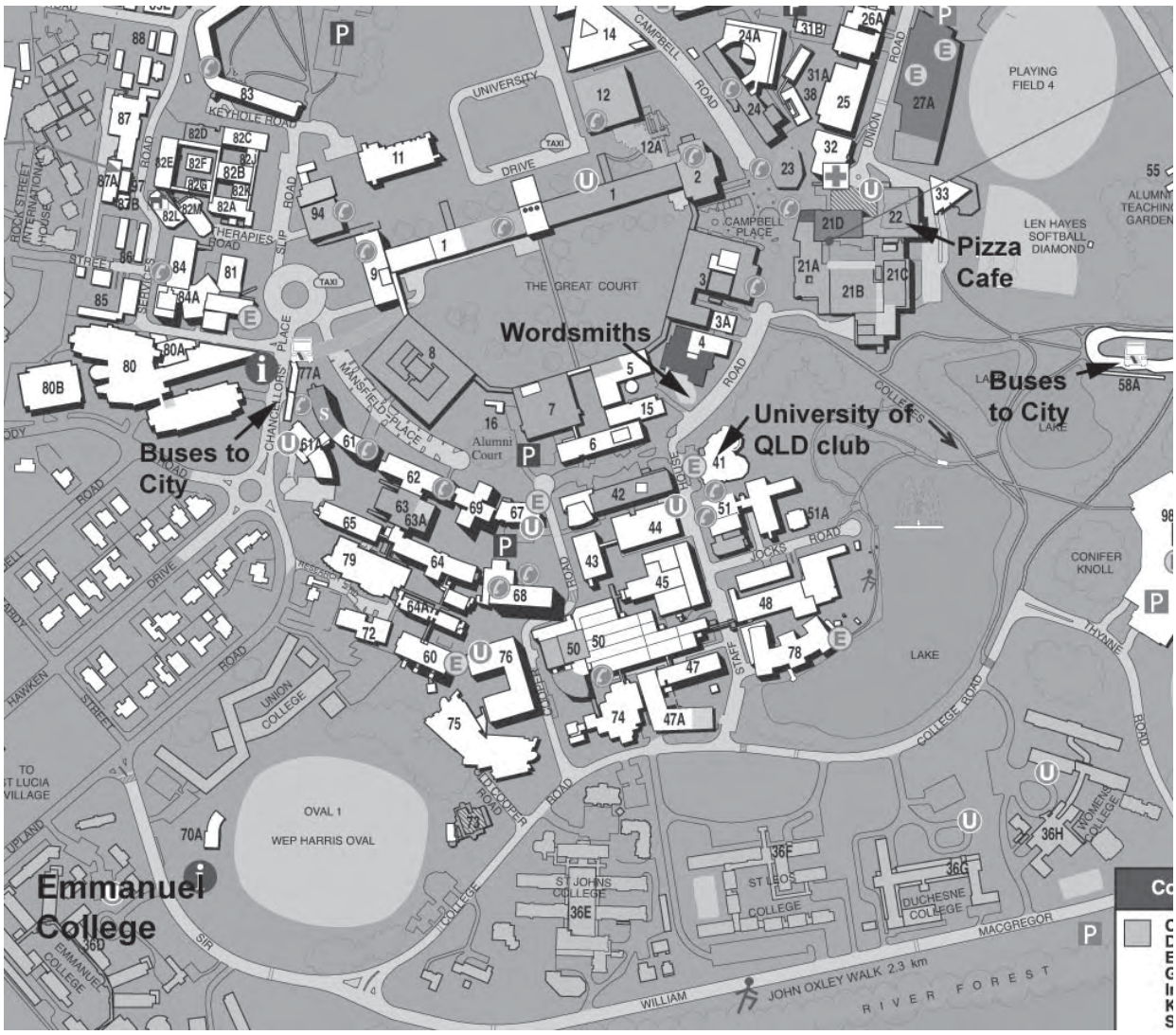
Hawken Village is within easy walking distance (about 10 minutes) from Emmanuel College and contains a number of restaurants including Thai, Malaysian, Indian, Japanese and Seafood. The village also has a Coles supermarket, bottle shop, bakery, Post Office and Medical Centre.

Brisbane City Centre is easily accessible by bus (number 412 from Chancellors Place) or Citycat.

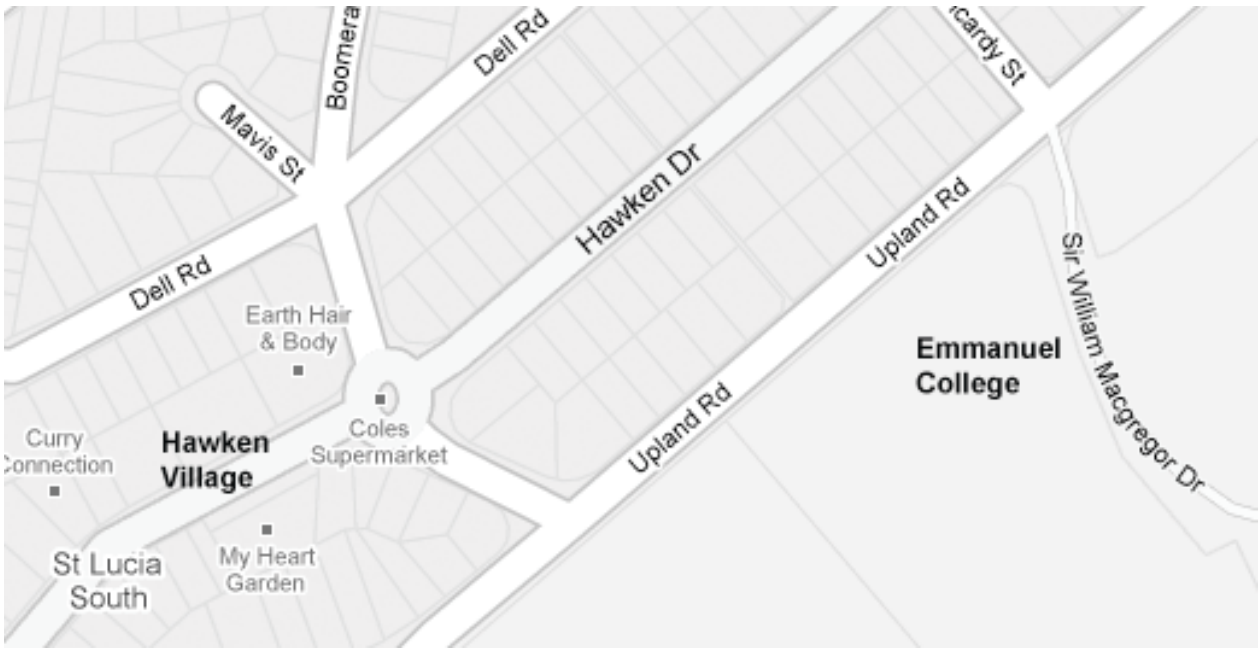
Nightlife

As the conference takes place during University vacation, on-campus licensed venues will close early. The closest pubs to the University are the Royal Exchange (RE) and the Regatta, which are both accessible by bus (number 412 from Chancellors Place).

UNIVERSITY CAMPUS MAP & LOCAL AREA STREET MAP



LOCAL AREA STREET MAP



GENERAL INFORMATION

Emmanuel College

Molluscs 2009 conference will be held at the Emmanuel College, St Lucia, Brisbane, walking distance from local restaurants and accommodation.

The main plenary of the conference will be held in the Riverview Room each morning. Breakout sessions will be in the Riverview Room, Seminar Rooms and Kyle Common Room - as marked on the timetables.

Registration

The Registration Office will be located in the Steven Bonnin Room at Emmanuel College and will be staffed from 1500 - 1730 on Tuesday 23rd and 0830 - 1700 Wednesday - Friday.

Speaker Assistance: Please see staff in the Kyle Common Room

PowerPoint Presentations

All presentations are to be loaded onto laptop computers in advance - you cannot use your own laptop. If you have not uploaded or sent your PowerPoint presentation by email in advance, please ensure that you take your CD / USB to the Speakers Prep area (Kyle Common Room) to be loaded well before your session and to enable you to check your presentation during a break prior to your presentation. Please do not leave this until the last moment. Speaker Assistance will be available on Tuesday at the Kyle Common Room from 1400-1700 (prior to the Welcome Function and from 0800 each day. We encourage you to take advantage of this and have your talk uploaded at least the day before your presentation.

Dress for the Conference

Dress for the conference is business-casual comfortable clothing. Ties and jackets are not necessary. Dress for the MSA dinner on Thursday 26 November is smart casual.

Name Badges

Delegates are requested to wear their name badge at all times during the conference. This badge is also your ticket to included functions.

Messages Please check the notice board by the Registration Desk regularly for messages.
During conference hours: Secretariat Telephone is: 0400 358 302

Posters

Posters are to be assembled and hung on Tuesday 24th from 15:00 hrs until the Welcom Function, and will be on display throughout the conference until Thursday evening in the Stevens Bonnin Room, near to the areas where lunch and morning/afternoon tea will be served.

Poster Removal

Posters are to be removed from the display at the end of the sessions on Thursday afternoon, before the commencement of the Conference Dinner on 26th November.

No responsibility will be taken for posters left at the venue after 9:30 am on Friday 27th November.

CONFERENCE STRUCTURE & SOCIAL PROGRAM

Conference Structure

Each morning, there is a plenary session with symposia keynote speakers until morning tea. Following this, two concurrent sessions will run all day.

Most talks are 20 minutes: approximately 15 minute presentations with 5 minutes for questions. Times will be strictly adhered to, please do not get upset with your session chairs when they ask you to stop! As sessions are concurrent, this allows delegates to move between rooms and presentations.

The scientific program finishes at 1620 hrs on Friday, with the presentation of student prizes and the Conference Concluding Address.

MSA Annual General Meeting and Election of Office Bearers

The Malacological Society Annual General Meeting is on Thursday at 1235 in the Riverview Room. The new Committee will be nominated at this meeting. This is a plenary session and all delegates are invited to attend.

Social Functions (included in full registration)

Welcome Reception	Tuesday 24 November	Stevens Bonnin Room	1730 – 1930
Poster Cocktail Session	Wednesday 25 November	Stevens Bonnin Room	1730 – 1930
MSA Conference Dinner	Thursday 26 November	Riverview Room	1830 – 2400

Entry will be with your delegate name tag - please ensure you wear it at all times during the conference. Additional Tickets for all functions (if available) can be purchased from the Registration Desk.

Icebreaker – Welcome Function

A **Welcome Function** will be held on Tuesday 24 November from 1730 - 1930 hrs in the Stevens Bonnin Room. The Welcome Function is a cocktail function, with a short formal component. It is included with all full registrations.

Morning and Afternoon Teas and Lunches

Catering (morning and afternoon tea and lunch) will be in the Stevens Bonnin Room and nearby garden areas (weather permitting) at the times allocated on the timetable.

Poster Cocktail Evening

A 2-hour session will be held on Wednesday evening, 25 November from 1730 - 1930 hrs. Canapes and drinks will be served during this time. The Poster Evening is designed to give poster presenters the opportunity to discuss their work with conference participants. Authors must attend at their posters for discussions. Registrants only please - extra tickets can be purchased from the Registration desk until 1700 hrs Wednesday. Student posters are judged at this time, so all judges must be present. It is included with all full registrations.

Conference Dinner

The Conference Dinner will commence with canapes and drinks on the Terrace from 6:30pm, then dinner will be served in the Riverview Room. Music will be provided by Nik Comonos, *Project Smooth*. The function concludes at 11:30pm. It is included with all full registrations.

MSA COMMITTEES: CONFERENCE AND COUNCIL

MOLLUSCS 2009 ORGANISING COMMITTEE

Organising Committee

Bernie Degnan (Chair) University of Queensland, School of Biological Sciences
Fred Wells (President, Malacological Society of Australasia
Winston Ponder, Australian Museum
John Healy, Queensland Museum
Darryl Potter, Queensland Museum
John Stanisic, Queensland Museum
Carmel McDougall - University of Queensland

Scientific Program Coordinator

Carmel McDougall - University of Queensland

Conference Secretariat

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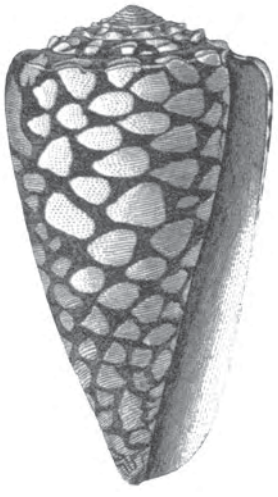


MALACOLOGICAL SOCIETY PRESIDENT'S WELCOME

Welcome to Molluscs 2009!!

As you know, molluscs rank second only to insects in their biological diversity. They have an incredible variety of forms that include well known groups such as the giant squids, octopuses, oysters and abalone and little known groups like the worm-like aplacophorans. Molluscs live in a broad range of habitats, everywhere from the deepest ocean depths to the upper extremes of the intertidal region. There is a rich diversity of species in freshwater and terrestrial habitats. Just about the only thing molluscs don't do is to fly. But if you have ever seen a gymnosomatous pteropod swimming effortlessly through the water, you'd think it was in fact flying.

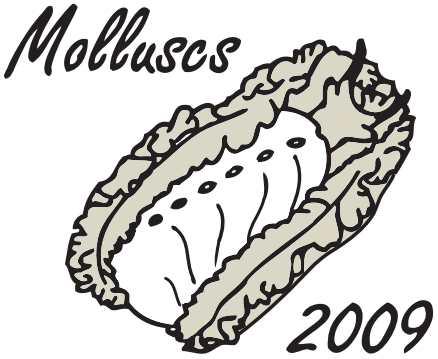
Molluscs are important to people in many ways. Their shells enlighten us about the earth's fossil history, and their bodies exhibit many evolutionary developments. Some carry diseases, both of humans and animals. Many species are widely used as environmental indicators and others are used as fancy jewellery. Australia is the leading producer of South Sea pearls in the world. And let's not forget that many are tasty to eat! Right now Perth is in the middle of the annual abalone season, when 5000 people descend on the small intertidal platforms for one hour on each of six successive Sunday mornings to search for these delicacies – this must be the shortest scheduled fishery in the world! With its large coastline and varied land and freshwater habitats, Australia has a large portion of the world's species of molluscs.

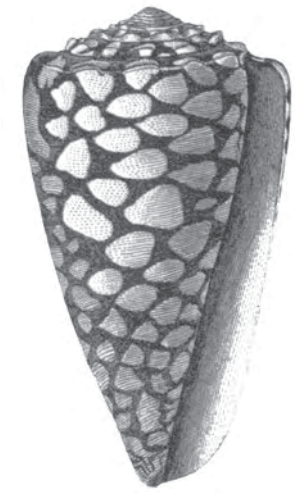
Just as molluscs are diverse, so are the people who are interested in them. Mollusc people range from the kid next door who has just started a shell collection through to very skilled collectors who have a wealth of knowledge about their shells and the habitats where they are found. Some of the kids who started as shell collectors went on to become scientists who have devoted their entire careers to working on molluscs. I count myself among this lucky group. The line between "amateur" and "professional" in malacology is thankfully blurred. We have an excellent example from Brisbane, the late Kevin Lamprell, who spent his entire working life as a skilled tradesman. Later in life Kevin developed a love of molluscs, increasing his skills to the point where he wrote books on shells and was awarded a Doctorate of Philosophy degree for his work.

We are fortunate that for the last half a century, the Malacological Society of Australasia has served as an umbrella group to bring together a wide range of people united by their interest in molluscs. One of the key activities of the Society in recent years has been organising a triennial conference on molluscs. The conferences at Rottnest Island (WA) in 1997, Sydney in 2000 and Wollongong in 2006 have all been very successful. We were fortunate in 2004 that the MSA conference was shared with Unitas Malacologica as the World Congress of Malacology, with over 360 malacologists from around the world.

A small, but very strong group, here in Brisbane has come together to organise Molluscs 2009. I would like to warmly and sincerely thank all of them for their tireless and effective work in bringing us together and on their behalf am pleased to be able to invite you to fully enjoy Molluscs 2009.

Fred Wells
President, Malacological Society of Australasia

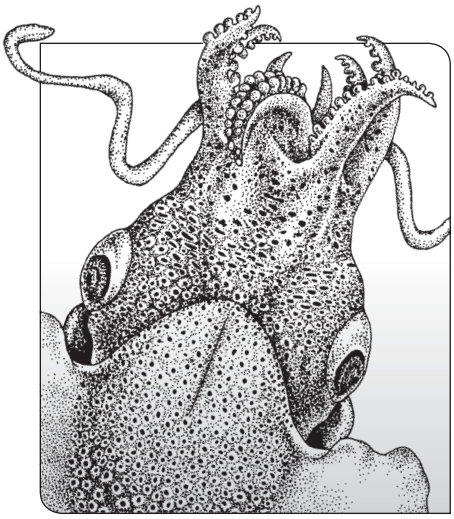




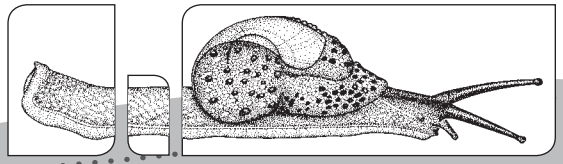
OUR SPONSORS - ABRS

Australian Government

Department of the Environment, Water, Heritage and the Arts



The **Australian Biological Resources Study** (ABRS) is the Australian Government focal point for species discovery, taxonomy and biological collections in Australia. It collates and disseminates biodiversity information, funds taxonomic research through the National Taxonomy Research Grant Program and undertakes policy initiatives on issues associated with taxonomy and biological collections.



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The Australian Faunal Directory

A premier initiative of ABRS, the Australian Faunal Directory (AFD) is a freely available online catalogue of taxonomic, distributional and biological information on terrestrial and aquatic Australian animals. Data for around 87,000 species, about 80% of the known Australian fauna, is currently available. Visit:

www.environment.gov.au/biodiversity/abrs/online-resources/fauna/afd/home

ABRS

australia's nature
there is more still to be discovered…

AFD & Mollusca
AT PRESENT

- The Australian molluscan fauna includes about 8,700 described species.
- AFD currently lists 2,267 species: Aplacophora (11 species), Polyplacophora (171), Scaphopoda (107), Cephalopoda (188) and Pulmonata (1087) as well as some representatives from Bivalvia (203) and other Gastropoda (500).
- Bibliographies and species lists can be generated and downloaded from AFD, and statistics can be compiled for included taxa.

AFD & Mollusca
THE FUTURE

- An ambitious project is underway, in partnership with the scientific community, to complete the AFD list of names of Australian molluscs. Where possible, together with names (valid, synonyms, generic combinations, common), nomenclatural and biological information will be added.
- The current list of names and associated information will be revised and updated regularly, providing a readily accessible summary of the Australian mollusc fauna.
- Whenever available, images and line drawings of species and higher taxa will be added to illustrate the wonderfully diverse Australian mollusc fauna.

environment.gov.au/biodiversity/abrs/index.html

OUR SPONSORS - BAAM

To our Sponsors

The triennial conference of the Malacological Society of Australasia (MSA) appreciates the very important support of our sponsors. The organising committee would like to thank each of these organisations for their generous support to Australia's only moluscan sciences conference.

The Malacological Society of Australasia is a non-profit organisation dedicated to promoting malacological science and co-ordinating discussion and debate among researchers. The MSA triennial conference is a major event for the Society and attracts moluscan researchers and students from many institutions, universities and private companies around Australia. Molluscs 2009 will again provide the opportunity for interaction between scientists, technologists, industry and policy-makers, and will heighten national and international awareness of molluscan science.

The **Australian Biological Resources Study, Department of Environment, Water, Heritage and the Arts** is a Silver Sponsor.

Biodiversity Assessment and Management Pty Ltd have generously sponsored the Welcome Function on Tuesday evening.

On behalf of the members of the Malacological Society of Australasia and the organisers of the Molluscs 2009 Conference, we thank all the sponsors for their support. Your sponsorship will help to ensure that Molluscs 2009 is a success.

Molluscs 2009 Organising Committee

KEYNOTE SPEAKERS - BRIEF BIOGRAPHIES

The keynote speakers at Molluscs 2009 are a wonderful mix of the finest researchers in malacological science. Abstracts for each Keynote presentation are in the abstracts in alphabetical order by last name. The listing below is by Symposia, with brief biographies following - also in alphabetical order by last name.

Invasive Species, Parasites and Diseases

Assoc. Prof. David Raftos | Dr Richard Willan | Mr Gary Barker

Physiology and Evolutionary Development

Prof. Leonid Moroz | Prof. Justin Marshall |Assoc. Prof. Andreas Wanninger

Phylogeny, Systematics & Biogeography

Prof. Hamish Spencer | Dr Frank Köhler |Dr Mark Norman

Fisheries, Aquaculture and Bioactives

Prof. David Adams | Dr Kirsten Benkendorff | Dr Robert Rose

Ecology, Conservation and Indicators of Environmental Change

Dr Rachel Przeslawski | Dr Sandie Degnan | Assoc. Prof. Steven Smith

Professor David Adams, RMIT University

Professor David Adams is currently Professor and Director of the Health Innovations Research Institute at RMIT University. He was previously Professor and Chair of Physiology at the University of Queensland (UQ), Head of Department of Physiology & Pharmacology (1998-2000), Head of the School of Biomedical Sciences (2001-2007) and Professorial Research Fellow in the Queensland Brain Institute, UQ (2008-09). His research focuses on membrane ion channel function and is currently funded by an NHMRC Program Grant and ARC Discovery Grants (2010-14). David has published 132 refereed journal articles (86 as first or senior author) in highly rated physiology, pharmacology and neuroscience journals, 15 book chapters and an inventor on two patents. He is currently the elected President of the Australian Physiological Society (AuPS; 2004-10); a member of the National Committee for Biomedical Science, Australian Academy of Science (2005-09); a member of three Editorial Boards of international scientific journals.

