

Australian Museum

Report on the implementation of the Science Research Strategy, 2007–2012

for the period: 1 July 2009 – 30 June 2010

nature culture **discover**



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2. Research Grants – Funding from 1 July 2009 – 30 June 2010

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Abbreviations

ABRS: Australian Biological Resources Study

ALA: Atlas of Living Australia

ARC: Australian Research Council

CHSI: Cultural Heritage and Science Initiatives Branch

CITES: Convention on International Trade in Endangered Species

EPBC Act: Environment Protection and Biodiversity Conservation Act

GBIF: Global Biodiversity Information Facility

IUCN: International Union for Conservation of Nature

PGA: Postgraduate Award recipient

RA: Research Associate

SEM: Scanning Electron Microscope

SF: Senior Fellow

VCF: Visiting Collections Fellow

VRF: Visiting Research Fellow

Glossary of Terms

Alluvium is loose, unconsolidated (not cemented together into a solid rock), soil or sediments, eroded, deposited, and reshaped by water in some form in a non-marine setting.

Assemblage, a taxonomic subset of a community.

Benthic, the benthic zone is the ecological region at the lowest level of a body of water such as an ocean or a lake, including the sediment surface and some sub-surface layers.

Bioerosion describes the erosion of hard ocean substrates – and less often terrestrial substrates – by living organisms.

Biostratigraphy is the study of the spatial and temporal distribution of fossil organisms, often interpolated with radiometric, geochemical, and paleoenvironmental information as a means of dating rock strata.

Camaenid/Camaenidae, a family of air-breathing land snails.

Commensalism is a biological relationship in which one species benefits from an interaction, while the host species is neither positively nor negatively affected to any tangible degree.

Conodonts are extinct animals resembling eels, (see reconstruction on p.36).

Cryptic species are two or more species that look identical but are genetically distinct.

Endemism, an organism being ‘endemic’ means exclusively native to a place or biota.

A **geographic information system** (GIS) is an information system for capturing, storing, analysing, managing and presenting data which are spatially referenced.

Genomics is the study of the genomes of organisms; the **genome** is the entirety of an organism's hereditary information. It is encoded either in DNA or, for many types of virus, in RNA.

Genus (plural: **genera**), a low-level taxonomic rank (a taxon) used in the classification of living and fossil organisms. See also ‘species name’ below.

Gondwana is the name given to a southern precursor supercontinent which formed around 550–500 million years ago, and which began to break up in the mid-Jurassic (about 167 million years ago).

Holocene, the period of time from ~12,000 years ago to the present.

Identification key, a printed or computer-aided tool that assists the identification of biological entities, such as plants, animals, fossils and microorganisms.

Last Glacial Maximum refers to the time of maximum extent of the ice sheets during the last glaciation, or ice age, 20,000 years ago.

Malacologist, a zoologist specialising in the study of molluscs.

Mid-Pleistocene, is the middle period of the Pleistocene epoch, ie. around 850,000 years before the present.

Ontogeny is the origin and development of an individual organism from embryo to adult.

The **Ordovician** is a geologic period and system, the second of six of the Paleozoic Era, and covers the time between 488 to 444 million years ago.

Phycology, scientific study of algae.

Phylogeny is the evolutionary development and history of a species or higher taxonomic grouping of organisms. Also called *phylogenesis*.

Phylogeography is the study of the historical processes that may be responsible for the contemporary geographic distributions of genetic diversity.

Pleistocene epoch is part of the geologic timescale, usually dated as 1.8-1.6 million to 10,000 years before present.

Population bottleneck (or genetic bottleneck) is an evolutionary event in which a significant percentage of a population or species is killed or otherwise prevented from reproducing.

Scincid lizard, alert agile lizard with reduced limbs and an elongated body covered with shiny scales; more dependent on moisture than most lizards; found in tropical regions worldwide.

A **species name** (or scientific name) consists of two Latinized words. The first word is the name of the genus to which the organism belongs. The second word is the specific epithet or specific term of the species. Together, the genus plus the specific epithet make up the species name.

Speciose, rich in number of species.

Systematics is the study of the diversification of life, both past and present, and the relationships

among living things through time. Relationships are visualized as evolutionary trees.