Mr Gary Barker, Landcare Research, New Zealand

Gary Barker is a senior research scientist with the New Zealand crown research institute Landcare Research. Gary specialises in terrestrial molluscan systematics, ecology and conservation, but has interests in invertebrate ecology, systematic conservation planning and ecosystem function. Prior to joining Landcare Research (in 1996), Gary spend 25 years working on population ecology and management of invertebrates in agroecosystems. He has published over 200 scientific papers with contributions in the fields of molluscan systematics and ecology, invertebrate population ecology and pest management, endophytic fungal mutalisms in grasses, phylogenetic diversity as a biodiversity valuation approach, and relationships between biodiversity and ecosystem function.

KEYNOTE SPEAKERS - BRIEF BIOGRAPHIES

Dr Kirsten Benkendorff, Flinders University

Dr Benkendorff is a Senior Lecturer in the School of Biological Sciences at Flinders University. She completed a Ph.D. satisfying the requirements of two Departments (Biological Sciences and Chemistry) at the University of Wollongong in 1999. Kirsten undertook an Australian Research Council Postdoctoral Fellowship (2001) before moving to Flinders University in 2003. She now manages a productive interdisciplinary research laboratory focused on molluscan biodiversity and bioresources. Specific research projects include the development of a novel anticancer complementary medicine from muricid molluscs, investigation of the immune responses of marine molluscs to various stressors and baseline monitoring for the Adelaide desalination plant. She has attracted over $1.5M in research funding from a range of competitive and invited sources in the last 5 years and published over 35 peer reviewed research articles and three invited book chapters. Dr Benkendorff was awarded the 2000 Young Australian of the Year Award in Science and Technology, a 2001 Young Entrepreneur Award and a 2008 SA Young Tall Poppy Award for achievement in science. Kirsten is strongly committed to the communication of research outcomes to both scientific audiences and the broader public. She also coordinates undergraduate biology topics in Animal Diversity and Disease and Immunology and supervises a productive team of PhD and honours students.

Dr Sandie M Degnan, The University of Queensland

Sandie's path to her current Senior Lectureship at UQ has been convoluted and eclectic. She spent several years working as a field biologist on seabirds and turtles on the far northern GBR, marine fish behaviour in Japan, PNG and the Philippines, and especially robber crabs in Vanuatu. As an honorary South Pacific islander, she taught secondary school science and English. After a PhD on evolutionary genetics of island birds, which introduced her to the ever-expanding tools of molecular biology, Sandie returned to working in the ocean during postdoctoral studies at the University of California, Santa Barbara. At UQ, she now teaches diverse undergraduate courses, from the evolution of earth's biodiversity through to genomics, and lots in between. In her spare time, she runs a Marine Genomics research lab, with a core interest of better understanding how ecology and genes interact to drive local adaptation and population divergence in marine invertebrates. Her lab focuses especially on larval settlement and metamorphosis, as these transitional life history stages are crucial to the survival and distribution of natural populations. Although her students work with several different animal phyla, the molluscs remain a favourite!

KEYNOTE SPEAKERS - BRIEF BIOGRAPHIES

Dr Frank Köhler, Department of Environment and Conservation, Western Australia

frank.koehler@austmus.gov.au

Born in 1971, Frank Köhler grew up in Berlin, where he studied biology at the Humboldt University with majors in Zoology, Botany and Biochemistry. Undergraduate projects included research at the Department of Ecology as well as ethological studies of Natterer's bats at the Free University, Berlin. Having a strong interest in botany, Frank finished his diploma with a thesis on the vegetation ecology of bogs. In addition, for many years he has been an active member of various societies for the preservation of nature.

In 1998 Frank was awarded a two-year scholarship of the Konrad-Adenauer Foundation for his graduate studies on the phylogeny and evolution of Southeast Asian freshwater gastropods and received his doctorate in 2003 from the Humboldt University in Berlin. Thereafter, he has been responsible for the curation and databasing of molluscan types in the Museum of Natural History, Berlin. In 2005 he was employed as post doc in a project that aimed at understanding the evolution of reproductive isolation in European water frogs. From 2006 to 2008 he led his first own research project on the speciation and radiation of freshwater snails in Thailand. During his doctoral and post doc career, Frank travelled extensively in Southeast Asia and visited the collections of many natural history museums in Europe.

Most of his scientific work has been concerned with employing molecular and morphological data to address questions that relate to the systematics and biogeography of organisms and foster the understanding of patterns and processes of speciation and radiation. Currently employed by the Department of Environment and Conservation, Western Australia, and based at the Australian Museum, Sydney, he is involved with the study of a diverse radiation of largely undescribed land snail species in the north-western Australian Kimberley region.

Prof. Justin Marshall, University of Queensland

My principle aim is to understand how other animals perceive their environment. As arrogant humans we tend to assume we are the pinnacle of evolution, however, certainly in sensory terms this is far from true. By taking an approach to sensory systems which is based around ecology but also includes physiology, anatomy, behaviour and neural integration, I hope to decode languages such as colour and polarisation.

For further details of awards, publications, students and public domain output, please go to my web page: www.uq.edu.au/ecovis

Under the banner of sensory ecology, Marshall Lab. has 5 main research directions:

•Colour vision and colour communication in reef and rainforest.

- "Prawns in space" – using animal visual systems to redesign satellite and airborn remote sensing devices.
- "Deep-Downunder" – developing a submersible-based high-tech exploration capability for Australia.
- "CoralWatch" – a coral reef health monitoring system based on 'handy-man' paint charts.
- Polarisation vision in mantis shrimps – what will they think of next?

KEYNOTE SPEAKERS - BRIEF BIOGRAPHIES

Dr Leonid Moroz, University of Florida

I am interested in basic principles underlying the design of nervous systems, origins and evolution of neuronal signaling mechanisms. The major questions are: (1) why are individual neurons so different from each other, (2) how do they maintain such precise connections between each other, (3) how does this fixed wiring result in such enormous neuronal plasticity and (4) how does this contribute to learning and memory mechanisms? By taking advantage of relatively simpler nervous systems of invertebrate animals as models, my laboratory combine neuroscience, genomics, bioinformatics, evolutionary theory, zoology, molecular biology, microanalytical chemistry and nanoscience to understand how neurons operate, remember and learn.

For more than 25 years I have used a variety of molluscan species (including *Lymnaea*, *Aplysia*, *Pleurobranchaea*, *Clione*, *Octopus*, *Nautilus*, etc.) as powerful experimental paradigms in neuroscience and developmental biology as well as to study evolution of neural circuits, stereotypic and learned behaviors. I simply love molluscs! For their diversity, for their simplicity & complexity, for their colors & shells, and for revelations of their nervous systems… .

Recently, we and our collaborators have initiated several large-scale transcriptome and genome projects to support our physiological and evolutionary research (including the sequencing of the *Aplysia* genome as well as sequencing of ctenophore genomes using next generation of sequencing technologies).

Leonid L. Moroz earned his Ph.D. in Physiology and Evolutional & Developmental Biology under the tutelage of Prof Dmitry A. Sakharov at the Institute of Developmental Biology, Academy of Sciences in Moscow, Russia. His postdoctoral research was done with Prof. William Winlow at the University of Leeds in the UK and with Prof. Rhanor Gillette at the University of Illinois, Urbana. In 1998 Leonid Moroz joined the faculty of University of Florida. He is Professor of Neuroscience at the McKnight Brain Institute (College of Medicine) and Professor of Chemistry and Zoology (College of Liberal Art and Sciences) at the University of Florida, Gainesville & St. Augustine, USA.

Dr Mark Norman, Museum Victoria

Dr Mark Norman is Senior Curator of Molluscs at Museum Victoria in Melbourne, Victoria where he studies octopuses, squids, cuttlefishes and nautiluses (the cephalopods). He undertook his PhD on the systematics and biogeography of the octopuses of the Great Barrier Reef. This was followed by Harkness and QEII Fellowships on the Australian octopus fauna and octopus taxonomy in general. Since then his main research interest has been defining the Australian and Indo-West Pacific cephalopods, primarily the octopuses. Research interests include biodiversity, evolutionary origins and relationships, reproductive and defense behaviours, deep-sea faunas, and adaptations to key habitats and niches. He has undertaken field research throughout Australasia, Antarctica, Europe, United States and throughout the Pacific and Indian Oceans. He has also undertaken research into other invertebrates and Victorian fishes, and has published Australasian and world field guides on cephalopods.

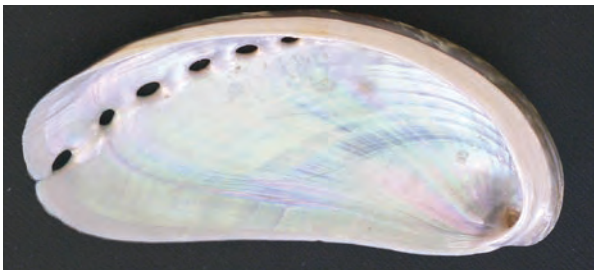
His current research activities include completion of a world revision of octopuses for the Food and Agriculture Organisation (UN), collaborations on phylogeny and higher-level classification of the octopods, regional revisions of the octopod fauna of China, Taiwan and New Caledonia, studies of cephalopod behaviour and reproductive biology, and the evolution and use of defensive toxins.

His broader interests include marine conservation and natural history interpretation through diverse media. He is series editor for the Museum Victoria Field Guides to Marine Life series and has published 12 children's books on natural history topics.

KEYNOTE SPEAKERS - BRIEF BIOGRAPHIES

Dr Rachel Przeslawski, Geoscience Australia

Rachel's research interests span larval ecology, global change biology, and marine habitat mapping. She completed her PhD at the University of Wollongong where she studied the effects of ultraviolet radiation and other stressors on the development of intertidal gastropods (otherwise known as the 'sunburnt sea snail' project). In 2006, she began a postdoc at Stony Brook University in New York where she continued to investigate the effects of stressors on molluscan larval development, particularly the role of brown tide in hard clam recruitment, as well as synthesising research on tropical benthic invertebrates and climate change. She is currently employed as an ecologist at Geoscience Australia where she is examining the utility of abiotic surrogates for marine biodiversity. This opportunity has allowed her to participate in several deep sea and tropical surveys and expand her study areas from temperate intertidal zones. In addition to her research, Rachel is also interested in science communication and tries to publish at least one popular science article each year in a glossy magazine that her mother will read.



Assoc. Prof. David Raftos, Macquarie University & Sydney Institute of Marine Science

Interests: marine biology, proteomics and invertebrate immunology

David Raftos is an Associate Professor of Marine Science at Macquarie University. He has over 25 years experience in marine biology, focusing on the cell and molecular biology of marine invertebrates. After completing his PhD, Associate Professor Raftos worked as a Fulbright Scholar at the University of California Los Angeles, and as an Australian Research Council Fellow at the University of Technology Sydney. He has since held faculty positions at the University of Technology Sydney and Macquarie University, and has also been a Visiting Professor at Cornell University in New York and the George Washington University in Washington DC. Associate Professor Raftos is currently acting as the Deputy Chair of the Department of Biological Sciences at Macquarie University and is Co-Director of the University's Marine Science Program. He is also a senior member of the Sydney Institute of Marine Science and has served on the editorial boards of the Journal of Experimental Zoology and Developmental and Comparative Immunology. His current research focuses on the effects of environmental stress on marine invertebrates at the cellular, protein and genetic levels, with particular emphasis on infectious disease and environmental contamination. His research projects, funded by the Australian Research Council and the Fisheries Research and Development Corporation, include the use of proteomics and transcriptomics to investigate the biological effects of environmental pollution and climate change on marine invertebrates, and molecular studies of disease resistance and susceptibility in oysters.

KEYNOTE SPEAKERS - BRIEF BIOGRAPHIES

Dr Robert Rose, Pearl Oyster Propagators Pty Ltd, Darwin

Dr Robert A Rose is a qualified marine biologist with over 30 years national and international experience in fisheries/aquaculture research, development and commercialisation. He is a managing director of Pearl Oyster Propagators P/L, Tropical Aquaculture Australia P/L, and Roberts & Rose Mariculture Corp (Philippines). He obtained a PhD from the University of Sydney in 1983 studying molluscan reproductive ecology, and has published over 30 scientific papers. Robert has research experience in the population dynamics of palinurid rock lobsters, prawns and mackerel from the Torres Strait during the 1970's and aquaculture experience with eight species of tropical/subtropical gastropods and bivalves during the 1980s-1990s. As a team leader with WA Fisheries in the 1980s, he helped developed the first successful, non-Japanese pilot-scale, hatchery in the world at Broome, Western Australia. Afterwards, he designed and project-managed six world-standard, commercial multi-species hatchery/grow-out farms in Australia and Southeast Asia. From 1990 to 2001, Robert has been the principle proponent and/or recipient of several federal research grants totalling $9.7 million to enhance the husbandry of commercial bivalve aquaculture. Between 2005 and 2008, Robert established the Mudla Farms' mudcrab project, the first Shared Responsibility Agreement of its kind between the Federal/Northern Territory Governments, and Indigenous Australians. Since 2000, he has commercially propagated and/or grown-out tiger prawns, saucer scallops, mud crabs, sea cucumbers, and evaluated recirculation systems designed for barramundi and eels. Currently, Robert is involved in an ARC Linkage genetics program between Pearl Oyster Propagators, Autore Pearling and University of Queensland. He is also a member of the Rural R&D Council responsible to the Australian Federal Minister for Agriculture, Fisheries and Forestry on matters relating to the national rural investment R&D programs. Dr Rose has recently commenced a commercial sea cucumber aquaculture project in Sabah, Malaysian in partnership with the Federal Ministry for Rural and Regional Development.

Assoc. Prof. Stephen Smith, University of New England

Steve is an Associate Professor at The University of New England (UNE) based at the National Marine Science Centre, Coffs Harbour, NSW. After completing his BSc (Hons) at Nottingham University, England, Steve travelled extensively until he arrived in Australia and decided that there was no better place for field-based marine research. Indeed, it was no hardship to trade the diver-training facilities (flooded quarries and 4°C water temperatures) of northern England for the blue waters of the Pacific! He subsequently completed a PhD at UNE, focusing on the impacts of sewage effluent on marine invertebrate communities associated with kelp holdfasts on shallow rocky reefs. Since then, Steve has remained with UNE, progressing from postdoctoral positions to his current role as Coordinator of Marine Science and Management. Steve has a broad interest in marine benthic ecosystems and, after a PhD project that involved laborious counting and identification of hundreds of thousands of small invertebrates, has been trying to find more efficient ways of conducting impact assessment and monitoring programs without sacrificing sensitivity or scientific rigor. It is on this basis that he has recently been investing more time in studies of molluscs in a range of marine and estuarine habitats. Over the last 7 years, Steve and his postgraduate students have been quantifying the spatial patterns and dynamics of molluscan assemblages on shallow reefs in eastern Australia. This research has provided important ecological information in a region where this is currently scant, and has allowed an evaluation of the suitability of mollusc surveys as a key component of biodiversity assessment and monitoring programs. While most of this research has been conducted in subtropical eastern Australia, Steve's research spans Antarctic through to tropical locations. Steve is not only a very keen diver but also enjoys underwater photography as a means of recording the remarkable biodiversity of the marine environment and conveying this to his undergraduate and postgraduate students as well as to a wider audience.

KEYNOTE SPEAKERS - BRIEF BIOGRAPHIES

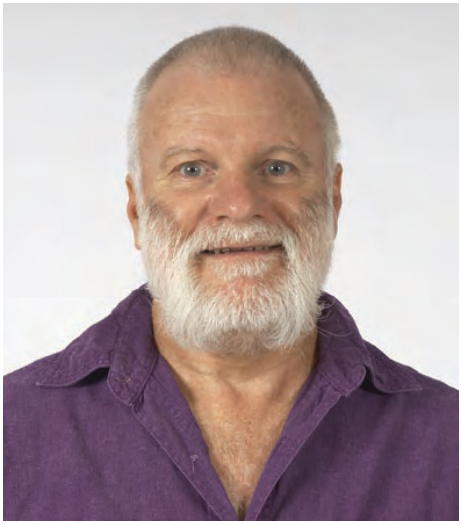
Professor Hamish G Spencer, University of Otago

Hamish is an evolutionary biologist in the Department of Zoology at the University of Otago, in Dunedin, New Zealand. He studied first at the University of Auckland, where he majored in mathematics for his undergraduate degree and in zoology for his masters; he subsequently won a Fulbright Grant to support his PhD study at Harvard University in population genetic theory. Hamish was appointed as a lecturer in the Department of Mathematics and Statistics at the University of Waikato in 1989, and three years later moved to the University of Otago to a position in Department of Zoology, where he is now head of department. Hamish has a wide range of research interests, having recently published on topics as diverse as the laws and attitudes surrounding first-cousin marriage and the developmental origins of human health and disease to mathematical models of frequency-dependent selection and the phylogenetic placement of the Galápagos Cormorant. In the last few years, he has also begun to apply molecular tools to answer evolutionary questions involving molluscs, most especially about their biogeography. In collaboration with a number of other workers, taxa studied include rhytidid and helicarionid landsnails, and a number of intertidal gastropods: lottiids, trochids, neritids, buccinids and onchidiids. Hamish is a principal investigator in two of the New Zealand government's Centres of Research Excellence, the Allan Wilson Centre for Molecular Ecology and Evolution and the National Research Centre for Growth and Development, and he also holds an appointment as an Honorary Research Fellow at the Liggins Institute, University of Auckland. In his spare time, Hamish is a keen bird watcher, reader and purchaser of too many bottles of wine.

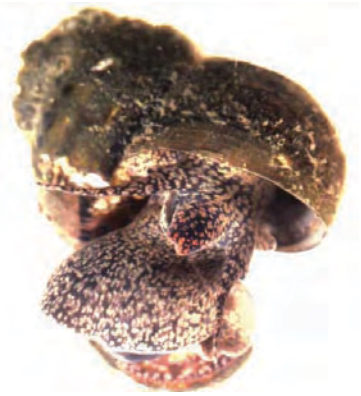
Assoc. Prof. Dr Andreas Wanninger, University of Copenhagen

I obtained my PhD degree in 2001 from the University of Munich/ Germany where I worked on comparative aspects of molluscan development. Since then, I have expanded my research interests across a wide diversity of marine invertebrate phyla including platyhelminths, annelids, brachiopods, entoprocts, ectoprocts, cycliophorans, and acoels. I am mostly interested in the ontogeny of the neuromuscular systems of these animals and we use immunocytochemistry, confocal microscopy, 3D reconstruction techniques, and gene expression analysis to infer lophotrochozoan interrelationships and basal morphological traits of hypothetical ancestors of selected nodes in the bilaterian tree of life. Since 2004 I have been employed at the Department of Biology, University of Copenhagen as Associate Professor and I am the leader of the Research Group for Comparative Zoology. Currently, there are 6 PhD students and a number of undergraduates in my lab. I teach courses at the undergraduate, graduate, and PhD level on animal diversity, comparative evolutionary zoology, and applications of confocal microscopy and 3D reconstructions in zoological research. Although my research has a broad, comparative approach, molluscan development and evolution has always remained an important cornerstone of my work, and I have recently entered the exciting field of cephalopod neurobiology and nervous system development.

Dr Richard Willan, Museum and Art Gallery of the Northern Territory



Dr Richard C. Willan has been studying nudibranchs for almost 40 years. He obtained his B.Sc. and Ph.D. from the University of Auckland studying the taxonomy and ecology of side-gilled sea slugs and sea hares. He then crossed the "ditch" as the Tasman Sea is popularly called to join the staff of the Zoology Department at the University of Queensland in Brisbane. After 12 years there, he moved into the tropics to take up the Curatorship in Molluscs at the Museum and Art Gallery of the Northern Territory in Darwin. He is a keen and still active diver. His research deals with the names (nomenclature), relationships (taxonomy) and evolutionary lineages (phylogeny) of nudibranchs (and other opisthobranchs - like bubble snails, sea hares, sap suckers and side-gilled sea slugs). He has published four books and numerous scientific papers on nudibranchs. Most recently he wrote the book "Undersea Jewels: A Colour Guide to Nudibranchs" with Gary Cobb. He has prepared several applications on the names of nudibranchs to the International Commission on Zoological Nomenclature. He has supervised several postgraduate students working on research projects associated with nudibranchs.



POST-CONFERENCE WORKSHOPS

Two post-conference workshops are to be held at the Moreton Bay Research Station, Stradbroke Island, on the weekend following the conference (28-29 November)

Freshwater molluscs – Organiser Dr Winston Ponder (assisted by Dr Frank Koehler and Mr Hugh Jones).

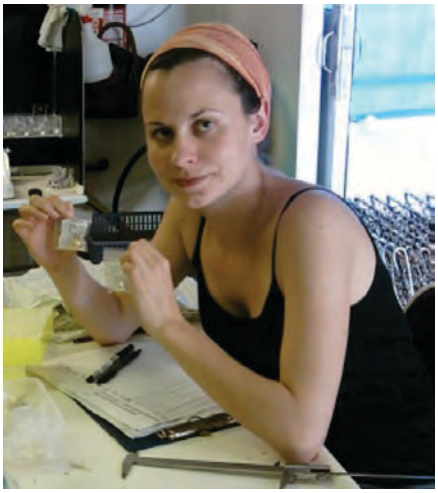
Australian marine bivalves – Organiser Dr John Healy (assisted by Dr Lisa Kirkendale and Mr Darryl Potter).

POSTER PRESENTATIONS

Poster	Authors	Title
1	Edwards, Vicki, Kirsten Benkendorff* and Fiona Young	An Assessment of Compounds from Dicathais orbita (Muricidae) on Human Female Reproductive Cells
2	Esmaeelian, Babak*, Kirsten Benkendorff, Catherine Abbott and Richard Le Leu	Preclinical testing of purified Muricid mollusc extract in rodent models for colorectal cancer
3	Ab Rahim, Emi*, John Donald, Kathryn Guthridge, John Forster and Brett Ingram	Better Blue Mussels: Genetic Tools for Breeding and Population Studies
4	Rose, Robert	Bridging the Gap between Old and New with Research and Development
5	Laffy, Patrick W*, Westley, Chantel, Benkendorff, Kirsten and Abbott, Catherine	Identification of a novel Ciliate Protozoan in the Hypobranchial Gland of Dicathais orbita: A Transcriptomics approach
6	Yamada, Chiharu*, Gyo Itani, Yukihiko Matsuyama and Hideo Sekiguchi	Larval Development of Hormomya mutabilis and Septifer bilocularis (Bivalvia: Mytilidae)
7	Printrakoon, Cheewarat* and Yoawaluk Chitramvong	Heavy Metal Accumulation in Mangrove Molluscs in the Upper Gulf of Thailand
8	Brown, Dianne, Rod Simpson* and Ian Hutton	Captive Breeding of the land snail, Placostylus bivaricosus, on Lord Howe Island
9	Hallan, Anders*, Chivas, Allan, García, Adriana and Devriendt, Laurent	From Lake to River: Lentidium in the Gulf of Carpentaria, northern Australia
10	Shea, Michael, Don Colgan, John Stanisic	Systematics and Phylogeography of the Landsnail Genus Gyrocochlea (Mollusca: Charopidae)
11	Criscione, Francesco*, Winston Ponder	Testing the monophyly of Rissooidea
12	Middelfart, Peter & Winston Ponder*	Worldwide review of the Galeommatoidea
13	Ponder, Winston	Identification made easy - an interactive key and information system for the shelled molluscs of SE Australia – stage 1
14	Ponder, Winston and Davis, Andrew	A course about molluscs – the molluscan biology course at the University of Wollongong
15	Ponder, Winston	The biology and evolution of the Mollusca – a new text book
16	Huelsken, Thomas, Dahlmann, Tim, Clemmensen, Marina, Healy, John*, and Hollmann, Michael	DNA barcodes of gastropod spawn: a case study for species identification of the endofaunal caenogastropod family Naticidae

TIMETABLE AND PROGRAM

SCIENTIFIC PROGRAM CO-ORDINATOR



Dr Carmel McDougall

Originally from Brisbane, I completed my undergraduate degree at the University of Queensland. My honours year was spent in Bernie Degnan's lab investigating the development of the shell of the tropical abalone, *Haliotis asinina*, before I headed overseas to complete my PhD. In a brief departure from molluscan studies, I spent time at both the University of Oxford and the University of St Andrews studying the development of the marine polychaete, *Pomatoceros lamarckii*. I've now returned to UQ and Bernie Degnan's lab as a postdoc investigating the genetic basis and evolution of shell formation in molluscs, using both *Haliotis asinina* and the pearl oyster *Pinctada maxima* as my study species.

OVERALL CONFERENCE TIMETABLE AND PROGRAM EXPLANATION

The full conference program from Wednesday 25th to Friday 27th is outlined in the following coloured pages.

Abstracts are in alphabetical order by the last name of the first author, with the presenting author marked with an asterisk. For oral presentations being presented by an author other than first author, there is also a second entry under the presenter's last name.

Poster Authors will be beside their posters during the Poster Cocktail Session on Wednesday evening to discuss their work and answer questions. Student judging of posters will be done during this session.

TIMETABLE TUESDAY

Program - Day 0 - Tuesday 24th November

	Emmanuel College, Stevens Bonnin Room
15:00 – 17:30	Registration and Poster Preparation
17:30 – 19:30	**WELCOME FUNCTION** **Introduction by Bernie Degnan, Chair, Conference Organising Committee:**

Information Disclaimer

The speakers, topics and times are correct at the time of publishing. In the event of unforeseen circumstances, the organisers reserve the right to alter or delete items from the Conference Program.

TIMETABLE - WEDNESDAY

Program - Day 1 - Wednesday 25th November

	Riverview Room	
9:00-9:15	Welcome introduction by **Fred Wells**	
9:15-9:20	**Fred Wells - Introduction to symposium:** **Invasive species, parasites and diseases**	
9:20-9:50	Keynote paper - **David Raftos** (Macquarie University) - QX Disease and the Sydney Rock Oyster immune system	
9:50-10:20	Keynote paper - **Richard Willan** (Museum and Art Gallery of the Northern Territory) – Should the chair that flew around the world have been a rocking chair?	
10:20-10:50	Keynote Paper – **Gary Barker** (Landcare Research) - Ecological interactions and the impact of invaders in New Zealand ecosystems	
10:50-11:10	**Morning Tea** (Stevens Bonnin Room)	
11:10-11:15	**Bernie Degnan - Introduction to symposium:** **Physiology and evo-devo**	
11:15-11:45	Keynote paper - **Leonid Moroz** (University of Florida College of Medicine) – Evolutionary genomics of gastropod and cephalopod molluscs: from pain to memory mechanisms	
11:45-12:15	Keynote paper - **Justin Marshall** (University of Queensland) – Cephalopod camouflage, conservation and central nervous system: some new advances in sensory biology and ecology	
12:15-12:45	Keynote paper - **Andi Wanninger** (University of Copenhagen) - Evo-Devo and the origin of Mollusca	
12:45-14:00	**Lunch** (Stevens Bonnin Room)	
	CONCURRENT SESSIONS	
	Riverview Room	***Seminar Rooms***
	Physiology and Evo-Devo Chair: **Andi Wanninger**	**Invasive species, parasites and diseases** Chair: **Richard Willan**
14:00-14:20	**Cummins, Scott** (University of Queensland) - Making scents of chemical communication in molluscs: from slugs to squid	**Green, Timothy** (University of Queensland) – Parasites, pathological conditions and mortality of Sydney rock oysters during the QX disease risk period
14:20-14:40	**Kranz, Alexandrea** (University of Queensland) - Identifying the germ-line in the tropical abalone *Haliotis asinina*	**Chimbari, Moses** (Harry Oppenheimer Okavango Research Centre, Botswana) - An assessment of schistosomiasis transmission in Maun, Botswana, sixteen years later

TIMETABLE - WEDNESDAY

	Riverview Room	*Seminar Rooms*
14:40-15:00	**Jin, Young** (University of Queensland) – Temperature changes induce transcriptional responses of heat shock family genes in the intertidal abalone *Haliotis asinina*	**Riginos, Cynthia** (University of Queensland) - Cryptic invasion of *Mytilus galloprovincialis* in Australa: sympatry and possible hybridization with a native *Mytilus* spp.
15:00-15:20	**Cranston-Guenzel, Hannah** (University of Queensland) – Expression patterns of *Pax6* and *Opsin* through embryonic development in the Pygmy Squid, *Idiosepius notoides*	**Rodely, Sam** (University of Wollongong) - Does shell thickness explain selective consumption of the invasive Pacific oyster by the muricid gastropod, *Bedeva hanleyi*?
15:20-15:40	**Afternoon Tea** (Stevens Bonnin Room)	
	Riverview Room	***Seminar Rooms***
	Physiology and Evo-Devo Chair: **Leonid Moroz**	**Invasive species, parasites and diseases** Chair:
15:40-16:00	**McDougall, Carmel** (University of Queensland) - A comparison of the nacre building gene sets of two molluscan classes	**Wilkie, Emma** (Macquarie University) - Ecological redundancy in habitats provided by native and non-native oysters: implications for managing disease afflicted estuaries
16:00-16:20	**Shaw, Jeremy** (University of Western Australia) - Understanding tooth biomineralisation in chitons: What's known and where to from here?	**Dang, Vinh** (Flinders University) - In vitro antiviral activity against Herpes virus in abalone, *Haliotis laevigata* and *Haliotis rubra*
16:20-16:40	**Ueda, Nobuo** (University of Queensland) - Variations in Heat Shock Protein 70 expression among larval and early spat developmental stages in the eastern oyster, *Crassostrea virginica*	
16:40-17:00	**Degnan, Bernie** (University of Queensland) - The impact of ecologically relevant heat shocks on heat shock protein function during the development of the vetigastropod *Haliotis asinina*	
17:30-19:30	**Poster Cocktail Session** (Stevens Bonnin Room)	

TIMETABLE - THURSDAY

Program - Day 2 - Thursday 26th November

9:00-9:05	Announcements (**Riverview Room**)	
9:05-9:10	**John Healy - Introduction to symposium:** **Phylogeny, systematics and biogeography**	
9:10-9:40	Keynote paper - **Hamish Spencer** (University of Otago) - Molluscan Molecular Phylogenies: Their Pros & Cons	
9:40-10:10	Keynote paper - **Frank Köhler** (Australian Museum) - Phylogeny and evolution of the Camaenidae in north-western Australia: A model case for the study of speciation and radiation	
10:10-10:40	Keynote paper - **Mark Norman** (Museum Victoria) - Diversity, evolutionary pathways and classification of octopuses	
10:40-11:00	**Morning Tea** (Stevens Bonnin Room)	
11:00-11:05	**Carmel McDougall - Introduction to symposium:** **Fisheries, aquaculture and bioactives**	
11:05-11:35	Keynote paper – **David Adams** (RMIT) – Conotoxin modulators of pain pathways	
11:35-12:05	Keynote paper – **Kirsten Benkendorff** (Flinders University) - A snail a day keeps the doctor away: investigating molluscan natural remedies	
12:05-12:35	Keynote paper – **Robert Rose** (Pearl Oyster Propagators) – Pearl oyster aquaculture: how will past and present R,D&E affect the future?	
12:35-13:15	***Malacological Society of Australasia AGM*** (***Riverview Room***)	
13:15-14:00	**Lunch** (Stevens Bonnin Room)	
	CONCURRENT SESSIONS	
	Kyle Common Room	***Seminar Rooms***
	Phylogeny, systematics and biogeography symposium Chair: **Hamish Spencer**	**Fisheries, aquaculture and bioactives symposium** Chair: **Robert Rose**
14:00-14:20	**Wilson, Nerida** (University of California) - Resolving controversy in molluscan phylogeny with new monoplacophoran sequence data	**Day, Rob** (University of Melbourne) - Density dependent mechanisms in abalone populations: how do they sustain fisheries?
14:20-14:40	**Sanpanich, Kitithorn** (Burapha University, Thailand) - Gastropods and bivalves from the Chang and Kood Islands, Trat Province, Thailand	**York, Patrick** (University of Queensland) - Isolation of growth and reproduction-related genes in *Haliotis asinina* ganglia by suppression subtractive hybridisation

TIMETABLE - THURSDAY

	Kyle Common Room	*Seminar Rooms*
14:40-15:00	**Kirkendale, Lisa** - "Their day in the Sun"- Molecular phylogenetics, origin of photosymbiosis and character trait evolution in the other group of photosymbiotic marine clams (Cardiidae: Fraginae)	**Jahangard, Samad** (Fisheries Victoria) - Success in development of commercial scale hatchery technology for Blue Mussel *Mytilus galloprovincialis* in Victoria, Australia
15:00-15:20	**Colgan, Don** (Australian Museum) - Phylogeographic patterns in southeastern Australian marine and estuarine Mollusca	**Dunstan, Andrew** (University of Queensland) - *Nautilus pompilius* fishing and population decline in the Philippines; a comparison with an unexploited Australian *Nautilus* population
15:20-15:40	**Afternoon Tea** (Stevens Bonnin Room)	
	Kyle Common Room	*Seminar Rooms*
	Phylogeny, systematics and biogeography Chair: **Frank Köhler**	**Fisheries, aquaculture and bioactives symposium** Chair: **Kirsten Benkendorff**
15:40-16:00	**Golding, Rosemary** (Australian Museum) - Phylogeny and Biogeography of Amphiboloidea (Gastropoda: Pulmonata) in Australia and South East Asia	**Cantin, Agnés** (Flinders University) - Validation of annual growth increments of the mud cockles, *Katelysia peronii* and *K. scalarina*, form the Section Bank, South Australia
16:00-16:20	**Hamilton, Zoë** (University of Western Australia) - Parapatry in Pilbara *Rhagada* - something old or something new?	**Noble, Warwick** (Flinders University) - Muricid fisheries and aquaculture: laboratory observations of the larval development of *Dicathais orbita* (Gmelin)
16:20-16:40	**Stankowski, Sean** (University of Western Australia) - Understanding the origins of morphological variation in the *Rhagada* land snails of Rosemary Island: population history or natural selection?	**Green, Timothy** (University of Queensland) - Development of disease resistance markers in the Sydney rock oyster
16:40-17:00	**Haynes, Alison** (University of the South Pacific, Fiji) - Biogeography of freshwater gastropods on Pacific Islands	
18:30-24:00	**Conference Dinner** (Riverview Room) commencing with drinks and canapés on the Riverview Courtyard	

TIMETABLE - FRIDAY

Program - Day 3 - Friday 27th November

9:00-9:05	Announcements (**Riverview Room**)	
9:05-9:10	**Winston Ponder Introduction to symposium:** **Ecology, conservation and indicators of biological change**	
9:10-9:40	Keynote paper - **Rachel Przeslawski** (Geoscience Australia) - Using molluscs to identify and predict the effects of changing environmental conditions in marine systems	
9:40-10:10	Keynote paper – **Sandie Degnan** (University of Queensland) – Molecular ecology of larval settlement in the marine gastropod *Haliotis asinina*	
10:10-10:40	Keynote paper – **Stephen Smith** (University of New England) – Molluscs as surrogates in biodiversity assessments of marine habitats: the pros and cons	
10:40-11:00	**Morning Tea** (Riverview Courtyard)	
	CONCURRENT SESSIONS	
	Kyle Common Room	***Seminar Rooms***
	General symposium Chair: **Don Colgan**	**Ecology, conservation and indicators of biological change symposium** Chair: **Stephen Smith**
11:00-11:20	**Talbot, Christopher** (University of Queensland) - The visual ecology of cephalopods	**Willan, Richard** (Museum and Art Gallery of the Northern Territory) – Quantitative studies of threatened land snails
11:20-11:40	**McBride, Candace** (Macquarie University) - The unusual formation of groups in the mourning cuttlefish, *Sepia plangon*: evidence of social interactions?	**Johnson, Michael** (University of Western Australia) - Three decades of climatic selection in the land snail *Theba pisana*
11:40-12:00	**van Gelderen, Rebecca** (EPA Victoria) - Imposex in *Thias orbita*: a case study of anthropogenic effects in molluscs	**Wright, Shelley** (University of New England) - Relic oysters as Holocene sea-level proxies on the Central Queensland coast and islands
12:00-12:20		**Salmo, Severino** (Central Luzon State University, Philippines) - Establishing mollusc colonization and assemblage patterns in planted mangrove stands of different ages in Lingayen Gulf, Philippines
12:20-14:00	**Lunch** (Riverview Courtyard)	

TIMETABLE - FRIDAY

	Kyle Common Room	*Seminar Rooms*
	General symposium Chair: **Bernie Degnan**	**Ecology, conservation and indicators of biological change symposium** Chair:
14:00-14:20	**Parkyn, Jonathan** (Southern Cross University) - The (short-term) dynamics of a population of the endangered species *Thersites mitchellae*	**Wong, Eunice** (University of Sydney) - Ocean warming and acidification effects on early development of the temperate abalone *Haliotis coccoradiata*
14:20-14:40	**Codi King, Susan** (Australian Institute of Marine Science) - Separation of the sympatric northern Australian rock oysters (*Saccostrea* spp.) by restriction fragment length polymorphism (RFLP) and terminal RFLP (TRFLP)	**Davis, Andy** (University of Wollongong) - Shell repair in an acidifying ocean: impacts on gastropod shell growth and integrity
14:40-15:00		**Stewart, Tom** (Flinders University) - Osmoregulation in the egg masses of *Sepioteuthis australis* and embryonic mortality in response to hypersaline brine discharge
15:00-15:20		**Holan, Jess** (University of Wollongong) - Call to arms: spicule armament as a defensive strategy against gastropod (Ranellidae) predators
15:20-15:40	**Afternoon Tea** (Riverview Courtyard)	
	Kyle Common Room	*Seminar Rooms*
	Fisheries, aquaculture and bioactives symposium Chair:	**Ecology, conservation and indicators of biological change symposium** Chair: **Rachel Przeslawski**
15:40-16:00	**Westley, Chantel** (Flinders University) - A histochemical approach to natural product research: biosynthesis of Tyrian Purple in *Dicathais orbita* (Neogastropoda: Muricidae)	**Payne, Nicholas** (University of Adelaide) - Operational sex ratios and 'time-in'; estimating the adult sex ratio of a coastal giant
16:00-16:20	**Wang, Ruoyang** (Flinders University) - The toxicity of anti-cancer extracts from *Dicathais orbita* (Muricidae) on human leukocytes	**Jones, Hugh** (University of Sydney) - Impact of catastrophic channel change on freshwater mussel populations in the Hunter River system
16:20-16:45	**Closing session**: Student Prizes and Concluding Address (***Riverview Room***)	
17:30	Bus departs for Stradbroke Island workshops	

Abstracts are in alphabetical order of first author last name, with the presenting author marked with an asterisk. If the presenting author is not the first author, there is a second entry in alphabetical order of the presenter, referring to the abstract text under the first author's nme.

Abstract Titles and Authors

Molluscs 2009
Abstracts

[Poster] Better Blue Mussels: Genetic Tools for Breeding and Population Studies

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Blue mussel (*Mytilus* sp.) production is one of Victorian aquacultures most rapidly growing industries. In 2006/07 blue mussel production was 3,116 tonnes (valued at $8.4 mil.), which represented 16% of total mollusc production (O'Sullivan and Savage, Austasia Aquaculture Trade Directory 2009). Research has been conducted on the blue mussel across many biological disciplines, including pollution monitoring, ecology, systematics and taxonomy. However, in the area of blue mussel hatchery breeding there is currently a paucity of knowledge. This paper describes genetic research supporting the establishment of a breeding program for blue mussel in Victoria, Australia. The aim of this project is to improve the growth rate, health and quality of blue mussel in a hatchery based system using a marker assisted selection breeding strategy. Founder family lines have been established using a total of 74 single pair crosses. Published Simple Sequence Repeat (SSR) markers from *Mytilus* sp. have been utilised (Yu and Li, Mol. Ecol. Notes 2007, 7:1308; Varela *et al*., Biochem. Genet. 2007, 45:565; Presa *et al*., Conservation Genetics 2002, 3:441) and additional SSR discovery was conducted *in silico* using publicly available *Mytilus* Expressed Sequence Tag (EST) libraries (Venier *et al*., BMC Genomics 2009, 10:72; Tanguy *et al*., Gene 2008, 408:27). These SSRs are being used to develop a parentage assignment test in order to assign individuals grown in a hatchery environment to their population. A further application for the SSRs is to assess the genetic diversity of blue mussel within and between Australian populations. The outcomes of this research will be applied to initiate a blue mussel selective breeding program to produce a genetically assured stock that will compete in both domestic and international markets.

[Keynote] Conotoxin modulators of pain pathways

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Alpha-conotoxins Vc1.1 (ACV1) and RgIA are peptides obtained from the venom of marine *Conus* snails that are currently in development as a treatment for neuropathic pain. Recently it was proposed that the primary target of Vc1.1 and RgIA is the α9α10 neuronal nicotinic acetylcholine receptor (nAChR). Surprisingly, however, we found that Vc1.1 and Rg1A more potently inhibit the N-type calcium channel currents in rat sensory neurons via a G protein-coupled receptor mechanism. N-type ($Ca_v2.2$) channel specific ω-conotoxins have been shown previously to be potent inhibitors of nociceptive signalling, however, this is the first demonstration of α-conotoxins acting via G protein-coupled $GABA_B$ receptors to modulate native $Ca_V2.2$ channels. The prevailing view in the literature until now has been that α-conotoxins primarily target nAChRs, so our current findings have the potential to introduce a paradigm shift in thinking about the targets of α-conotoxins. $GABA_B$ receptors may play a critical role in pain pathways and are a clear therapeutic target for these and novel "designer" conotoxins.