Taxonomy/ Alpha Taxonomy is the science of finding, describing and categorising organisms, thus giving rise to taxonomic groups or taxa (singular: *taxon*), which may then be named.

Taxa, see above.

A **terrane** in geology is a fragment of crustal material formed on, or broken off from, one tectonic plate and 'sutured' to crust lying on another plate.

Vicariance, the separation or division of a group of organisms by a geographic barrier, such as a mountain or a body of water, resulting in differentiation of the original group into new varieties or species.

Wrasses are a family of marine fish, many of which are brightly colored.

Executive Summary

Fittingly, the Australian Museum's researchers marked the International Year of Biodiversity with an outstanding record of winning competitive grants, with particular success in the areas of species documentation and impacts on biodiversity. In the last 12 months, Museum researchers were awarded grants totalling \$1,106,262 (up from the previous year total of \$807,760) with an average value of \$32,537 (compared with the previous year average of \$31,029). Grants successes for the last four years are shown in the graph below. The increase is an outstanding achievement given that staffing numbers have remained relatively stable.

We were successful in filling 5 vacant invertebrate systematist positions, increasing our capacity in entomology and DNA barcoding, malacology, polychaete worms and crustaceans. Four of the 5 appointees commenced after this report was compiled. Unfortunately, we were unable to fill a fish research position and will need to explore alternative funding and recruiting approaches in the coming year.

A mid-term review of the Science Research Strategy was undertaken during the year. As a result of the review, Program 3 'Increasing our understanding of the genetic variation in key taxa (species) of the Australasian and Indo-Pacific biota', was absorbed into other programs. The program title is still mentioned in this report to provide continuity, but the research relevant to it is incorporated in the reports of other programs.

The change was made to reflect the full integration of molecular approaches into our taxonomic and systematics projects. All of the Museum's zoologists (including new appointees) now incorporate both morphological and molecular techniques in their research.

Some minor changes were also made to Program 5 in recognition of the need to study a broader range of human activities impacting on

Australia's biodiversity while not down-playing our concerns about climate change.

In last year's summary I highlighted the relevance of our research to contemporary societal issues in three areas – species discovery and documentation; conservation and management; and cultural heritage and diversity. This year, the theme that stands out strongly for me is 'connectivity'.

Connectivity is a feature of the way in which Museum research is conducted, the content of our research and the application of our research results.

Over the last year, Museum researchers participated in a host of collaborative projects with a broad range of scientists, managers, policy makers and indigenous communities. Research involved joint projects with 28 institutions and agencies, including 5 prestigious Australian Research Council (ARC) Linkage Projects. While most collaborations were based on complementary expertise from similar disciplines, a few drew together truly multi-disciplinary teams – for example archaeologists and geologists; and biologists, oceanographers and modellers. Incorporation of new technologies into research projects also increased our capacity to answer long-standing questions.

The 'Bush Blitz' project is one example of multi-institutional collaboration in which Museum researchers participated. Bush Blitz involved several intensive surveys of properties across Australia's national reserve system. The survey methodology joins scientists from different institutions with volunteers, supported by government and business, to sample the biota of key conservation areas. The survey results help to fill gaps in our knowledge of biodiversity and provide a baseline for detecting future changes in the biota.

Collaborations with a number of Indigenous communities have been particularly important in contextualising our collections through incorporation of traditional knowledge and, in

turn, using the collections to re-connect people to their heritage. Connectivity is being facilitated through increasing use of the internet to provide access to our cultural collections through such projects as the Virtual Museum of the Pacific, a project with the Wonnarua Aboriginal Corporation and an ARC-funded Linkage Project with the University of Sydney 'Understanding Balinese Paintings: Collections, Narrative, Aesthetics and Society'. The Wonnarua project included research and preparation of an online gallery featuring the Morrison collection of materials from the Hunter Valley, NSW. Community representatives visited the Museum's collection stores to assess the material and around 70 youth and 15 community members living in the Hunter Valley attended workshops.

In a biological context, connectivity is fundamental to understanding evolutionary and ecological processes, informing management strategies and assessing the implications of human impacts, including climate change. Many of the projects outlined in this report highlight the fundamental importance of accurately identifying species and knowing their distributions with a view to investigating the relationships among taxa, assessing their vulnerability to extinction and understanding the risks of invasive pests.