[Keynote] Ecological interactions and the impact of invaders in New Zealand ecosystems

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Using New Zealand as a case study, I will highlight the role of ecological interactions in biological invasions. First I will consider molluscs as the invaders, with examples of both direct (e.g. herbivory, predation, competition) and indirect (e.g. as vectors of pathogens and parasites) effects on native and non-native species. While consequences can be significant for affected species, terrestrial molluscs evidently function as keystone invaders – determining ecosystem-level properties – only in simple, synthetic system such as agricultural crops. Secondly I consider non-mollusc invaders, showing that while there can be direct effects on non-native and native mollusc communities, more generally effects are indirect and involve complex ecological interactions. As is well illustrated by New Zealand examples, many invasive mammals, and some plants, insects and fungi, function as keystones invaders, driving ecological cascades and causing major alterations in ecosystem structure and functioning. In all biological invasions, temporal, spatial, environmental and ecological contexts are hugely important in determining the nature and consequence of impacts. Often land-use has the primary role in perturbation of ecological communities. Land-use also has a major role in facilitating invasion by exotic species which, in turn, can heighten extinction risk in native species already affected by habitat loss.

[Keynote] A Snail a Day keeps the Doctor away: Investigating Molluscan Natural Remedies

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Molluscs have long provided a source of medicinally useful products for many cultures around the world. Currently, several bioactive natural products derived from molluscs are under development for pharmaceutical drugs and a number of molluscan therapies are listed on the Homeopathic Materia Medica and the Natural Medicines Comprehensive database. Molluscs also feature in a range of traditional medicines from South Africa, India and China. In most cases there is no data to support the application of traditional and homeopathic remedies from molluscs, although preliminary data available for some bivalves, cephalopods and caenogastropods, suggests that there is likely to be some chemical basis to their medical applications. There are increasing research efforts towards investigating the biologically active molecules produced by molluscs. Interestingly, however, there is no correlation between the number of species from different molluscan taxa that are used in medicines and the number of species that have been subject to investigation in the natural products literature. In particular, relatively few marine heterobranch molluscs feature in molluscan medicines, despite intensive chemical investigation. Conversely, the Cephalopoda and Polyplacophora feature in some traditional medicines, despite relatively few or no chemical investigations. Further studies aimed at identifying the bioactive factors in molluscan natural remedies are warranted to ensure their safe and effective application.

[Poster] An Assessment of Compounds from *Dicathais orbita* (Muricidae) on Human Female Reproductive Cells

Edwards, Vicki[1], Kirsten Benkendorff[2*] and Fiona Young[1]

Benkendorff presenting - refer Edwards for abstract text.

[Poster] Captive Breeding of the land snail, *Placostylus bivaricosus*, on Lord Howe Island

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The land snail, *Placostylus bivaricosus* (Gaskoin, 1855), is endemic to Lord Howe Island. Owing to pressures from past settlement and introduced predators (rats and birds) *Placostylus bivaricosus* is listed as an endangered species. Captive breeding and rearing of the species form part of a recovery plan, both to protect populations during planned intensive rodent eradication and to assist in the recruitment into wild populations. The breeding program will build on preliminary knowledge of the life cycle and habits of the snail to enhance the survival of hatchlings and juveniles from small captive populations.

Validation of Annual Growth Increments of the Mud Cockles, *Katelysia peronii* and *K. scalarina*, from the Section Bank, South Australia

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Katelysia peronii and *K. scalarina* are commercially important bivalve species (family: Veneridae) in South Australia, with the most significant fishery at Section Bank near Adelaide. After exponential increases in fishing effort over the past decade, catches and catch rates are now declining, leading to concerns about the sustainability of the fishery. Obtaining information on the ages of individuals in a population is invaluable for understanding population biology and for estimating recruitment, growth and mortality rates to facilitate fishery management. However, the ageing method must be validated to ensure that age estimates are accurate. Sectioned shells of both *Katelysia* spp., when treated with Mutvei's solution demonstrate interpretable patterns of increments. This study used several methods to determine the periodicity and timing of formation of these increments, i.e. calcein tagging, stable isotope analysis and marginal increment analysis (MIA). In the sectioned shells of all calcein-treated individuals, a clearly visible fluorescent band was evident close to the growing edge. One increment was formed in each shell through the period between treatment and capture. The high resolution $\delta^{18}O$ values showed that prominent translucent growth increments corresponded, in the most part, with a peak in $\delta^{18}O$, which indicated that this part of the shell was laid down during colder months. MIA analyses did not reveal any clear pattern and proved inconclusive for both species. The results of calcein tagging and stable isotope ratios indicated that the increments are formed annually, which means that they can be counted to estimate age in years. Two hundred animals, from across both species, have now been aged by counting such annual increments. These estimates of age were used to construct age structures and growth curves and also to calculate mortality rates.

An Assessment of Schistosomiasis Transmission in Maun, Botswana, Sixteen Years Later

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A national survey for schistosomiasis done in Botswana in 1978 led to the establishment of a control programme (1985-1993) in Ngamiland district resulting in a reduction of schistosomiasis prevalence from 28.7% to 6.7%. A rapid assessment conducted in 2000 suggested that prevalence of schistosomiasis in Maun could increase to the 1985 pre-control level due to the growing population and the steady flow of water maintained in Thamalakane river, the main river passing through Maun. A study initiated in 2009 is assessing the current situation of schistosomiasis in Maun. The study activities include monthly snail sampling to determine the presence and infection status of snails involved in the transmission of the disease, screening of high risk groups (school children, fishers and gardeners) and analysis of clinical records at health centres in Maun to show the number of schistosomiasis cases presenting at the centres. Results of snail surveys conducted at sentinel sites have shown few or no intermediate host snails and larger numbers of non-intermediate host snails. Clinical data from health centres showed very few cases of schistosomiasis. A prevalence survey to determine schistosome infections in screened people is not yet done. The observed few intermediate host snails at sentinel sites are explained by unusually high floods (highest in 20 years) experienced at the beginning of the surveys. Intermediate host snails were flushed downstream leaving behind larger prosobranch snails that are able to withstand the increased water current. The low numbers of cases in health centres is partly attributed to poor diagnosis of cases particularly in the case of *Schistosoma mansoni* and poor reporting by infected individuals. The role of variable flooding in the Okavango Delta in determining snail abundance and changes in human population densities resulting in increased human water contact are discussed.

Separation of the Sympatric Northern Australian Rock Oysters (*Saccostrea* spp.) by Restriction Fragment Length Polymorphism (RFLP) and Terminal RFLP (TRFLP)

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Rock oysters belonging to the genus *Saccostrea* occur commonly in the middle littoral throughout the northern, tropical regions of Australia and are viable as bioindicators for water quality monitoring. Three very similar species have been identified in northern coastal regions – *S. mordax*, *S. cucullata* and *S. mytiloides*. Shell morphology, alone, is not always reliable for identification to species and this represents uncertainty in studies where species level responses are being measured. The aim of this study was to develop a molecular test to differentiate between these *Saccostrea* species in northern, tropical Australia. DNA was extracted from oyster samples using the DNeasy tissue kit (Qiagen) and the mitochondrial 16S rRNA gene amplified by polymerase chain reaction (PCR). Mitochondrial 16S rRNA genes were sequenced for 20 oysters. For restriction fragment length polymorphism (RFLP) analysis, the 16S rRNA genes amplified by PCR were digested separately with the restriction enzymes *Hae*III and *Sau*3AI (Promega). For terminal restriction fragment length polymorphism (TRFLP) analysis, the 16S rRNA genes were amplified using a primer labelled with fluorescent dye and products were digested with *Sau*3AI. Sequence analysis confirmed three *Saccostrea* species at the site assessed in the Northern Territory and also revealed *S. cucullata* type A and D (Lam and Morton classification system). *S. mordax*, *S. mytiloides* and *S. cucullata* showed different banding patterns after digestion with restriction enzymes *Sau*3AI and *Hae*III. RFLP analysis using one enzyme allowed differentiation of the species; however a second enzyme was required for confirmation. TRFLP analysis allowed differentiation of each species using a single enzyme (Sau3AI), which generated terminal fragments of 365bp (*S. mytiloides*), 356bp (*S. cucullata*) and 251bp (*S. mordax*). *S. cucullata* types A and D could not be differentiated using TRFLP or RFLP analysis. RFLP and TRFLP proved suitable for *Saccostrea* species identification.

Shell repair in an acidifying ocean: impacts on gastropod shell growth and integrity

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Common intertidal gastropods in SE Australia show high levels of shell repair, reflecting attacks by crabs, particularly the black-fingered crab, *Ozius truncatus*. Previous studies of shell repair in gastropods have revealed that the integrity and strength of the shell is not compromised, but it remains unclear if this will be the case as the ocean acidifies. We simulated crab predation on the apertures of *Subninella undulata* and *Austrocochlea porcata* and then maintained them in recirculating aquaria at current (pH=8.2) and near-future levels of acidification (pH=7.9, 7.7) for a period of two and three months respectively. We predicted that shell repaired at the lowest pH would produce the thinnest and weakest shells, as well a reduction in snail condition (dry body mass: shell ratio). Our predictions were not borne out however; the lowest pH produced the thickest and strongest shells in each species. The same pattern has been observed in barnacle tests held at low pH. Shells were repaired rapidly and the aragonite/calcite ratios were little changed, but it seems that amorphous calcite was laid down at the lowest pH. In addition, we did not detect a difference in the index of snail condition among the treatments. Taken together our data indicate that an acidifying ocean is unlikely to modify interactions between gastropods and their crustacean predators.

Phylogeographic patterns in southeastern Australian marine and estuarine Mollusca

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Genetic studies have made significant progress in describing the biogeography of the marine gastropods of southeastern Australia but they have also shown that the evolutionary history of this area is complex. We will illustrate this by examining the distribution of genetic variation in relation to Bass Strait which has long been recognised as a significant biogeographic boundary. Most commonly, this has been explained in the context of environmental changes during glacial cycles and geographic isolation induced by landbridge formation at glacial maxima. For example, the line from the Furneaux Group to Wilsons Promontory that is the approximate location of the last land bridge between Victoria and Tasmania following the most recent glacial maximum still divides haplotype lineages in *Nerita*. We have examined phylogeographic variation in a number of species from different taxonomic groups and habitats, generally using mitochondrial DNA. These include the gastropod genera *Siphonaria*, *Tatea*, *Phallomedusa* and *Austrocochlea* and the bivalves *Brachidontes*, *Xenostrobus* and *Lasaea*. Whilst the influence of Bass Strait geological history can be seen in many cases, novel patterns of haplotype distribution are exhibited among these species. For example in the *A. constricta* group and *Xenostrobus pulex* the main haplotype classes are each found both east and west of the Furneaux line. In *Phallomedusa* the eastern lineage extends west of the line but the western form does not extend east. Remarkably, no major phylogeographic discontinuities were found in either of the two *Tatea* species. The most frequent haplotypes were identical in each species, and ranged from northern New South Wales to north of Perth. In general, comparisons between studied species suggest that phylogeographic structure is more marked in marine than estuarine taxa. Species phylogenies and genetic distance calculations suggest that the influence of the penultimate and possibly earlier glacial cycles can still be discerned.

Expression patterns of *Pax6* and *Opsin* through embryonic development in the Pygmy Squid, *Idiosepius notoides*

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Most notable for their complex visual systems are vertebrates and coleoid cephalopods. The camera type eyes of vertebrates and cephalopods are morphologically similar, however they have different embryonic origins. Eye morphogenesis in vertebrates and coleoid cephalopods is initiated by a homologous gene *Pax-6*. Characterising expression patterns of regulatory genes, such as *Pax-6,* in cephalopods will yield insight into how modification of conserved developmental programs can lead to convergence on morphologically similar end products (such as camera eyes and complex brains). I present the spatial and temporal pattern of *Pax-6* and *opsin* expression through embryonic development in the pygmy squid *Idiosepius notoides*. *Pax-6* expression patterns in *I. notoides* are consistent with this gene having a critical role in eye and olfactory organ development, as has been observed in other cephalopods, vertebrates, and other bilaterians. *Opsin* expression patterns in *I. notoides* are in agreement with a well established role in photoreceptor morphogenesis across metazoans. Novel expression of these genes during adhesive organ formation in *I. notoides* may reflect a species-specific function, as the adhesive organ is unique to Sepiolida.

[Poster] Testing the monophyly of Rissooidea

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The superfamily Rissooidea is one of the largest and most diverse molluscan superfamilies, with 22 recognized recent families and includes marine, freshwater and terrestrial members. Recent molecular analyses of caenogastropod relationships, including only a few rissooideans, have indicated that the group is at least diphyletic. Within the whole subfamily, only Rissoidae have been cladistically treated and there have been several analyses encompassing the numerous and diverse freshwater members of the group, which comprise at least nine families. However, no comprehensive molecular and morphological phylogenetic analyses of most of the members of the superfamily have been carried out so far, and its relationships with the related superfamily Cingulopsoidea are unresolved. This project will will encompass several species belonging to most of the families of Rissooidea and Cingulopsoidea based on material already collected from the Mediterranean Sea as well as from ongoing collecting in Australia. This is being supplemented by material obtained from other parts of the world. Morphological, molecular and combined phylogenetic analysis will test the congruence of commonly adopted morphological characters with molecular data. The phylogeny produced will be used to modify the classification for these groups where necessary. Preliminary results from a molecular phylogenetic analysis of a subset of rissooidean and cingulopsoidean taxa are presented.

Making scents of chemical communication in molluscs: from slugs to squid

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Life in the animal kingdom is about finding a mate, and in environments where vision is limited, animals may rely solely on olfactory signals. By far the most important signalling molecules are pheromones - chemical stimuli that are released by one animal that prompt hormonal and often behaviour change in another. Researchers have discovered thousands of pheromones, but most of these have come from insects. In recent years there has been important progress in our understanding of molluscan pheromone signalling systems. Our research has aimed at decoding pheromone-induced behavioural systems in molluscs. This multidisciplinary research has demonstrated that: (1) In the gastropod sea slug *Aplysia*, attraction and resultant breeding aggregations is the result of water-borne protein pheromones. Chemosensory detection appears to involve multi-transmembrane receptors present on the rhinophore sensory epithelia. (2) In the cephalopod squid *Loligo*, male-male aggression is the result of a contact protein pheromone. Male squid are visually attracted to female eggs, but need to physically touch the eggs to trigger the most aggressive behaviours, including fin-beating, forward-lunge grabbing and grappling - as they compete for access to fertile females. We've now been able to integrate all these finding into a clearer picture as to how molluscs communicate via pheromones.

In vitro antiviral activity against Herpes Virus in Abalone, *Haliotis laevigata* and *Haliotis rubra*

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Severe mortality of abalone due to Abalone Viral Ganglioneuritis (AVG) has been reported in south-east Australia and is caused by a herpes-like virus. In all reported outbreaks on farms and in the wild, a small proportion of abalone (10-50%) survived, indicating some individuals may have relatively strong antiviral defense. However, antiviral activity in abalone against this type of virus is still unknown. This research investigates antiviral activity in haemolymph and in water, lipid, and peptide extracts from different tissues of the greenlip *Haliotis laevigata* and the blacklip *Haliotis rubra*. The *in vitro* antiviral assay was based on inhibition of herpes simplex virus type 1 (HSV-1) replication in Vero cell monolayers. Different mechanisms of antiviral activity were detected in the abalone haemolymph and digestive gland lipid extracts (minimum inhibitory concentrations required for at least 20% protection of Vero cells = 5%v/v and 375 µg/ml respectively). The haemolymph plasma only showed antiviral activity when added to Vero cells simultaneously with HSV-1, but not if added 1 hr after viral infection, whereas lipid extracts from the digestive gland reduced the number of HSV-1 plaques either when added simultaneously or 1 hr after infection. This suggests the haemolymph may be inhibiting viral entry into the cells, whereas the extracts can also act at an intracellular level to affect HSV replication. Mean efficiency of protection from virus infection was similar between *H. laevigata* and *H. rubra*, but there was substantial variation between individuals within each species. Using 5% haemolymph, the reduction in viral plaques ranged from 4.4% to 68.5% across 15 individuals from each species. This variability in antiviral activity across individuals of these two abalone species could help explain why some abalone survived the AVG outbreak. Our results facilitate subsequent studies on the antiviral compounds in abalone and enable selection of virus-resistant abalone.

Shell repair in an acidifying ocean: impacts on gastropod shell growth and integrity

Coleman, Dan[1], Maria Byrne[2] and Andy Davis[1]*

Davis presenting - refer Coleman for abstract text.

Density dependent Mechanisms in Abalone Populations: how do they sustain Fisheries?

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It has long been recognized that populations to sustain harvesting over time must have compensatory density dependent (DD) mechanisms. Yet studies of these mechanisms for harvested species are very scarce. We studied DD responses in greenlip abalone (*Haliotis laevigata*) at all life stages, from settlement to reproduction, using experiments on abalone farms and in the wild. Settlement of larvae onto suitable algae appears to be density independent, but experiments in farms show post-larval mortality and growth are both strongly DD. The mortality of farm reared juveniles seeded into replicated reefs of natural rocks was weakly DD, but growth rate was strongly DD, and faster growth led to earlier maturation. Density manipulations at replicated sites with controls showed that at reduced densities, adults at the asymptotic size did not grow larger, but increased reproductive output. In smaller adult females, the proportion of extra somatic growth decreased relative to extra gonad growth as they approached the asymptotic size. Growth in smaller males increased in the same way, but all males increased testis size. Overall, the strongest effect is DD growth, which will shorten the effective generation time as density is reduced under fishing. Simulations of population dynamics under fishing that incorporate such strong DD growth and weak DD mortality and reproductive effects, show that standard stock assessments would be biased so as to increase the risk of fishery collapses.

The impact of ecologically relevant heat shocks on heat shock protein function during the development of the vetigastropod *Haliotis asinina*

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Heat shock proteins (Hsps) are essential for cellular maintenance, normal differentiation and morphogenesis, and protection against a range of environmental stresses. It is unknown which of these roles takes precedence when they are required simultaneously. Here we examined the impact of thermal stress on the complex developmental expression patterns of *HasHsp70* and *HasHsp90A* in the vetigastropod *Haliotis asinina*. We find that near-lethal heat shocks do not alter the spatial demarcation of Hsp expression despite such treatments impacting on the external character of the embryos. Using a suite of molecular markers that are both coexpressed with the Hsps (i.e in ventrolateral ectoderm and prototroch) and expressed in tissues that have lower (basal) Hsp expression (e.g. serotonergic nervous system and shell gland), we determined that Hsp-expressing tissues do not incur markedly less thermal damage than adjacent tissues. To explore the relationship of Hsp expression with sensitivity of specific cell territories to heat shock, we focussed on the formation of the prototroch, a tissue where *HasHsp70* and *HasHsp90A* are coexpressed. By heat shocking at specific developmental stages, we determined that the most sensitive period of prototroch development is during its early specification and differentiation, which overlaps with the time the Hsps are expressed at their highest levels in these cells. This correlation is consistent with heat shock impairing the function of Hsps in regions of the *H. asinina* embryo undergoing morphogenesis.

[Keynote] Molecular ecology of larval settlement in the marine gastropod *Haliotis asinina*

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A huge proportion of marine invertebrates, including many molluscs, have a biphasic lifecycle comprising a planktonic, dispersal phase (the larva) and a benthic, reproductive phase (the adult). Marine communities are structured primarily by larval colonisation events, and these are strongly linked to the environment. Dispersal ends when the larva detects an appropriate environmental cue that induces settlement out of the plankton and metamorphosis into the adult form. The interaction between animal larva and algal surface is intimate and crucial; when and where a larva settles will directly shape not only its own lifetime reproductive success, but also the benthic community to which it belongs. The tropical abalone, *Haliotis asinina*, is an ideal mollusc for studying molecular ecology of settlement. Building on knowledge of its larval development and phylogeography, we recently have identified natural algal cues that induce up to 100% of *H. asinina* larvae to metamorphose, and a suite of candidate genes involved in abalone settlement and metamorphosis. We find that larvae induced to settle by different species of coralline algae can all successfully undergo metamorphosis, but the exact nature of the algal cue significantly affects the post-larval transcriptional profile of several genes. Many genes continue to be differentially expressed for at least 40 hours after removal of the algae, clearly demonstrating a substantial carry-over effect of inductive cue on gene expression. These data unexpectedly reveal that transcriptional modulation of metamorphosis-related genes depends upon the precise composition of the benthic microenvironment experienced directly at induction of settlement. It has long been realised that larval experience prior to and during metamorphosis can significantly affect adult fitness, and our data now highlight gene expression as a mechanism that can mediate between larval and postlarval experiences. For new recruits into an abalone population, metamorphosis clearly does not represent a new transcriptional beginning.

Nautilus pompilius fishing and population decline in the Philippines; a comparison with an unexploited Australian *Nautilus* population

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The low fecundity, late maturity and long life span of *Nautilus* ensure their vulnerability to overfishing. Demand from the ornamental shell trade and restricted habitat preferences contribute to their rapid decline. This study reports fishing effort and related changes to *Nautilus* populations in the Philippines as compared to an unexploited population in Australian waters. Baseline capture, mark and release studies of *Nautilus pompilius* conducted at Osprey Reef, Coral Sea, Australia show this unexploited population to demonstrate a stable CPU over 12 years, a marked difference to the exploited Nautilus populations of the Philippines. Data from a detailed interview questionnaire of *Nautilus pompilius* fishers and traders in Palawan, Philippines highlight a fishery which is both unsustainable and culturally unimportant. The results show up to 80% declines in catch rates during periods ranging from 1980 to the present. Protection of *Nautilus* from fishing would provide minimal long term impact on the local culture or economy as there is no cultural relevance to local communities and the fishery only provides approximately 10 - 20 years of economic return before becoming non-viable. Identification of new *Nautilus* fishing sites and training of locals by buyers from distant depleted fishing areas shows the value and demand *Nautilus* shells have to generate fishing effort. Similar international demand has driven the introduction and subsequent decline of shark and beche de mer fisheries to the same developing Indo-Pacific nations of known *Nautilus* populations. *Nautilus* populations have been shown to be genetically different where divided by deep (>800m) ocean barriers to connectivity. This precludes recolonisation of depleted sub-populations and supports a strong argument for protection of all nautilus stocks to maintain genetic diversity. Strong evidence exists for *Nautilus pompilius* (and by ecological association, other *Nautilus* species) to be assessed as 'ENDANGERED' in the IUCN Red List and provides impetus for CITES listing.

[Poster] An Assessment of Compounds from *Dicathais orbita* (Muricidae) on Human Female Reproductive Cells

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The Australian Muricidae, *Dicathais orbita*, produces a range of bioactive compounds, including tyrindoleninone and 6-bromoisatin, which have anticancer effects *in vitro.* Muricidae are also the source of a homeopathy remedy used for the treatment of gynaecological disorders including chronic endometriosis, polycystic ovary syndrome and cancer of the uterus. We aimed to investigate the reproductive toxicity of bioactive compounds from *D. orbita* on primary-derived and cancerous human reproductive cell lines. Primary derived granulosa cells were isolated from the follicular aspirates of women undergoing assisted reproductive technology and compared to the female reproductive cancer cell lines, KGN and JAr (n=3). Granulosa cells and cancer cells were exposed to 3 semi-purified fractions from *D.orbita* at concentrations 0.005-1mg/ml for 4, 24 and 48h. Supernatant was collected for the measurement of progesterone by radioimmunoassay. Cell viability was determined using a tetrazolium salt cell proliferation assay. Fraction 2 containing the compound tyrindoleninone significantly reduced cell viability in the cancer cell lines at 0.05mg/ml after 4h exposure (49 and 59% for KGN and JAr cells respectively; $p \leq 0.001$). In comparison, there was only a 24% reduction in primary-derived granulosa cells treated with fraction 2 (0.05mg/ml). KGN and JAr cell viability was also reduced by 67 and 61% respectively at 0.5mg/ml ($p \leq 0.001$) with fraction 3 containing 6-bromoisatin ≥ 4h. The same exposure only reduced primary-derived granulosa cell viability by 33%. Fraction 1, containing a mixture of the compounds tyrindoxyl sulphate, 6-bromoisatin, tyrindoleninone and tyrindolinone was more toxic to primary-derived granulosa cells than to cancer cells. In conclusion, semi-purified extracts from *D.orbita* significantly reduced cell viability in human reproductive cancer cell lines compared to human granulosa primary-derived cells. Fractions 2 and 3 containing tyrindoleninone and 6-bromoisatin are the most promising candidates for future research and development, as analysis has shown greater specificity towards cancer cells than primary-derived reproductive cells.

[Poster] Preclinical testing of purified Muricid mollusc extract in rodent models for colorectal cancer

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The Australian whelk, *Dicathais orbita* (Muricidae), is a novel source of bioactive compounds with anticancer properties. Crude extracts from this mollusc have been tested *in vitro* and *in vivo* using short-term rodent models for toxicity and efficacy in the prevention of colorectal cancer. One important limitation of the preclinical models was the lack of purification in the extract. The crude extract used contains significant amounts of the oxidation product 6-bromoisatin, which is cytotoxic to both cancerous and normal human cells. Therefore, this compound could be responsible for some of the toxic effects observed in the liver. Consequently, in this ongoing research, we are trying to purify these bioactive compounds using flash column chromatography and test for anticancer activity in the presence of antioxidants. The results from liquid chromatography-mass spectrometry for purified compounds will be presented. Appropriate dosage of purified compounds for preclinical study will be measured using a cell proliferation assays on HT29 and Caco-2 colorectal cancer and IEC-6 normal gut epithelial cell lines. The longer term *in vivo* prevention model for colorectal cancer will be assessed by the regression of tumors and hepatotoxicity of bioactive compounds in rodents. This research will facilitate the development of Muricidae extracts as a novel complementary medicine for colorectal cancer.

Phylogeny and Biogeography of Amphiboloidea (Gastropoda: Pulmonata) in Australia and South East Asia

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The Amphiboloidea are a small superfamily of basal pulmonate gastropods containing approximately 12 known species. Amphiboloids are operculate, estuarine and have remarkably diverse and complex reproductive anatomy. Their phylogenetic position amongst the basal pulmonates is controversial, but the unique combination of plesiomorphic (marine, operculate, with reproductive monauly in some taxa) and derived characters (elaborate copulatory structures, with reproductive diauly in some taxa) confirms that amphiboloids are significant in the early evolution of Pulmonata. A recent morphological taxonomic revision recognised Amphibolidae (*Amphibola*, *Salinator*, *Lactiforis* and *Naranjia*) and two new endemic Australian families, Phallomedusidae (*Phallomedusa*) and Maningrididae (*Maningrida*). This project explores the relationships within and between these amphiboloid families to test their systematic validity and reconstruct their biogeographic history. To examine the internal relationships of Amphiboloidea, a molecular dataset of partial 28S, COI and 16S sequences was compiled, representing almost all known amphiboloid taxa and several additional new species from South East Asia and the Arabian Gulf. Material from several locations within the current distribution of *Salinator burmana* (Indonesia to the Arabian Gulf) demonstrates that this identity actually comprises several different species from at least two genera. A phylogenetic analysis of the molecular dataset indicates that the monotypic family Maningrididae is distinct and basal to the remainder of Amphiboloidea. Some amphiboloid taxa which are supported by morphological synapomorphies are polyphyletic in this molecular phylogeny. *Amphibola*, represented by a single New Zealand species, does not cluster with other 'amphibolid' genera, rendering the Amphibolidae paraphyletic. The molecular topology suggests that Amphiboloidea originated in Australia/New Zealand with multiple subsequent northward radiations throughout Asia.

Development of disease resistance markers in the Sydney rock oyster

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The Sydney rock oyster industry suffers from isolated but severe outbreaks of QX disease. QX disease is caused by a paramyxean protozoan parasite, *Marteilia sydneyi*. Prevention of QX disease currently relies on maintaining estuarine health and the future development of QX-resistant oysters. A genetic improvement program was initiated in 1994 to develop QX-resistant *S. glomerata* and selection over several generations has revealed that QX-resistance is heritable and likely to be controlled by multiple genes. The goal of this project was to improve our knowledge of the genes involved in immunity of *S. glomerata* to disease. Comparison of the transcriptome response of hemocytes isolated from *S. glomerata* bred for QX-resistance (**QXR**) with those from non-selected oysters revealed that increased survival of QXR oysters is largely attributed to constitutive changes in immune gene expression or increased 'general vigour'. This increase in general vigour may help explain why QXR oysters are also resistant to non-related diseases, such as disseminating neoplasia. The basal-expression of peroxiredoxin 6 (*Prx6*) gene was shown to be down-regulated in QXR oysters. In eukaryotes, differences in gene expression is usually linked to differences in transcriptional rate. Analysis of the promoter region of the *Prx6* gene from QX-disease resistant and susceptible oysters revealed several polymorphic sites, which potentially affect the binding of regulatory elements. Notably, the frequency of -231G/G was 0.400 in resistant oysters compared to 0.067 in susceptible oysters ($p = 0.059$). The presence of -231G/G resulted in the absence of a putative heat shock element in the *Prx6* promoter region in position -229 to -233. This SNP is a potential marker for disease resistance in *S. glomerata*.

Parasites, pathological conditions and mortality of Sydney rock oysters during the QX disease risk period

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The Sydney rock oyster industry currently suffers from isolated but severe outbreaks of QX disease. This disease is caused by an opportunistic paramyxean parasite, *Marteilia sydneyi*, when the immune system of *S. glomerata* is compromised due to one or more unknown transient environmental stressors. The disease usually occurs over the southern hemisphere summer months of January to April. Monitoring survival and histological observation of rock oysters in field trials over the QX-disease risk period revealed that mortality of oysters is not always the result of *M. sydneyi*. Several parasitic and pathological conditions have been observed infecting *S. glomerata*, possibly resulting in either host mortality or modulating the immune system of *S. glomerata* for increased susceptibility to *M. sydneyi*. The pathological condition, disseminating neoplasia was found to be the cause of significant rock oyster mortality in the Pimpama River, QLD during 2006/2007. Until this point, the Pimpama R. was believed to have yearly outbreaks of QX disease caused by *M. sydneyi*. The causative agent of disseminating neoplasia is currently unknown, but is possibly viral in origin. Other parasites have also been commonly observed infecting *S. glomerata* during the QX disease risk period. These include the microsporidian parasite, *Steinhausia* sp. which infects developing oocytes in the gonad of female oysters and *Rickettsia*-like prokaryote (RLPs) infections of the gill and digestive gland that are similar to RLPs that cause mortality of razor clams and abalone on the west coast of USA. From a selective breeding perspective, these results suggest that QX disease is a complex interaction of disease agents and has serious implication for the design and success of the Sydney rock oyster breeding program and immunological studies that rely on field infection of QX disease. Future field studies that rely on field infection of QX disease will need to conduct histological studies to determine the cause of mortality.

[Poster] From Lake to River: *Lentidium* in the Gulf of Carpentaria, northern Australia

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Throughout the Last Interglacial Period (~130 000 years ago until present) the Gulf of Carpentaria in northern Australia has fluctuated between a series of environments. These include fresh/brackish lake, saline playa and open marine, the latter as we know the region today. A species of the bivalve genus *Lentidium* Cristofori & Jan 1832 (Family Corbulidae), previously not recorded in the Southern Hemisphere and currently being described, flourished in great abundance from approximately 80,000 – 12,000 years ago when, for long periods, the Gulf was a lacustrine system separated from the surrounding oceans. The only extant described species of this genus, *Lentidium mediterraneum* (Costa O.G. 1829), inhabits euryhaline environments in the Mediterranean and Black Sea and exhibits a striking resemblance to the Gulf species with respects to shell morphology and environmental preferences. In the Gulf of Carpentaria, *Lentidium* dominated the molluscan fauna for millennia and its ubiquity provides a useful geochemical proxy for palaeo-environmental reconstruction. With the exception of open marine environments, it has been found in great abundance in sediments associated with relatively saline to comparatively fresh conditions, commonly with co-occurring planorbids, thiarids and clenchiellids. Furthermore, when the lacustrine phases ceased and the Gulf gradually became an open marine environment, the species retreated into rivers along the western Cape York Peninsula where it is found today, albeit elusively and yet to be observed alive in situ. As a narrative of the Gulf this species gives the opportunity to not only potentially reconstruct the environments in which it has lived, but also to follow its changes in size and its morphological variety from the lake of the past to the modern rivers. An account of its recorded history in this remote region is given while aiming to reconcile aspects of its variable appearances, surrounding environments and chemical signatures.

Parapatry in Pilbara *Rhagada* – something old or something new?

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Rhagada species from the Pilbara mainland, like so many of the Australian camaenids, have relatively small, non-overlapping geographic distributions. Eleven described species of *Rhagada* form a series of geographic replacements from Cape Leveque, in the Kimberly, southwards to Shark Bay (Solem, 1997). No obvious geographical barriers to dispersal explain the lack of geographical overlap. Current interpretation of the distributions of species of *Rhagada* is based on solely on morphological taxonomy, and the lack of overlap has precluded direct tests of reproductive isolation. Our extensive search for areas of transition between morphological forms revealed a sharp cline over less than 10 km between the large, unbanded, coastal species *R. convicta*, and an inland, small, heavily banded undescribed morphological form of *Rhagada*. We are investigating the population genetics of this transition, and the evolutionary history of these distinct forms. To test whether the meeting of the forms is the result of primary or secondary contact, relationships were investigated using two mitochondrial (COI and 16s) and one nuclear gene (ITS1). Both phylogenetic analyses and levels of sequence divergence between the two forms suggest secondary contact. The next stage of this study will be to examine whether gene flow occurs between these distinct forms, to attain some insight as to why parapatry and allopatry are typical in this genus, and whether shell morphology is a reliable indicator of species relationships.

Biogeography of Freshwater Gastropods on Pacific Islands

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Most gastropod species on Pacific islands belong to the families Neritidae and Thiaridae. They originated in South-East Asia where many of the same species are found. As both families are good dispersers, not many endemic species have evolved on each island. Some speciation in both families has occurred at the limit of their range. French Polynesia has three endemic neritid species and Samoa has two and Fiji one endemic thiarid species. The Hydrobiidae genera that are present on the islands are related to those in Australia They have undergone considerable speciation, with 54 species in New Caledonia, 10 species in Fiji and six species in Austral Islands. The reproductive system of the neritid genus *Septaria* is modified so that males in many species no longer produce sperrmatophores. Distinct species of *Septaria* have evolved in each island group. The males in some species are smaller than the females and the males in *Septaria macrocephala* from Fiji and New Caledonia change into females when they reach 12-15 mm long. Fewer of the same species present in south Pacific islands are found on North Pacific islands. However, the more isolated Hawaiian Islands have three endemic *Neritina* species and three endemic Lymnaeidae species. The number of gastropod species on each island depends on variables such as the size of the island, area of freshwater, height of the island and the distance it is from the source of gastropods.. Using multiple regression analysis it was found that the total area of water on an island was the factor that accounted for 84% of the variation in the number of species present. Distance contributed more to variation in species number on small islands where extinction rates were high, but the chance of re-colonization was greater if islands were nearer the source of gastropods.

Call to arms: spicule armament as a defensive strategy against gastropod (Ranellidae) predators

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Generalist gastropod predators have developed strategies to overcome defenses of their invertebrate prey. The rocky intertidal ascidian*, Pyura praeputialis*, is readily consumed by gastropods despite its tough outer tunic. *Cabestana spengleri* (Ranellidae) accesses the mantle of this ascidian by drilling holes through the tunic, while *Ranella australasia* (Ranellidae) extends its proboscis down through the ascidian's siphon. In contrast, feeding trials with these predators revealed that they failed to attack another common ascidian in SE Australia, *Herdmania grandis*. The mantle of *H. grandis* has large spine-like calcareous spicules which constitute ≈50% of the dry weight of this tissue. These spicules are up to 3mm in length and possess barbed tips. It is the only ascidian genus that has mantle spicules. We tested the defensive role of these physical elements in a series of laboratory feeding trials with the gastropods. We used palatable agar discs composed of freeze-dried and ground *P. stolonifera* mantle combined with ecologically relevant quantities of *H. grandis* spicules. Control discs were identical but lacked spicules. Both gastropod species consumed less of the discs when spicules were included and this was statistically significant for *C. spengleri*. Gastropod predators are significant determinants of the distribution and abundance of solitary ascidians in other regions of the world; in SE Australian waters we conclude that the spicules in *H. grandis* constitute an effective defence and likely account for its high abundance in the shallow subtidal-zone.

DNA barcodes of gastropod spawn: a case study for species identification of the endofaunal caenogastropod family Naticidae

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Determining the species composition of endofaunal gastropods is problematic, as species are often rare and hard to find due to their burrowing way of life. Recently, DNA barcoding has been demonstrated to be a valuable tool for species identification. Here, we demonstrate the efficacy of DNA barcodes (COI, 16S) for determining the species composition of the endofaunal gastropod family Naticidae of Lizard Island (Queensland, Australia) based on the comparison of molecular data from randomly collected naticid egg masses ("sand collars") with live-collected, ethanol-preserved specimens. Contrary to the animals themselves, the egg masses of the Naticidae are very abundant and are generally deposited on top of the sand surface where they are easily accessible. For a comprehensive investigation of the naticid species composition we initially identified those species that potentially could occur on Lizard Island. Together with published data and material vouchered in the Australian Museum (Sydney) and the Queensland Museum (Brisbane) our analysis revealed a total of at least 44 naticid species occuring on the Great Barrier Reef, which are assignable to 11 different genera within the 3 traditional subfamilies Polinicinae, Naticinae, and Sininae. Thirty out of these 44 species were found to occur sympatrically in the sandy habitats of Lizard Island. When compared with available sequences obtained from species that are generally assigned to the Great Barrier Reef and the North-Western Australian coastline, our molecular data allow a clear assignment of 58 sand collars to 7 species, five of which are known to be widely distributed in the Northern Great Barrier Reef and the Indo-Pacific region (Mammilla melanostoma, Notocochlis gualtieriana, Tectonatica suffusa, Natica pseustes, Naticarius onca). Three more egg masses with identical sequences could not be assigned to any specific taxon. Based on their position in a naticid phylogenetic tree and their low genetic distances to Sinum species, these egg masses are assumed to represent a member of the subfamilial subgroup Sininae (genera Sinum, Eunaticina). One egg mass that could be identified to species was shown to belong to Naticarius concinnus, a species that was hitherto known to occur only in the Indo-West-Pacific and on the Western Australian coastline. However, for reliable species identification multiple sequences are required since many marine gastropods are known to display several haplotypes, a problem that considerably complicates DNA barcoding. Our phylogenetic analyses based on 10 specimens and 29 egg masses clearly demonstrate the presence of at least 12 closely related haplotypes of N. gualtieriana, thus demonstrating that molecular analyses of egg masses in addition to species identification allow insight into the genetic structure of naticid populations. Finally, our molecular analyses additionally identified four taxa previously unknown from Lizard Island.

In summary, based on a combined analysis of live-collected specimens, randomly collected egg masses, and vouchered material from museums, DNA barcoding of egg masses of naticid species demonstrates an alternative, versatile technique for estimating naticid biodiversity that could easily be extended to studies of the genetic structure of populations and species, identification of unknown species, and phylogenetic relationships.

A comparison of the nacre building gene sets of two molluscan classes

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The metazoan capacity to biomineralize is closely linked to the rapid expansion of multicellular animal life during the early Cambrian. As a result, biomineralised structures exist in a wide range of taxa in a number of different forms. However the degree to which biomineralised structures are related in terms of the genetic and biochemical processes that underlie them is currently unknown. Here, using an Expressed Sequence Tag (EST) approach, we compare the genes that are expressed in the nacre (mother-of-pearl) forming cells from two molluscan classes: a bivalve (the pearl oyster *Pinctada maxima*) and a gastropod (the tropical abalone *Haliotis asinina*). Our results indicate that, once housekeeping genes are removed, only 10% of the genes are shared between the two datasets. Additionally, when the dataset is restricted to genes that are predicted to encode secreted proteins (i.e., the genes most likely to influence shell construction), less than 15% are shared. Despite these differences, both datasets contained a high proportion of novel genes that possess repetitive low complexity domains, particularly glycine-rich repeats. We also detect fundamental bivalve-gastropod differences in extracellular matrix proteins known to play roles in molluscan shell formation. *P. maxima* expresses a chitin synthase and several chitin deacetylation genes at high levels, in contrast with *H. asinina* in which only a single EST relating to chitin synthesis was found, suggesting that the organic matrix upon which calcification proceeds differs fundamentally between these species. Large-scale differences in genes expressed in nacre forming cells of oysters and abalone are compatible with the hypothesis that gastropod and bivalve nacre is the result of convergent evolution.

Success in Development of Commercial Scale Hatchery Technology for Blue Mussel *Mytilus galloprovincialis* in Victoria, Australia

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Victoria has historically dominated the blue mussel faming industry in Australia with production reaching a maximum of 1,582 tonnes ($3.73 million) in 2001/02. However, since then production has declined to just 824 tonnes ($2.31 million) in 2006/07. This decline has been attributed mainly to significant decreases in availability of wild spat, which has also reduced product quality and reliability of supply to markets. Reasons for this decline are not clear but factors associated with climate change issues and presences of exotic invasive fouling organisms have been implicated. To overcome shortfall in natural spat settlement, in 2008 a joint venture project was established between Fisheries Victoria (FV) and the mussel industry group, Victorian Shellfish Hatchery Pty Ltd (VSH) to develop hatchery technologies for commercial scale mussel seed production system at Queenscliff. The hatchery was commissioned in June 2008 and 6 spawning runs were completed by November which produced 5.5 million spat, but with inconsistent survival and variable and low densities on ropes (10'000 spat/5m rope). Following a critical review of operations in early 2009 (expert panel), and refinement of algal and larval culture systems and husbandry practices, production has become reliable and routine with in excess of 200 million spat (75,000 spat/5m rope) produced this year. It is estimated that the 2009 spat production at the VSH/FV hatchery could contribute to an increase of over 500 tonnes of edible mussels. This success has also extended the spat supply period from 2-3 months in nature to over a 9-10 month period a year. DPI's hatchery at Queenscliff is a pilot scale facility that is incapable of meeting the commercial mussel spat production needs of the broader industry. The challenge for the industry partners, buoyed by the success of the pilot hatchery to date, is to transfer this technology and intellectual property to a larger and commercial scale hatchery which realises economies of scale and stimulates new investment and industry growth. It is estimated that this technology developed through the joint venture project has the potential to make the Victorian mussel industry a $20 million (10,000 tonnes) industry within next 5-6 years.