As an example, the Circum-Australian Amphipod Project, which has been providing distribution data to the Department of the Environment, Water, Heritage and the Arts (DEWHA) over the last four years, was completed. Involving identification of over 4,000 specimens from State museum collections and collection of new material from previously un-sampled locations, this project has made a major contribution to understanding the biodiversity and biogeography of Australian shallow-water fauna. The information generated has been used in the Australian Natural Heritage Assessment Tool initiative, a resource for conservation and management strategies.

The outputs of Museum projects connect our research to the wider scientific community through publications and conference attendance; to resource managers and policy makers through involvement in joint projects, advisory committee membership and submissions on draft strategies and policies. During the last year, Museum researchers produced 138 publications, presented research findings at more than 40 conferences and participated in 63 advisory and editorial committees (see graph below for publications and new species discovery information).

The year ahead will present substantial challenges. It is clear that to continue the high quality and quantity of research we will need to explore new sources of funding, new partnerships and new opportunities. In this context, the generous support of the Geddes Foundation in funding the Museum's Visiting Fellowships and Postgraduate Award scheme is an extremely welcome fillip to our research capacity and our ability to support the next generations of museum researchers.

Dr Brian Lassig, Assistant Director
Research & Collections
30th August 2010

Structure of Report

1. The **narrative information** provided represents the collective achievements and activities of research scientists across the Research & Collections Division, and is not a report of individual performance. Rather than presenting a comprehensive description of all research undertaken, the narrative aims to highlight key achievements and progress against each of the research programs and key research goals, as set out in the Science Research Strategy.
2. The qualitative narrative information is supplemented by **quantitative indicators** of performance, including **grant funding**

(**Appendix 2**) and **publications** (**Appendix 3**). NB: publications and grants are for the period 1 July 2009–30 June 2010.

3. The **table of research areas/projects** (**Appendix 1**) lists research undertaken in the reporting period in each of the research programs. It shows contributing staff for each project/area, including Senior Fellows.
4. Staff, Senior Fellows, Research Associates and Visiting Fellows and Postgraduate Award recipients who have contributed to a program are listed under each program.

Two researchers from across the three branches of the Division were nominated to coordinate the input for each research program:

Prog 1: Biota in Australasian marine environments

- Pat Hutchings (Research);
- Steve Keable (Collections)

Prog 2: Biota in Australian terrestrial and freshwater environments

- Andrew Mitchell (Research);
- Frank Köhler (Research)

Prog 3: Genetic variation in key taxa of Australasian and Indo-Pacific biota

- Not reported

Prog 4: Origin, evolution and biogeography of the biota of Indo-Pacific and Australasian region

- Don Colgan (Research);
- Buz Wilson (Research)

Prog 5: Understanding human impacts on Australian biota

- Richard Major (Research);
- Ross Sadler (Collections)

Prog 6: Investigating human cultures and communities over time.... in Australia and the Pacific

- Val Attenbrow (Research)
- Stan Florek (CHSI)

Prog 7: Linking intangible and tangible heritage

- Robin Torrence (Research);
- Dion Pieta (CHSI)