Temperature changes induce transcriptional responses of heat shock family genes in the intertidal abalone *Haliotis asinina*

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The tropical abalone *Haliotis asinina* lives on the coral reef flat where it likely experiences a high degree of temperature fluctuation with daily tidal cycles. We examined *H. asinina* gene expression response to both chronic (19, 23, 27 and 31°C) and acute temperature changes (+0, +2, +4 and +6°C) of three different heat shock family genes that are known to confer thermotolerance, and are useful indicators of thermal tolerance limits of organisms. Gene expression profiles were compared against growth trends to examine potential association between transcript abundance and the phenotypes. Hsp genes were significantly up-regulated in response to chronic temperature increases, although the magnitude of the up-regulation was only small. Growth also tended to increase as chronic temperature increased. However, an apparent plateau in growth between 27°C and 31°C chronic treatments was observed. Hsp genes have dual functionality as regulators of both growth and maintenance (thermo-tolerance), and trade-offs appear to exist between the two functions. Two of the genes - Hsp70 and Hsp90 - showed a dramatic up-regulation in response to the highest acute temperature treatment (31+6°C), but the response of HSF genes did not significantly deviate from that observed at other temperatures. This difference in transcriptional response suggests that the regulatory mechanisms of Hsp genes are independent of those for HSF genes. Together, these observations suggest a plasticity and acclimatory adjustment of heat shock genes in the face of chronic and acute environmental temperature changes. This plastic and acclimatory response of Hsp may be crucial for abalone that experience widely varying environmental conditions on both seasonal and daily basis.

Three decades of climatic selection in the land snail *Theba pisana*

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The Mediterranean snail *Theba pisana* is polymorphic for banding on the shell. In introduced populations in coastal dunes near Perth, Western Australia, the proportion of effectively unbanded snails is higher in low, sparse vegetation than in adjacent, dense thickets of *Acacia*. A transect across the contrasting habitats has been censused each year since 1977, allowing powerful analysis of temporal variation. Although the *Acacia* habitat has extended 20 m into the Open habitat over this period, the association of shell banding with habitat has been stable. Nevertheless, variation in the proportion of banding morphs has varied substantially over time. There has been a small, but significant trend towards higher frequencies of effectively unbanded shells, but this is small, relative to the large increases and decreases from year to year. The pattern of genetic changes has been the same in the *Acacia* and Open habitats, consistent with an association with weather conditions. Controlling for habitat, the average proportion of effectively unbanded snails is significantly correlated with average maximum summer temperatures. This temporal association of shell banding with climate supports the hypothesis that microclimatic selection contributes to the genetic difference between habitats, whereby the paler, effectively unbanded snails are favoured in the more exposed habitats, as well as in hotter summers. Based on the rate of change in the frequency of banding morphs from one year to the next, it the annual selection coefficient on this polymorprhism related to temperature is about 0.16. Thus, in this species, changes in climate are associated with strong selection and rapid adaptation.

Impact of catastrophic channel change on freshwater mussel populations in the Hunter River system

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Australia has a distinct suite of endemic freshwater mussel species, several which are restricted to southeastern Australia, an intensively modified region supporting much of the nation's population and where pressures on freshwater ecosystems are increasing. We surveyed 78 sites in the Hunter River system to determine the distribution and abundance of the six mussel species occurring in the region, identify threatening processes and locate populations of high conservation value. Mussel populations were mainly distributed in the hydrologically stable southern Barrington rivers, where those in the Williams River have the highest conservation value. Strongholds for *Hyridella drapeta* were found in Wollombi Brook. Mussels were not detected at 40% of the sites, some of which supported mussels in the past. These were mainly reaches that have undergone river metamorphosis. Where found, most mussel populations had low densities and were highly fragmented. Major threats to these remnant populations are degradation of riparian and instream condition from agricultural activities, extreme climatic events (flood and drought) and the introduced macrophyte, *Salvinia molesta*. While threat mitigation can be achieved by habitat protection and strategies to reconnect mussel populations, managers are largely unaware of this invertebrate group. Formal recognition of regionally threatened mussel populations would do much to focus efforts on conservation. The proposed construction of a large dam on the Williams River is a potential threat to the most important mussel populations in the Hunter River system.

"Their Day in the Sun"- Molecular phylogenetics, origin of photosymbiosis and character trait evolution in the other group of photosymbiotic marine clams (Cardiidae: Fraginae)

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The subfamily Fraginae (Cardiidae) is a morphologically diverse group of small-bodied marine clams inhabiting shallow seas worldwide. Like the exclusively photosymbiotic giant clams (Cardiidae: Tridacninae), some fragines are known to host zooxanthellae photosymbionts. However, surveys to widely determine photosymbiotic status and the lack of a comprehensive phylogeny have hindered attempts to track the evolution of photosymbiosis in the group. Worldwide sampling of all fragine genera and subgenera with phylogenetic reconstructions based on four gene regions [nuclear (28S) and mtDNA (16S, cytochrome oxidase I, cytochrome *b*)] does not support a monophyletic Fraginae, with sampled taxa forming four restructured clades: (1) the '*Fragum*' group, (2) the '*Trigoniocardia*' and '*Ctenocardia*' groups, (3) the '*Parvicardium*' group and (4) the '*Papillicardium*' group. In contrast with earlier studies, direct live examination of > 50% of species reveals that less than half of derived genera and subgenera host photosymbionts, supporting a single and relatively late origin of photosymbiosis in the Fraginae. The comprehensive phylogeny coupled with the origin of photosymbiosis permits the evolution of key characters, including window shell microstructure, to be placed in a phylogenetic context. The evolutionary implications for a small and little modified earliest diverging photosymbiotic lineage to fragines, as well as giant clams, are discussed.

[Keynote] Phylogeny and evolution of the Camaenidae in north-western Australia: A model case for the study of speciation and radiation

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Camaenidae are Australia's most diverse land snail group encompassing 454 currently recognised species in 89 genera. The current systematisation rests predominantly on morphology-based works from the late 1970s to 1980s while more comprehensive molecular phylogenies have remained unavailable. Camaenidae are especially diverse in the Australian tropics, where they often show marked patterns of narrow-range endemism. A survey of the camaenid fauna of the Kimberley (WA) revealed consistent patterns of differentiation in anatomical (i.e., genitalia) and molecular markers. Most species are confined to well-defined and restricted habitats (rainforest patches, vine thickets, woodlands) often occupying ranges well below 20 km in diameter. Rarely, species are found at more than one locality. Data suggests that species numbers even in comparatively well-studied areas have been underestimated. For the Kimberley, I project an approximately two-fold increase in species numbers from currently 137 described species to about 250. This estimate is based on analyses of 300 samples from about 145 localities in the Kimberley (including 22 offshore islands that were surveyed for the first time) and adjacent areas of the Northern Territory. Patterns of genetic differentiation are not significantly different when island and mainland species are compared, which suggests that these patterns have evolved prior to more recent sea level fluctuations during the Pleistocene. It is assumed that the fragmentation of formerly more widespread rainforest habitats, caused by more arid climatic conditions since the Oligocene, has triggered the camaenid radiation by mediating isolation and parallel patterns of speciation in different lineages. The identification of previously overlooked cryptic (with respect to shell morphology) lineages indicates the presence of possibly homologous traits and prompts questions as to their adaptive significance. Similarly, the occurrence of sympatric sister species (e.g., on the Mitchell Plateau) suggests the possibility that isolation by spatial separation might not be the only speciation mode in camaenids of semi-arid Australia.

Identifying the germ-line in the tropical abalone *Haliotis asinina*

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To completely understand the sexual development of most species, two developmental processes need to be investigated: (1) germ-line development and (2) the development of the somatic cells and tissues that are necessary to support, enclose, and - if required - transport and expel these gametogenic cells; as each of these components have separate origins. Members of the *Vasa* and *Nanos* gene families are important for the specification and development of the germ-line in diverse animals. Here we determine spatial and temporal expression of *Vasa* and *Nanos* to investigate germ-line development in the tropical abalone *Haliotis asinina*. This is the first time these genes have been examined in an equally-cleaving lophotrochozoan species. We find that *HasVasa* and *HasNanos* have largely overlapping, but not identical, expression patterns during embryonic and larval development, with both being maternally expressed and localized to the micromere cell lineages during early development. By the trochophore stage, both *HasVasa* and *HasNanos* are expressed in the putative mesodermal bands of the larva. In order to investigate the development of the somatic portion of the gonad, we have isolated *HasDmrta1,* which appears to be expressed in the putative gonad primordium in larvae, prior to and following metamorphosis. Our results suggest that *HasVasa* is expressed in a population of undifferentiated multipotent cells, from which the primordial germ cells are segregated and compartmentalised into the somatic gonad later in development, i.e., that inductive signals and not maternally-inherited cytoplasmic determinants specify primordial germ cell development in this organism.

[Poster] Identification of a novel Ciliate Protozoan in the Hypobranchial Gland of *Dicathais orbita*: A Transcriptomics approach

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Suppressive subtractive hybridization (SSH) is a useful tool in transcriptomics studies to investigate key differences in gene expression between different tissue types, tissue disease states or the effect of environmental conditions. A SSH study was performed identifying genes differentially expressed in the hypobranchial gland (HBG) of the neogastropod *Dicathais orbita* (Muricidae), comparing expression between mantle tissue and HBG tissue. The identification of a subset of sequences with repeated stop codons within seemingly correct coding regions prompted further investigation into the expression patterns within this cDNA library. It was identified that this subset of "non-coding" sequences displayed significant homology to known ciliate protozoan sequences, a group of organisms whose codon translation frequently includes the standard stop codons TAA and TAG being translated to tryptophan residues. Furthermore, detailed analysis of ribosomal RNA sequences, commonly produced in transcriptomics studies but usually removed from the final dataset, identified the expression of ribosomal RNA sequences closely matching known ciliate protozoa. Subsequent histological analysis of the hypobranchial gland of *D. orbita* identified intracellular ciliate protozoa within the gland. This is the first study to identify the presence of ciliate protozoan within the hypobranchial gland of gastropods, and identifies a potential new use of SSH, namely for the discovery of parallel genomes within a single tissue sample.

[Keynote] Cephalopod camouflage, conservation and central nervous system: some new advances in sensory biology and ecology

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This talk details a number of ongoing projects in our lab, all falling within the general subject area of Visual Ecology. New findings presented include: How different are the visual systems of an octopus, squid and cuttlefish? Within a single group, how does a benthically oriented squid differ to one living in mid-water or the deep sea? At the ecological end of these studies, the latest findings in Nautilus ecology and conservation are presented and the behaviour of both this living fossil and Coleoid cephalopods are discussed. This includes vertical migrations, polarization vision and dynamic body-colour camouflage strategies. Finally, we are beginning to re-address the information processing part of this picture. Cephalopods were the original physiological model in understanding how nervous systems function in all animals. Remarkably, little is known about the comparative specializations and function of cephalopod CNS (central nervous system) for the animals themselves. We seek to interpret how visual information is processed and again, take a comparative, phylogeny-and-habitat, approach using new methods such as MRI along with basic anatomy and physiology.

Cryptic invasion of *Mytilus galloprovincialis* in Australia: sympatry and possible hybridization with a native *Mytilus* spp.

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Earlier work based on mitochondrial DNA suggests that Mediterranean *Mytilus galloprovincialis* has been introduced to Australian waters where it may be sympatric with an endemic southern hemisphere *Mytilus* species. Using both microsatellites and mtDNA, we demonstrate that there are indeed two distinct *Mytilus* taxa in Australia. Our preliminary data shows no evidence for gene introgression based on microsatellite loci, which would be expected if hybridzation were frequent. However, individuals with mismatched (female) mtDNA and nuclear backgrounds are identified, indicating incomplete reproductive isolation between these taxa. All populations surveyed from New South Wales, Victoria, and Tasmania are comprised of individuals with *M. galloprovincialis* and native *Mytilus* mtDNA types, consistent with widespread sympatry between nonindigenous and native mussels.

The unusual formation of groups in the mourning cuttlefish, *Sepia plangon*: evidence of social interactions?

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The formation of aggregations is widespread amongst the animal kingdom and has important implications for population dynamics and habitat utilisation. Gregariousness is a significant component in the development of social behaviour as it provides a framework for individuals to interact. The level of social organisation within a group is governed by the function of such aggregative behaviour. Cephalopods, an important group of animals to all marine ecosystems, whilst thought to show little or no social organisation, exhibit an array of behavioural patterns ranging from the solitary octopus to the shoaling squid. Current literature remains ambiguous about the level of social organisation displayed by cuttlefish, suggesting that most species are solitary for much of their lives with the formation of loose aggregations occurring only during their peak reproductive period. *Sepia plangon* is a small species of cuttlefish found in large abundances along estuaries on the east coast of Australia, in particular, Sydney Harbour. Unlike many other species, this cuttlefish forms small aggregations throughout the year, however the function of this grouping behaviour is unknown and may be attributed to defence, increased reproductive opportunities, conspecific attraction or a habitat association. This study investigated the function of this unique grouping behaviour through a series of daily and monthly SCUBA surveys, collections and genetic analysis at four sites within Sydney Harbour. *Sepia plangon* were found to be terminal spawners with their primary reproductive period occurring during summer. Group formation, sex and size composition varied on both a diel and seasonal basis. Group size was dependent on individual size, with larger groups consisting of smaller individuals and vice versa. Tissue samples collected from a large group of young cuttlefish did not reveal any genetic relationship between individuals, suggesting that groupings are not a result of a large number of conspecifics hatching from the same clutch.

A comparison of the nacre building gene sets of two molluscan classes

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McDougall presenting - refer Jackson for abstract text.

[Poster] Worldwide review of the Galeommatoidea

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The Galeommatoidea constitutes a highly diverse and taxonomically confusing assemblage of small marine bivalves greatly in need of revision. The most current revision is now 50 years old and was based only on shell characters (Chavan, 1959) in the *Treatise on Invertebrate Paleontology*. Many members of this family are unusual in having commensal relationships with other invertebrates. In addition some exhibit temporary or permanent enclosure of the shells by the mantle and even considerable shell reduction. A new analysis of known and emerging characters is in progress. Our study includes characters drawn from observation of types, secondary material, and the literature but also extensive observations on, and drawings and photographs of, living animals and a great deal of new data on associations collected over more than 30 years. The project is seeking a three-tiered phylogenetic basis for a contemporary revision of the superfamily, including (1) an analysis based on shell characters to compare with Chavan's results, (2) An analysis of shells and animals (including anatomy) to provide new insight into the evolution of the group, and (3) an ecological overlay to look at evolutionary patterns and possible co-evolution of commensal relationships. It is hoped that molecular phylogenetics will be included at a later stage. A character matrix of 74 characters has been established and scored for each of the more than 100 genera. To illustrate the diversity of characters involved in this study, we present as a case study a group of galeommatoideans associated with holothurians.

[Keynote] Evolutionary Genomics of Gastropod and Cephalopod Molluscs: From Pain to Memory Mechanisms

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For more than 70 years Gastropod & Cephalopod molluscs have served as powerful model organisms for comparative biology and neuroscience in particular. They represent a broad spectrum of complexity in their neuronal organizations: from numerically simpler nervous systems with giant identified neurons to one of the most complex brains in the animal kingdom. However, a major limitation in the field has been the lack of genomic information. As the initial steps in this direction, the genomes from three gastropod species (*Aplysia, Lottia* and *Biomphalaria*) have been sequenced. Furthermore, we have sequenced >5,000,000 ESTs/cDNAs from key model gastropod (*Aplysia, Philaplysia, Pleurobranchaea*, *Clione*, *Tritonia*, *Hermissenda, Melibe, Lymnaea,* and *Helisoma*) and cephalopod (*Nautilus*, *Octopus*, *Loligo* and *Rossia*) molluscs. These sequences (derived from developmental stages and various tissues) were assembled and cross-annotated primarily using the extensive transcriptome and genomic information from *Aplysia californica*.

Here, I will present a comparative analysis of these genomes and transcriptomes. *First*, this approach allowed us to identify both evolutionarily conserved neuronal genes and numerous genomic innovations within the phylum Mollusca including novel genes encoding signal molecules such as neuropeptides, prohormones and components of developmental programs. Molluscs have relatively slow evolving genomes allowing us to reveal numerous examples of extensive gene loss and gain across animal phyla (primarily associated with immunity, development and neuronal functions). *Second*, we have implemented several novel approaches that allowed us to characterize nearly all RNAs and epigenomic modifications in single functionally characterized neurons of the feeding and defensive neural circuits. As a result we were able to experimentally address three fundamental problems: (i) the logic controlling regulation of the entire genome in different neurons, (ii) parallel evolution and maintenance of the enormous diversity of neuronal cell lineages (homologous neurons) and (iii) identification of evolutionarily conserved molecular toolkits underlying learning and memory mechanisms. I will illustrate results from this analysis suggesting that injury-associated mechanisms leading to secretion of signal peptides (and related molecules) can be considered as evolutionary predecessors of various forms of memory and as major factors in the appearance of neurons in the first place. Similar evolutionary logic has also been applied to explain complex transcriptome responses following plasticity tests, leading to development of a model for parallel evolution of neurons and plasticity mechanisms.

The established molecular resources and the ability to map gene expression in a diversity of species should allow detailed study of the molluscan phylogeny and evolution of various biochemical, developmental and neuronal systems as well as provide a critical bridge between genes, circuits and behavior in the broad evolutionary context.

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Muricid fisheries and aquaculture: Laboratory observations of the larval development of *Dicathais orbita* (Gmelin)

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The term "whelk" is applied to a broad range of predatory marine gastropods from a number of families that include the Muricidae, Buccinidae, Melongenidae, and Fasciolariidae and others. Whelks have long been harvested for food, their often ornate shells, and for some species of Muricidae, the vibrant purple dye produced. Significant fisheries still exist to satisfy the demand by seafood markets around the world. In this paper is a brief review of the extent and value of worldwide whelk fisheries, their sustainability and the aquaculture potential of various species in order to mitigate the strain on the wild fisheries. In South Australia one potential candidate for muricid aquaculture is *Dicathais orbita*. Intracapsular development results in high hatching rates (~100%) of planktotrophic veligers. We investigated the post-hatching larval development of this species, in an attempt to close the life cycle. Newly hatched larvae were fed a mixed diet of green (*Tetraselmis sp., Nannochloropsis occulata*) and brown (*Isochrysis* tahitian*, Chaetoceros muelleri*) unicellular algae and maintained at a temperature of 22˚C. Observations were made daily for 40 days until they reached full competency prior to settlement. The larval stages and timing of this species will be discussed in the context of larval dispersal and aquaculture.

[Keynote] Diversity, evolutionary pathways and classification of octopuses

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An octopus is not just an octopus. Scientific and public conceptions of octopuses tend to be of a relatively standard large muscular animal, based on the model of the best-studied species in the world, the Common Octopus of the Mediterranean Sea and Atlantic Ocean, *Octopus vulgaris*. In truth, octopuses are the most diverse of any cephalopod group, far more diverse in morphology and behaviours than for all other cephalopod groups, particularly the cuttlefishes and many squid, which are physically constricted by their internal cuttlebones/shells. This paper reviews the diversity in form and behaviour of octopuses and, within the shallow-water octopuses, recognises distinct guilds of species that share similar ecological niches. Guilds may contain members of shared ancestry or member species that represent evolutionary convergence in form and behaviour. We report the results of molecular phylogeny research that challenge the current conception of octopus origins and relationships, and necessitate revision of octopod higher-level classification.

The (short-term) dynamics of a population of the endangered species *Thersites mitchellae*

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Mitchell's Rainforest Snail (*Thersites mitchellae*, Cox 1864) has been officially protected in New South Wales (NSW) since 1997, being the first invertebrate listed as Endangered under the New South Wales *Threatened Species Conservation Act* 1995 (TSC Act). The species is now listed nationally and internationally. *T. mitchellae* has a restricted distribution in remnants of lowland subtropical rainforest and swamp sclerophyll forest on the coastal plains of northeastern NSW, Australia. This habitat is vulnerable to the rising sea levels and increasing aridity predicted as a result of climate change. In January 2009 a population of the species was located at the Byron at Byron Resort just south of Byron Bay. The site is part of an intermittently open or closed lake and lagoon system (ICOLL). Pollock's robust design was applied to a mark-recapture study with analysis using Program MARK. The study was conducted within a 30 x 30m grid, the elevation of which varied by 50cm, the lower portion frequently inundated during the study. The pH ranged from 4.15 at low elevations to 5.57 at high elevation. The site was occupied by *Melaleuca quinquenervia* closed forest. One hundred and five individuals were captured at least once in our 18 sampling occasions. The weight of individuals varied between 0.3g and 31.2g with a mean(sd) of 8.84(9.25)g. The estimated probability of apparent survival was greatest at around 99.5% for mid-sized individuals, but less than 95% for the smallest and largest individuals. The humidity of the night was found to be an important positive covariate for the (re)capture parameters. The information learnt about this population will improve the chances of finding the species at other sites, and suggests some important factors that will assist its conservation.