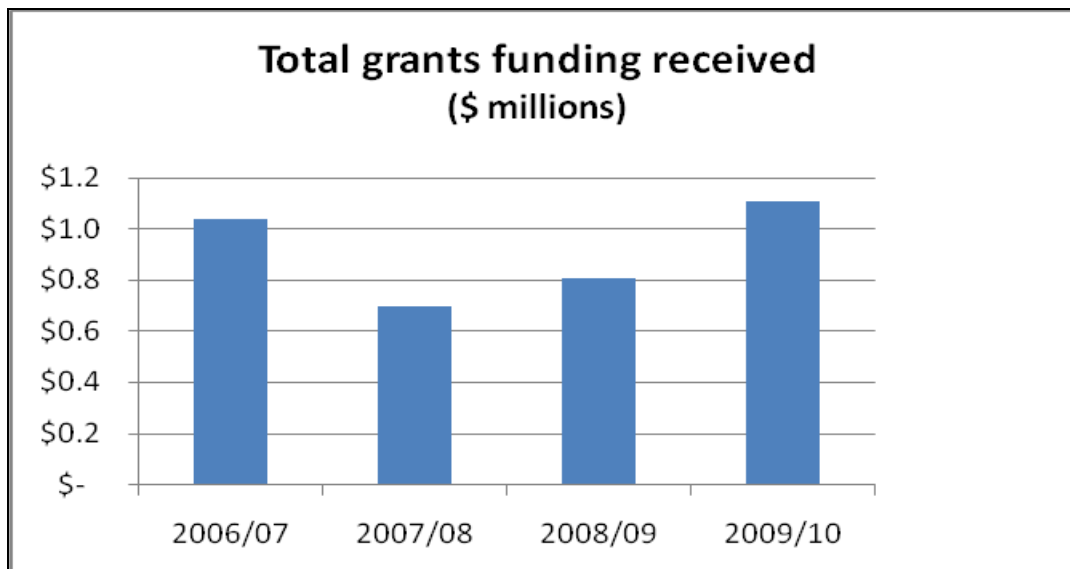
Prog 8: Investigating extant and extinct faunas and environmental systems in context of recent geological history ...

- Ross Pogson (Collections)
- Yong Yi Zhen (Collections)

This report does not include the research output of Lizard Island Research Station (LIRS) except where it has been undertaken by staff, Fellows and students of the Australian Museum.

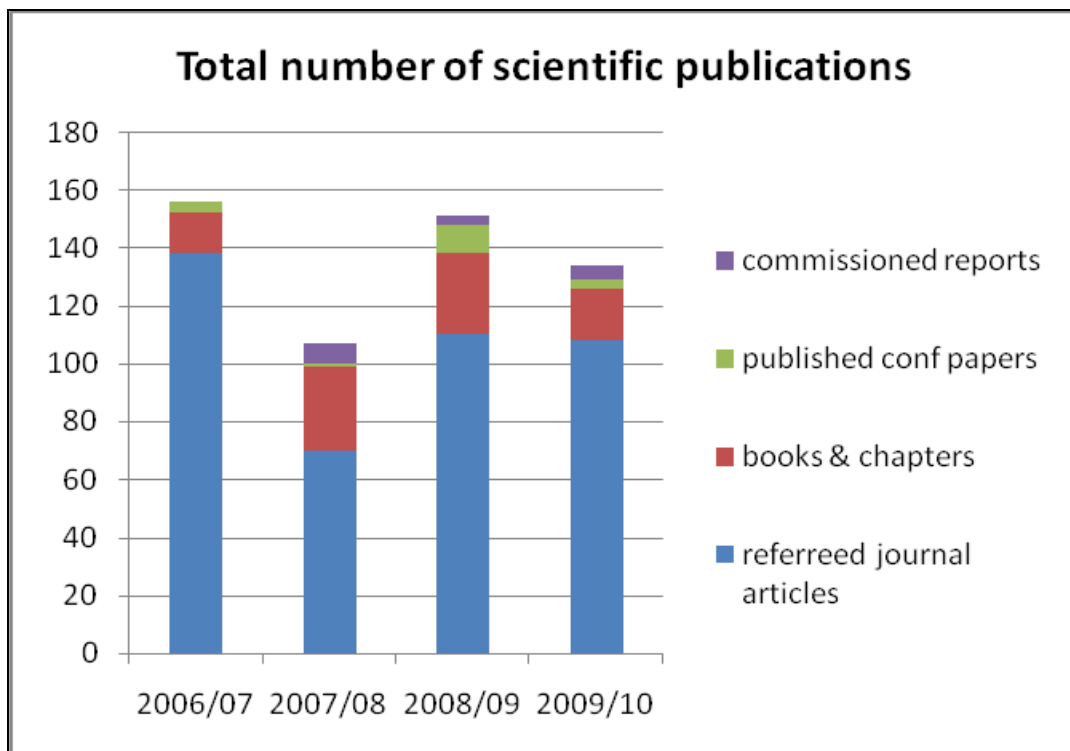
Snapshot of research performance from 2006/07 to 2009/10 .

1.