Operational sex ratios and 'time-in'; estimating the adult sex ratio of a coastal giant

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The operational sex ratio (OSR) receives considerable attention in studies of mating systems, as it is considered a primary driver of intra-sexual competition and sexual selection. In contrast, the adult sex ratio (the ratio of each sex at maturity, ASR) is often ignored, or simply assumed to be unbiased, despite its potential influence on the OSR. Employing a relationship typically reserved for the calculation of OSRs, we used the known OSR of a giant Australian cuttlefish (*Sepia apama*) breeding aggregation (M:F 4:1), and quantified the ratio of 'time-in' between sexes in order to estimate the population ASR. The ratio of two 'time-in' metrics (residence time and residence period) between sexes were strikingly similar to the OSR of the population (3.7:1 and 4.6:1 respectively), suggesting that the ASR is indeed unbiased. Furthermore, the overall residence times of cuttlefish were small relative to the breeding season, suggesting that previous abundance surveys are likely to have significantly underestimated population size.

[Poster] Worldwide review of the Galeommatoidea

Middelfart, Peter[1] & Winston Ponder*[2]

Ponder presenting - refer Middelfart for abstract text.

[Poster] The biology and evolution of the Mollusca – a new text book

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Work is well advanced on a text book on molluscan biology and evolution written by Winston Ponder and David Lindberg (University of California, Berkeley) and illustrated by Julie Ponder. It includes chapters on the main systems (digestive, reproductive etc.) and all the main taxon groups, as well as more general chapters on physiology, 'natural history', research directions and human interactions (including conservation). Its strong evolutionary focus incorporates palaeontological information and the latest literature and ideas in all relevant areas of molluscan research. The poster provides some examples of the art work and more details about the contents. The book is scheduled to be completed in early 2010 and hopefully published by 2011.

[Poster] Identification made easy - an interactive key and information system for the shelled molluscs of SE Australia – stage 1

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An interactive key containing 550 taxa will be released live on the internet early in 2010 after a very long production phase. The key contains all groups – chitons, gastropods, bivalves, scaphopods and shelled cephalopods such as sepiids. There are 253 characters lying behind the key, making it a very powerful tool for identification and information retrieval. Information such as distribution, habits and references are provided and all included species are illustrated with colour figures. The production of this key has been possible through financial support by the Australian Museum in past years, and the involvement of a team of people including Michael Shea, Rowan McBain, Des Beechey and, most recently, Marlene Vial and Eunice Wong. The key is designed for use by people that do not have any particular familiarity with molluscs. Characters can be chosen in any order and most are illustrated enabling easy recognition. The program (IntKey) automatically chooses the best character to separate the remaining set of taxa. As characters are chosen, the possible taxa are quickly reduced in number. Images of them can be viewed at any point in the process. This key is intended to complement Des Beechey's Seashells of NSW website (http://seashellsofnsw.org.au/) which is based on families and intended for users with more familiarity with molluscs. **Stage 2** will include the addition of more taxa from Se Australia, including some of the micromollusc groups. A **Stage 3** is also planned and will include taxa from other parts of temperate Australia. There is no funding for this project and its further development will depend on the involvement of volunteers.

[Poster] A course about molluscs – the molluscan biology course at the University of Wollongong

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This twelve-day residential intensive course at the University of Wollongong commenced in 2003 and has been run four times with the fifth in January 2010. It is run by Winston Ponder and Assoc. Prof. Andy Davis with one or two other staff from the Australian Museum also involved (currently Dr Don Colgan). The course is probably the most comprehensive on molluscs available anywhere in the world. It involves an intensive schedule of lectures and laboratories, as well as field work, including a weekend at a field laboratory. It covers details of the main groups of molluscs, including their biology, diversity, conservation, classification and significance to humans. It is available to students from any Australian and overseas universities, as well as to post graduates and interested individuals. Students enrolled in universities can claim cross-institutional credit but must sit an exam at the end of the course.

[Poster] Heavy Metal Accumulation in Mangrove Molluscs in the Upper Gulf of Thailand

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Seven heavy metals, As, Cd, Cr, Cu, Ni, Pb and Zn were assessed in molluscs in six sites along the upper Gulf of Thailand. Most molluscs had the tendency to accumulate Cu or Zn in their tissues the best at all site. Both carnivore and herbivores at Leam Chabang industrial estate trended to have the best heavy metal accumulations in their tissues. The highest heavy metal accumulations in molluscs tissues were found in both carnivore and herbivores at Ang Sila of aquaculture area. Herbivores, scavenger and filter feeders at Khlong Khon, conservation area tended to have the best heavy metal accumulations. Comparison heavy metal accumulation among feeding strategy, from the highest to the lowest, was carnivore> scavenger>filter feeder> herbivore. Overview result**,** in the same trends, carnivore species, *Thais gradata* and *Chicoreus capucinus* had the highest As, Cd and Cu accumulation in areas that present this group such as both industrial estates. In Thai mangrove demonstrate, bioaccumulation in occurred at this study show Zn>Cu>Cd>As>Ni>Cr and Pb, respectively in tissue. Littorinidae, *Neritina violacea* and *Cassidula* spp., were common molluscs in this study. It is probably be all-round accumulator although it accumulates less in some metal that lower than Muricidae, effectively accumulated species show the highest levels of almost heavy metals. *Littoraria* spp. to be a more reasonable biomonitoring work in estuarine and coastal regions. In the Gulf of Thailand, especially *Littoraria melanostoma* may be a good indicator among Littorinidae. This study can conclude that sediment is the importance as a potentially important source of metal accumulation in the molluscs in mangrove habitat.

[Keynote] Using molluscs to identify and predict the effects of changing environmental conditions in marine systems

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Modelling has yielded many global and regional predictions of changing environmental conditions due to both anthropogenic and natural processes, many of which show great variation in the identity, strength, and timing of abiotic stressors. Marine molluscs represent an ideal group with which to identify and predict the effects of climate change due to their comparative ease of identification, prevalence in most habitats, and range of developmental modes, mobility and trophic guilds. Recent studies have shown that molluscs as a group are potentially vulnerable to almost every stressor associated with climate change, although some species have the capacity to adapt and even thrive in changing conditions. Importantly, marine organisms are exposed to multiple and possibly interacting stressors, and molluscs have already been used to investigate the effects of multiple stressors on development, reproduction, and mortality. The effects of changing environmental conditions are not limited to individuals and populations, and the cascading community and ecosystem effects may be dramatic, unpredictable, and persisting.

[Keynote] QX Disease and the Sydney Rock Oyster Immune System

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QX is an infectious disease in Sydney rock oysters (*Saccostrea glomerata*) caused by the protozoan parasite, *Marteilia sydneyi*. QX disease epizootics have resulted in substantial losses in the Sydney rock oyster industry since the 1970's. To combat QX disease, Industry and Investment NSW has incorporated selective breeding for QX disease resistance into their Sydney rock oyster breeding program. This has led to substantial decreases in QX-associated mortalities among selectively bred oysters. Our work has shown that QX disease outbreaks are associated with the suppression of one component of the oyster immune system, the defensive enzyme phenoloxidase (PO). The suppression PO activity associated with QX disease outbreaks occurs in response to environmental stress. Other studies indicate that resistance and susceptibility to QX disease is at least partially associated with the expression of different PO isotypes within oysters. The frequency of one isotype (PO^b) is significantly lower in mass selected oyster lines bred for QX disease resistance when compared to non-selected wild type oysters. The same pattern is evident in single pair family lines, where high frequencies of PO^b are found in families that suffer high QX-associated mortalities. Conversely, an alternative form of PO (PO^d) is more frequent in families that have low QX-associated mortalities. The data also suggest that other factors, in addition to PO, contribute to QX disease resistance. We have identified a number of these additional factors using proteomics. In particular, two superoxide dismutases, which may work in conjunction with PO to kill *M. sydneyi* parasites after phagocytosis, are expressed at higher levels in QX disease resistant oysters relative to wild types. Overall this project indicates that heritable resistance to QX disease is associated with changes in the phagolyosomal system that enhance the cellular defences of oysters against infection.

Cryptic invasion of *Mytilus galloprovincialis* in Australia: sympatry and possible hybridization with a native *Mytilus* spp.

Mather, Andrew[1], Shields, Jody[1], and Riginos, Cynthia*[1]

Riginos presenting - refer Mather for abstract text.

Does Shell Thickness Explain Selective Consumption of the Invasive Pacific Oyster by the Muricid Gastropod, *Bedeva hanleyi?*

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The Pacific oyster (*Crassostrea gigas)*, a non-native species in Australian waters, has established breeding populations in most NSW estuaries south of the Macleay River. Field observations in a far south coast oyster lease (Nelson Lake) indicated that a shell-boring predator exhibited a strong feeding preference for the invasive *C. gigas* over the native Sydney Rock oyster (*Saccostrea glomerata*). These findings ran counter to the predator-release hypothesis for invasive species. Subsequent laboratory feeding trials confirmed that *Bedeva hanleyi* (Muricidae) was the predator in question and that it exhibited a strong preference for *C. gigas*. We tested the hypothesis that shell thickness was a key determinant of this preferential feeding; making the prediction that the shell of *C. gigas* would be thinner than that of *S. glomerata*. We also predicted that the muricid would drill the thinnest sections of the shells of both species. Shell thickness measurements across drill holes for each oyster species did not support either of these predictions. We did not detect a difference in shell thickness between the two oyster species, nor did *B. hanleyi* seek out the thinnest sections of their shells. We contend that other factors, perhaps shell hardness, contribute to the observed preference. Our findings have implications for the control of this noxious 'fish' at oyster leases. They also suggest that the spread of this invader may be slowed and its impact on community structure and function reduced by this native predator.

[Keynote] Pearl oyster aquaculture: how will past and present R,D&E affect the future?

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The value of white South Sea Pearl production in Australian is linked to offshore market prices that vary markedly with economic conditions and foreign exchange rates. Demand for high quality pearls is likely to remain weak until supplies dry up, with many companies stock piling to avoid selling pearls at below recovery costs. Prior to the global financial crisis in 2008, the annual production value of Australian molluscs was under AU$ 255 million in 2006/07 with SSPs from *Pinctada maxima*, ranking highest at $142.3m followed by Pacific oysters at $51.1m, Sydney rock oysters at $35.1m, abalone at $17.5m and others (mussels, scallops, native oysters and *P. radiata*) at $9m. The trend in Australian pearl production over ten years shows a decline in value from almost AU$ 250m in 1998/99 to $142.3m in 2009. Global SSP production (with Australia contributing 61.4% of the total value or 38% by weight during 2009) has steadily increased from 0.4 tonne in 1982/83 to 2.4t in 1998 to 12.5t in 2009. In contrast, the value of SSPs produced over this 27-year period, initially increased from US$ 30m in 1982/83 to peak at US$ 220m in 1998 before decreasing to US$ 172m by 2009. A similar pattern of increasing production associated with diminishing returns has occurred with black SSPs and akoya pearls. 1980's R&D ensured that hatchery production will continue to provide inexpensive, robust oysters for experimental pearl cultivation, thus facilitating innovation and adoption of new technologies to mitigate deteriorating seawater conditions associated with climate variations and pollution. Recent veterinary research into Chlamydia-like bacteria and viral pathogen outbreaks amongst farm oysters, along with genetic/molecular studies into pearl biofabrication are priority areas for industry to remain competitive. Future education extension programs should be developed to ensure the workforce has skills to utilise new innovations towards improving productivity.

[Poster] Bridging the Gap between Old and New with Research and Development

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During the late 1970's, high levels of mortality amongst wild populations of the south sea pearl oyster, *Pinctada maxima*, seriously affected the viability of the Western Australian pearling industry. Cooperation between the WA Fisheries, Commonwealth Fishing Industry Trust Account (now the Fisheries Research Development Corporation or FRDC) and the Pearling Industry, led to an eight-year R&D aquaculture program that provided the Industry an alternative method of sourcing pearl oysters by the late 1980s. The newly developed biotechnology was first commercialised in 1989 by Pearl Oyster Propagators. Within thirteen years, this company had reached its first milestone in artificially propagating over one million adults that were seeded and harvested. Pearls produced generated at least a total of AU$ 182 million. The cost to produce a 5mm spat fell from 43 cents per individual during the R&D period to between 3 and 10 cents depending on the location and scale of operation. As illustrated pictorially, the essential areas of research involved understanding the biology, reproductive ecology and life cycle of *Pinctada maxima*. Development and commercialisation required adopting pre-existing aquaculture biotechnologies established during the 1960's and 80's by national/ international researchers for edible bivalves and abalone. High-volume production of premium pearls from hatchery-produced oysters was achieved by modifying techniques established with wild oysters by the Japanese in the 1960's. Hatchery technology in Australia is still evolving with many challenges ahead. Due to the high supply and low demand of pearls globally and the general deterioration of coastal seas, Pearl Oyster Propagators remains competitive today by engaging in ARC-Linkage research partnerships with the University of Queensland and Autore Pearling to further domesticate and selectively breed for a "merino" pearl oyster.

Establishing Mollusc Colonization and Assemblage Patterns in Planted Mangrove Stands of Different Ages in Lingayen Gulf, Philippines

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We investigated the assemblage patterns and species composition of infaunal molluscs in different ages of planted mangroves (6-, 8-, 10-, 11- and 18-year old) in Lingayen Gulf, northwestern Philippines. The study aimed to determine if the mollusc assemblage was associated with the developing forest and if such patterns could provide evidence for restoration of habitat functionality. A total of eleven mollusc species were recorded. Only two species, *Cerithidea cingulata* (Gmelin, 1791) and *Nerita polita* (Linnaeus, 1758), consistently appeared in all stands with the former as more prominent and the latter having less presence in maturing stands. Vegetation structure and productivity, and sediment characteristics changed between younger and more mature plantations. Mollusc assemblages significantly vary and have clear separation among different age stands, although the 8-yr stand precluded an otherwise clear trajectory. Moreover, species succession of the various molluscs groupings with maturing stands was tentatively described, as: rapidly decreasing (species that were initially high but disappeared in older stands); no detectable change (species that do not show any trend); possibly peaking (species that initially had low biomass, peaked at intermediate stands, and then diminished in mature stands); and, steadily increasing (species that have increasing biomass with maturing stands). In summary, this study affirms two things: (1) rehabilitated mangroves can be effective in facilitating infaunal colonization, albeit only part way for these stands; and (2) assemblage patterns change progressively as stands grow older.

The gastropods and bivalves from the Chang and Kood Islands, Trat Province, Thailand

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Trat is the most eastern province of the Gulf of Thailand, connected to Cambodia. The study on the marine gastropods and bivalves diversity of marine mollusks had been carried out in December, 2006, February and March, 2007 at 18 sites of Chang and Kood Islands, Trat Province. The specimens were collected randomly by using SCUBA diving along the coral reefs around the islands. 384 species were recorded and had been classified in Class Bivalvia 31families 79 genera 177 species and Class Gastropoda 55 families 93 genera 207 species. The abundances are as follow: 134 species (Mark Island), 107 species (Mai Si Island) and 102 species (Wai Island) respectively. The fewest diversity of molluscs area is at Hin-yuk Island about 19 species. Based on the number of localities where each species was collected, *Lioconcha annettae* (17 sites), *Tapes literatus* (Veneridae) (15 sites) and *Fulvia aperta* (Cardiidae) (14 sites) were the most common and widespread bivalves whereas *Polinices mammilla* (Naticidae) (15 sites), *Atys cylindricus* (Haminoeidae) (12 sites) and *Cypraea cylindrica* (Cypraeidae) (9 sites) were the most common and widespread gastropods. Sites with both the largest and smallest recorded mollusk diversity varied geographically. Most of the sites with high diversity were in the Kood Islands, while sites with low diversity were concentrated in the Chang Islands. The most occurrent frequency of gastropod is in Family Conidae and Cypraeidae and bivalve is in Family Veneridae, Cardiidae and Tellinidae, respectively.

Understanding tooth biomineralisation in chitons: What's known and where to from here?

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For almost 50 years, researchers have scrutinised the teeth of chitons in the hope of unlocking the secrets of how these animals harden their major lateral teeth with iron biominerals. For chitons, tooth mineralisation endows the animals with the ability to feed upon hard substrates, thereby allowing them to occupy niches off limits to their softer toothed cousins. For scientists, understanding the processes of tooth mineralisation may hold the key to developing new materials and devices based on a system that nature has perfected during millions of years of evolution. In general, biomineralised structures can be stronger, harder and stiffer than synthetic analogues, and may possess unique magnetic, electronic or optical properties. Importantly, the hard biomaterials deposited by organisms are formed under physiological conditions of pH, temperature and pressure; conditions that are benign and inexpensive compared to laboratory or industrial methods of synthesis. To date, the basic mineral composition and architecture of teeth from various chiton species has been determined, and, to some extent, the cellular delivery of raw materials needed for the mineralisation process has been elucidated. With the continual development of new technologies for characterising these tissues, what can be achieved, and where are our research efforts best placed to finally answer the mysteries of biomineral synthesis in these animals?

[Poster] Systematics and Phylogeography of the Landsnail Genus *Gyrocochlea* (Mollusca: Charopidae)

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The gastropod family Charopidae is very broadly distributed in the continents and islands of the Southern Hemisphere. It has great potential as a model system in phylogeography and has been the subject of several classical malacological studies. Yet what is known of the Australian fauna suggests that intensive studies will be required to elucidate the intricate systematic and biogeographic relationships of the family. In this project we are concentrating on some of the numerous land snail species currently placed in the genus *Gyrocochlea* . This genus has historically been used as a catch-all for most planorboid charopids found in eastern Australia. We have assembled databases detailing more than 100 conchological characters from more than 400 specimens from museum collections and new field sampling. These observations have revealed an enormous diversity in the genus, suggesting that our sample represents more than 30 species and morphospecies. Observations of the embryonic shell, the protoconch, using scanning electron microscopy, strongly suggest that multiple genera (possibly eight or more) are present in the assemblage and that cryptic species may co exist with known species which have superficially similar gross shell morphology. Up to three genera co exist at some sites. Anatomical studies have concentrated on particular structures within the male reproductive organ and the configuration of structures in the entire reproductive system. These studies support the recognition of many new species and generic level differences. DNA sequencing of the mitochondrial cytochrome *c* oxidase subunit I gene of *Gyrocochlea* and putative outgroups has revealed very high levels of divergence within the taxon and supported the suggestion from our other data that *Gyrocochlea* is polyphyletic. Our analyses support the suggestions clarifying charopid systematics would greatly assist in understanding the highly complex biogeography of montane and coastal eastern Australia.

[Poster] Captive Breeding of the land snail, *Placostylus bivaricosus*, on Lord Howe Island

Brown, Dianne[1], Rod Simpson*[2] and Ian Hutton[3]

Simpson presenting - refer Brown for abstract.

[Keynote] Molluscs as Surrogates in Biodiversity Assessments of Marine Habitats: the Pros and Cons

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Despite the fact that molluscs predominate in many marine habitats, both in terms of diversity and abundance, seldom are they included in comparative biodiversity assessments. For example, the most commonly applied quantitative methods for tropical reefs include assemblage-wide surveys of fish and sessile benthic taxa (mostly corals) and population assessments of only a few dominant or charismatic molluscan taxa. Drawing mostly on research conducted in subtropical eastern Australia, this paper examines the use of molluscs in the assessment and monitoring of marine biodiversity. The paper will review common sampling methods used to survey molluscs and present the results of work conducted on intertidal and subtidal reefs exploring the suitability of molluscs for long-term monitoring. In particular, the discussion will focus on the "desirable" characteristics of biodiversity surrogates and critically examine how well molluscs perform against this list.

[Keynote] Molluscan Molecular Phylogenies: Their Pros & Cons

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Molecular phylogenetics has revolutionized molluscan taxonomy, in much the same way as for many other groups of animals. Nevertheless, these advances are not without problems. Using several examples, most taken from work in my group on various gastropod groups – lottiid limpets, trochoideans, neritoideans and rhytidid landsnails – I highlight what I see as some of the advantages of a molecular approach to taxonomy. I also discuss some of the potential pitfalls of molecular systematics, and suggest ways in which these problems can be identified and avoided or, at least, ameliorated.

Understanding the Origins of Morphological Variation in the *Rhagada* Land Snails of Rosemary Island: Population History or Natural Selection?

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Understanding the roles that history and natural selection play in shaping geographical patterns of variation is a long-standing aim of population genetics. While natural selection is viewed as the primary mechanism shaping levels of variation within and among natural populations, selection can only act on the variation present. Events that take place during a population's history (*e.g.* founder events, bottlenecks and drift) can drastically influence the level and nature of variation within that population, resulting in broader geographical patterns that cannot be explained by selection alone. Land snails, and their notoriously variable shells, have contributed enormously to our understanding of the relationships between selection, history and the geographic distribution of variation. The aim of the present study was to understand how these forces have influenced patterns of shell shape and size in the *Rhagada* land snails of Rosemary Island, Western Australia. These snails vary enormously in both their shape (from globular to keeled-flat) and size. I collected *Rhagada,* and environmental data, from 103 locations on Rosemary Island. Geometric morphometric analysis conducted on 941 individuals confirmed the presence of profound morphological variation on the Island, but no clear morphological groups. Analysis by location revealed that the majority of variation, in both size and shape, was distributed among populations. Variation in shape (flatness) was correlated with environmental variables, while distribution of size was best explained by geographic position, with distinct large and small 'area affects' observed. No relationship was observed between flatness and size. These preliminary results suggest that both history and selection have influenced the distribution of morphological characters on Rosemary Island. While the shape of shells does appear to be an adaptive response to variation in habitat, the distribution of size may require a historical explanation. Molecular markers will be used to test these hypotheses.

Osmoregulation in the egg masses of *Sepioteuthis australis* and embryonic mortality in response to hypersaline brine discharge

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Recently numerous seawater desalination plants have been proposed in South Australia to meet the increasing demand for water. However, there is limited information available regarding the impacts of brine on local South Australian marine organisms. This study was undertaken to determine the effects of hypersalinity on the egg masses of the Southern calamary *Sepioteuthis australis,* as a model species for the potential impacts of desalination discharge into South Australian gulfs. Osmoregulation and osmotic tolerance were determined by exposing *S. australis* egg capsules to five salinity treatments 35, 45, 55, 65 and 75 ppt. Measurements of intracapsular fluid were taken at 0, 0.5, 1, 2, 4, 8 and 24 hours, and the embryos were assessed for mortality. It was found that *S. australis* egg capsules do not regulate salt flux and are therefore osmoconformers, with intracapsular fluid osmolarity equalling that of the external surroundings within a period of two hours. As a result of the inability of *S. australis* egg capsules to mediate changes in environmental salinity, significant increases in mortality could be detected at salinities higher than optimal conditions. It was found that a 100 percent mortality rate occurred after just 0.5 hours of exposure to salinities greater than 55 ppt, whereas a significant increase in mortality occurred at 24 hours exposure in the 45 ppt treatment. This study has shown *S. australis* to be a useful indicator species for assessing the impacts of brine discharge, as their embryos are vulnerable to changes in environmental salinity during encapsulated development. As *S. australis* is a semelparous species it is prone to population crashes as a result of recruitment failure and if hypersaline brine discharges are not dissipated effectively there is the potential for significant mortality effects.

The visual ecology of Cephalopods

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Coleoid cephalopods, consisting of octopus, cuttlefish and squid, are a highly advanced group of voracious marine predators endowed with a remarkable and complex visual system. These animals, which inhabit every type of spectral marine environment on the planet, are almost all monochromatic, however, their photoreceptors possess orthogonally-arranged microvilli, providing sensitivity to the *e*-vector of polarized light. Retinal specialisations, such as horizontal streaks and elongated areae, have been identified in several species, correlating with pupil shape and habitat niche, possibly providing higher levels of visual acuity and sensitivity to corresponding areas in their visual field. Many coleoids possess amazing body pattern repertoires due to highly pigmented and changeable skin. These patterns are used primarily for communication and camouflage. This study aims to conduct a comparative analysis of the features of the visual ecology of coleoid cephalopods, comparing visual characteristics with both ecological niche and spectral habitat. This will reveal whether environmental or phylogenetic pressures are primarily driving the evolution of their specialised visual system. Retinal structure and photoreceptor dimensions will be analysed to identify areas of specialisation and calculate sensitivity. Functional polarization sensitivity will be demonstrated using an optomotor and optokinetic apparatus. This apparatus will also be used to calculate and compare the ultimate sensitivity of the polarization vs. luminance visual system. These features can then be compared between across the three coleoid groups, and between species which inhabit different spectral environments e.g. a coral reef cuttlefish vs. a deep sea octopus vs. a pelagic squid.

Variations in Heat Shock Protein 70 Expression among Larval and Early Spat Developmental Stages in the Eastern Oyster, *Crassostrea virginica*

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Heat shock proteins (HSPs) are a group of molecular chaperones that assist during folding processes of proteins for functional conformations. They play as key metabolic regulators during normal cellular processes and as cellular defense mechanisms in the face of stress. Depending upon the expressional patterns, HSPs have been identified in two types, constitutively expressed forms (HSCs) which are thought to be localized in sub-cellular compartments and support translocation of nascent polypeptides, and stress induced forms (HSPs) which are involved in re-folding of denatured proteins in the cells. Due to the induction in response to stresses, HSPs have been extensively studied to quantify stress levels in organisms. In addition to stress-regulated expression, developmental regulation of these proteins is reported in many species, however, little is known about developmental regulation of HSPs in marine invertebrates. In our studies, differences in expression patterns of HSP 70 in the Eastern oyster, *Crassostrea virginica*, during larval and early spat stages were examined. In addition, the effects of temperature on expression patterns of HSP 70 were also studied in order to better understand how the combination of developmental changes and environmental stress impact the expression of these proteins. We found differences in the expression of both constitutive and inducible forms of HSP 70 among larval and early spat stages. The current results indicate differences in stress tolerant strategies between early and later life stages of *C. virginica*.

Imposex in *Thias orbita*: a case study of anthropogenic effects in molluscs

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Human impacts on the natural environment and wildlife are becoming more prominent in the minds of scientists, politicians and the general public. There is a greater concern for the toxicants that we release into the environment and their consequences. Molluscs are a biological group that are exposed to high levels of contaminants and the case of imposex in *Thias orbita* is a well studied and important cautionary tale. Imposex is a condition found in molluscs where male sex characteristics are 'imposed' on females. The putative agent of this condition is tributyltin (TBT), which is used in anti-fouling paints on aquatic vessels. The TBT leaches from the hulls of vessels and disperses into the water column. However due to the hydrophobic nature of organotins, TBT is more readily taken up by the surrounding sediments and biota. Levels of imposex are correlated with areas of high shipping activity such as harbours and marinas. Imposex can cause sterility, premature death and localised population extinctions. Legislation prohibiting the use of paints containing tributyltin (or any other organotins) on vessels with hull lengths less than 25m was enacted in Victoria in June 1989. The common whelk, *Thias orbita*, has been used as a biological indicator of TBT pollution in Port Phillip Bay to assess the effectiveness of these restrictions over time.

The Toxicity of Anti-Cancer Extracts from *Dicathais orbita* (Muricidae) on Human Leukocytes

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The Muricidae are a family of marine molluscs that produce a range of bioactive brominated indoles, including indirubins which are known to have anticancer and anti-inflammatory activity. They are also the source of a homeopathic remedy called Murex, which is used for a range of conditions, including cancer and hives, an inflammatory condition. Preliminary *in vivo* testing of the extracts from *Dicathais orbita* in rodent models supports their application for cancer prevention. However, the extracts appear to act synergistically with the chemotherapy drug 5FU to increase the proportion of inflammatory neutrophils, relative to monocytes, in the rodent blood samples. It is likely that this is due to a cell necrosis-induced inflammatory response through the activation of the inflammasome. Consequently, we investigated the direct effects of *D. orbita* bioactive extracts on human leukocytes, for future drug development. Peripheral blood monuclear cells (mainly T cells) were isolated from fresh human blood, treated with the extracts and then examined for ability to proliferate in response to the mitogen, PHA. The cells were also examined for cell death by assessing their ability to take up trypan blue. The extract was further examined for any effects on neutrophil functions of adherence, chemotaxis, phagocytoxis and oxidative burst. Neutrophil viability was also monitored. The result show that the *Dicathais* extracts are toxic for human leukocytes at concentrations from 2mg/ml to 0.2mg/ml. At lower concentrations (0.2mg/ml~0.002mg/ml) the extracts have no significant effects on lymphocyte proliferative or neutrophil function, although a small decrease in neutrophil phagocytosis was observed at the non-toxic concentrations of 0.2mg/ml and 0.1mg/ml. Our results suggest that the anti-cancer effects of *Dicathais* extracts most likely occur through the induction of leukocyte necrosis, releasing danger signals with pro-inflammatory potential. This research will facilitate the development of a novel complementary anticancer medicine from muricids extract within a nontoxic range.

[Keynote] Evo-Devo and the origin of Mollusca

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The recent years have seen a considerable increase in data concerning the ontogeny of a number of molluscan subclades, both on the molecular and on the morphogenetic level. This has led to significant insights concerning the evolutionary origin and the potential intra- and interphyletic relationships of this morphologically diverse lophotrochozoan phylum. As such, data on nervous, muscle, spicule, and shell formation have shown that these organs are formed in a different way than in animals that derive from a segmented ancestor (e.g., annelids and sipunculans), and that the neural anatomy of polyplacophoran trochophores highly resembles that of basal entoproct larvae. This and ultrastructural studies suggest a sistergroup relationship of Entoprocta and Mollusca with a ventrally intercrossing dorsoventral musculature, a complex larval apical organ, and a tetraneurous nervous system as key apomorphic characters (Tetraneuralia concept). Comparative analyses further suggest that larval protonephridia constitute an ancestral character that was already part of the lophotrochozoan ground pattern. Gene expression analyses have demonstrated that co-opted functions of bilaterian bodyplan patterning genes at least partly account for the wide molluscan phenotypic diversity. Accordingly, axis patterning genes such as *Hox1* and *Hox4*, together with the "segmentation gene" *engrailed*, function in shell formation of basal gastropods, while common neural patterning genes, e.g., certain POU genes, are used in radula sac, tentacle, and foot formation. The ongoing increase in metazoan genome data and routine availability of molecular, micromorphological, and imaging tools should result in further groundbreaking insights into the evolution of this fascinating group of lophotrochozoan animals in the near future.

A Histochemical Approach to Natural Product Research: Biosynthesis of Tyrian Purple in *Dicathais orbita* (Neogastropoda: Muricidae)

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A wealth of information exists on the composition and biosynthesis of Tyrian purple from prochromogens within the muricid hypobranchial gland. However, little is known on the biosynthetic origin and regulatory processes governing prochromogen and bioactive intermediate synthesis. As an alternative to radioisotopes, novel histochemical techniques for bromoperoxidase and the prochromogen, tyrindoxyl sulphate, were applied along with stains for the indole precursor tryptophan and arylsulphatase. Of the eight hypobranchial gland cell types which occur in *Dicathais orbita*, three contribute to dye genesis and two sites of prochromogen synthesis were identified. Dietary tryptophan is endocytosed by rectum epithelial cells and stored within secretory cells of the lateral hypobranchial epithelium, while bromoperoxidase is sourced from the rectal gland and concentrated by ciliated hypobranchial supportive cells. Upon exocytosis, ciliary action unites tryptophan and bromoperoxidase to facilitate tyrindoxyl sulphate synthesis. Synthesis also occurs in the subepithelial vascular sinus for storage by medial hypobranchial cells. Hydrolysis of tyrindoxyl sulphate and subsequent bioactive intermediate genesis on the epithelial surface is regulated by arylsulphatase liberation from adjacent supportive cells. Tryptophan, bromoperoxidase and tyrindoxyl sulphate are also transported within the vascular sinus to the capsule gland where arylsulphatase occurs. This histochemical approach has revealed that Tyrian purple prochromogens are *de novo* biosynthesized in a constitutive and controlled manner through the post-translational bromination of dietary tryptophan. The prochromogen and its biosynthetic constituents also appear to be incorporated into egg capsules as a form of maternal investment. These findings not only imply a naturally selected function for Tyrian purple precursors, but provide the location of biosynthetic tissues, which will undoubtedly aid the development of muricid natural products as therapeutic agents.

Ecological redundancy in habitats provided by native and non-native oysters: implications for managing disease afflicted estuaries

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Diseases are very detrimental to species and their ecosystems. In Australia, estuaries are threatened by a disease commonly called 'QX disease'. It is caused by the protozoan parasite, *Marteilia sydneyi*, which infects and kills native Sydney rock oyster, *Saccostrea glomerata.* The New South Wales *S.glomerata* industry, worth $34 million annually, is in danger as some aquaculture stocks have already suffered a loss of up to 94 % from QX disease outbreaks. Management strategies include the cultivation of selectively bred disease resistant *S. glomerata*, and sterile non-native Pacific oysters *Crassostrea gigas*. Yet, the ecological impacts of these strategies are unknown. Natural populations of *S.glomerata* provide important ecosystem services, which may be modified or lost when disease resistant *S.glomerata* and *C.gigas* are introduced into QX disease afflicted estuaries. We conducted a field experiment to determine whether habitats provided by wild-stock *S. glomerata*, selectively-bred disease resistant *S. glomerata*, and *C. gigas*, are ecologically redundant to macroalgae and invertebrate assemblages. Oyster spat were glued at natural densities to concrete plates. Plates were deployed at two intertidal heights of a rocky shore. After 2, 3, 7, 10 and 12 months, oyster mortality, growth, and percentage cover of macroalgae and invertebrates were sampled. *C. gigas* displayed significantly higher mortality and growth rates than wild-stock and disease resistant *S. glomerata* over time, at each tidal height. Yet, despite structural differences, oyster habitats consistently supported similar macroalgae and invertebrate assemblages. These results indicate that in the early stages of oyster population establishment, there are no functional differences in the habitat provided by wild-stock and disease resistant *S. glomerata*, or *C. gigas*. Ongoing sampling will assess long term algae and animal assemblages as oysters grow, and increase our understanding of how selectively bred native and non-native oysters may be sustainable management strategies in disease impacted estuaries.

Quantitative Studies of Threatened Land Snails

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Charles Darwin realised that land snails make excellent subjects for biogeographic studies because of their limited powers of dispersal. Additional features of land snails – their habitat specificity and intolerance of elevated desiccation stressors – endangers their survival in many regions of Australia subject to habitat modification by humans, particularly in the 'wet-dry' tropics of the north. Already over thirty land snail species are recognised as threatened in the Northern Territory. This paper outlines a quantitative technique to assess abundances of these snails. Field trials with two easily accessible species of *Torrisitrachia* (family Camaenidae) from the Katherine District with very small native ranges, neither of them described nor presently recognised as threatened, have proved the value of this survey method. Because both species of *Torresitrachia* are limestone obligates (as are others already listed as critically endangered), their populations are naturally fragmented. Alarmingly, our preliminary surveys have shown abundances of one of these species are in serious decline. This decline is the result of the 'grass-fire' cycle, wherein annual grasses are rapidly replacing woodland on limestone patches.

[Keynote] Should the Chair that Flew Around the World have been a Rocking Chair?

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The outbreak of the Black-striped False Mussel (*Mytilopsis sallei*) in Darwin, Australia, a decade ago was significant from many perspectives: it focussed the attention of the public, politicians and industry on non-native marine species; the campaign to eradicate the bivalve was successful (albeit environmentally deleterious); the campaign attained global coverage through the new medium of the Internet thereby raising awareness of the problems of invading marine species. Regulations relating to ballast water discharge and risk assessment of vessels entering/moving between ports were speedily enacted by the Federal Government of Australia and by the states, as was the declaration of a list of species assessed to pose a national threat (the CCIMPE Trigger List). Given the number of detections of non-native marine species made subsequently under these protocols, it is clear Australia is being constantly bombarded. However, it is now important to review this legislation to ensure it is targeted correctly in light of the recent successful colonisation of this country by some species – particularly molluscs – the (long- and short-term) failure of other marine species to establish and naturalise, and research questioning the role of ballast water as a major factor in the spread of marine species. Most importantly, the list of serious marine 'pests' needs emending as effort is presently being directed into searching for/monitoring species that are neither likely to enter Australian waters nor establish populations in areas where they are currently being searched for.

Resolving controversy in molluscan phylogeny with new monoplacophoran sequence data

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The use of molecular data has helped resolve many long-standing phylogenetic questions. Unfortunately for malacologists, the placement of extant monoplacophorans (Tryblidiida) with other molluscs using DNA has not been possible because of a lack of specimens fixed for molecular work. The first monoplacophoran sequence that became available was a short piece of 28S rDNA, and when included in a large molluscan data set, placed Tryblidiida inside Polyplacophora. That relationship was reflected by a new taxon name Serialia, reflecting the shared serial nature of musculature and other organs. The result was controversial because of the topology involved, and the small amount of monoplacophoran data that was used to generate it. To address this problem, we collected many specimens of the monoplacophoran *Laevipilina hyalina* off southern California. Here we incorporate five genes (28S, 18S, 16S, COI, Histone H3) from two individuals, and revisit the original data set to test if Serialia is maintained with additional data. I will discuss the results of these analyses, and the challenges remaining for progress in molluscan phylogeny.

Ocean warming and acidification effects on early development of the temperate abalone *Haliotis coccoradiata*

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In its most recent report *Climate Change 2007,* The Intergovernmental Panel on Climate Change (IPCC) predicted that by 2100 there will be a 4°C increase in global average sea surface temperature (SST) and a decrease in ocean pH by 0.4 units. Ocean warming and acidification has been shown to disrupt physiological functions of marine invertebrates (recent work has focused on echinoids and bivalves), but the synergistic impacts of the stressors, especially on early life stages of marine invertebrates have yet to be determined. We examined the impacts of temperature and pH on fertilization, cleavage, veliger development and calcification in the abalone *Haliotis coccoradiata*. Cross combination treatments of 0 - 4°C above ambient SST and 0 – 0.4 units of decreased pH below normal seawater were conducted. Fertilization success was high across all treatments but cleavage and veliger developement were highly sensitive to temperature and pH. Development displayed high abnormalities at high temperature and low pH, with the presence of unshelled veligers. These experiments provide insights into the potential effects of ocean warming and acidification on this fast-developing species.

Relic oysters as Holocene sea-level proxies on the Central Queensland coast and islands

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Radiocarbon dates from relic fixed intertidal biological indicators (FIBIs), in the form of calcareous tubeworm and barnacles, have produced time-elevation data suggesting a two stage model of mid to late Holocene sea-level for the south west and south east Australian coast. Recently, relic assemblages of tropical oysters, *Saccostrea cucullata* and *Crassostrea echinata*, and barnacle species preserved in growth position within the granite outcrops of Cape Edgecumbe, Cape Gloucester and Middle Island in Edgecumbe Bay, Central Queensland, have provided time-elevation data suggesting that mid to late Holocene sea-levels were indeed higher than present for this region. Models of predicted hydro-isostatic rebound based on radiocarbon dates from emerged fossil coral microatolls have been used previously by workers to explain patterns of emergence along the north Queensland coast. These models propose a higher relative mid Holocene sea-level with a linear fall to present. However, evidence from relic oysters at Edgecumbe Bay appears to support a stepped or oscillating model of sea-level change for this region with a rapid fall after 3800 cal.yr BP. With most of the current literature regarding the effects of future climate change on the Great Barrier Reef based on a model of smoothly falling relative sea-level for the past 6000 years, the time-elevation data from relic oysters on the Queensland coast is becoming increasing significant. Secondary evidence in the form of fossil coral and raised beachrock terraces from Edgecumbe Bay and barnacle species change within the relic assemblages further supports the oyster evidence. In order to refine the FIBI methodology and better understand the relic assemblages this study also considers the modern rocky intertidal associations, and their environmental and tidal conditions, for this region.

[Poster] Larval Development of *Hormomya mutabilis* and *Septifer bilocularis* (Bivalvia: Mytilidae)

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In order to clarify larval recruitment processes by which population dynamics of marine benthic invertebrates are determined, we need to identify larvae and juveniles of the invertebrates which are identifiable in adult forms. *Hormomya mutabilis* and *Septifer bilocularis* (Bivalvia: Mytilidae) are common species on tidal rocky shores in Southwest Japan, whose larval development have not been reported yet. In the present study, these larvae were reared in the laboratory to describe morphological features of the planktonic periods. The larvae of *H. mutabilis* and *S. bilocularis* were obtained by artificial fertilization and cultured in filtered seawater under controlled conditions for periods of 33 and 35 days, respectively, and were fed with *Isochrysis* sp., *Chaetoceros calcitrans* or *C. gracilis*. The temperature was kept at 28°C and the salinity at 33 psu. These larvae ware sampled every three or four days and fixed with 80% alcohol until settlement occurred. Morphological features of these larvae were examined using an optical microscope and SEM. The shell length of the planktonic periods of *H. mutabilis* and *S. bilocularis* were 110-263 μm and 110-221 μm, respectively. *Septifer bilocularis* was different from many mytilid larvae in that the development of umbo in the latter planktonic stage was not recognized, while larval hinge structure of *H. mutabilis* and *S. bilocularis* showed typical characteristics of mytilid species. The two species were clearly distinguished by the number and constitution of provinculum teeth as well as the shape of umbo in the planktonic periods. It was suggested that extremely low umbo is a common characteristic in the genus *Septifer*.

Isolation of Growth and Reproduction-Related Genes in *Haliotis asinina ganglia* by Suppression Subtractive Hybridisation

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There is currently a paucity of specific genetic data about growth and reproduction related processes in abalone, though the related gastropods *Aplysia* and *Lymnaea* are known to produce neuropeptides related to growth, feeding behaviour, and reproduction. Here, we use the technique of suppression subtractive hybridisation (SSH) to find growth and reproduction related gene sequences in the tropical abalone *Haliotis asinina*. Three SSH libraries were constructed from *H. asinina* ganglia: (1) well nourished individuals subtracted against food deprived ones; (2) well nourished animals subtracted against reproductively active ones; and (3) reproductive abalone subtracted against non-reproductive individuals. A subset of the differentially expressed genes were confirmed by quantitative PCR, validating this approach. For example, the feeding and reproduction-related gene myomodulin showed significant upregulation in well-nourished individuals. The genes that are differentially expressed in the ganglia of *H. asinina* in the various physiological states – satiated and reproductive – fall into a wide range of functional categories including biological regulation, cell proliferation and lipid metabolism.

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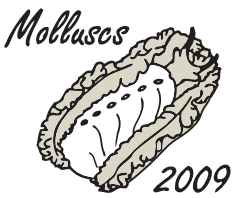

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