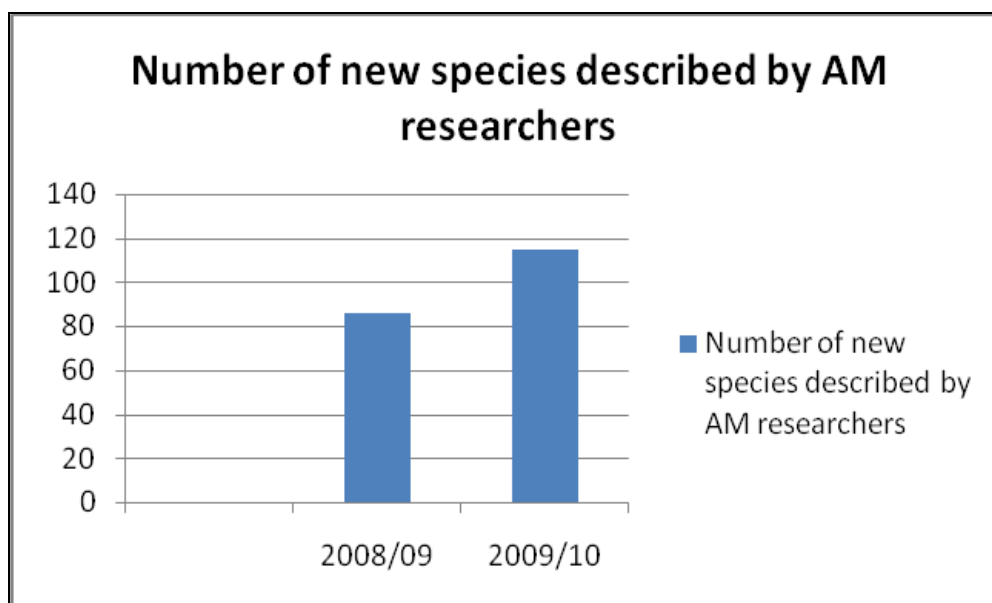
Figures are as reported in annual reports.

2.



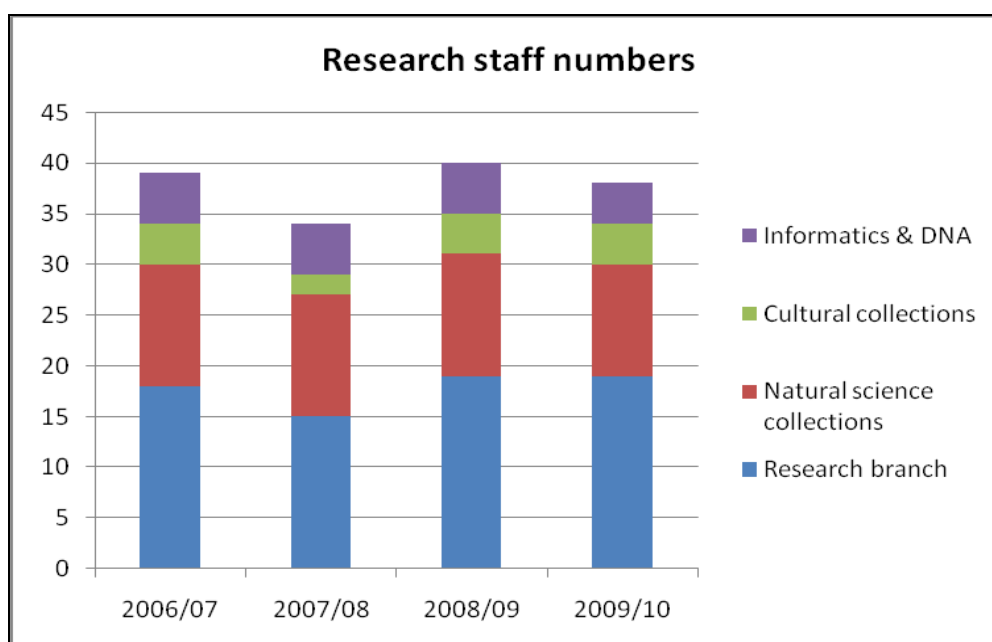
Numbers are as reported in annual reports.

3.



Numbers are as reported in annual reports. Information not available for 2006/07 and 2007/08.

4.



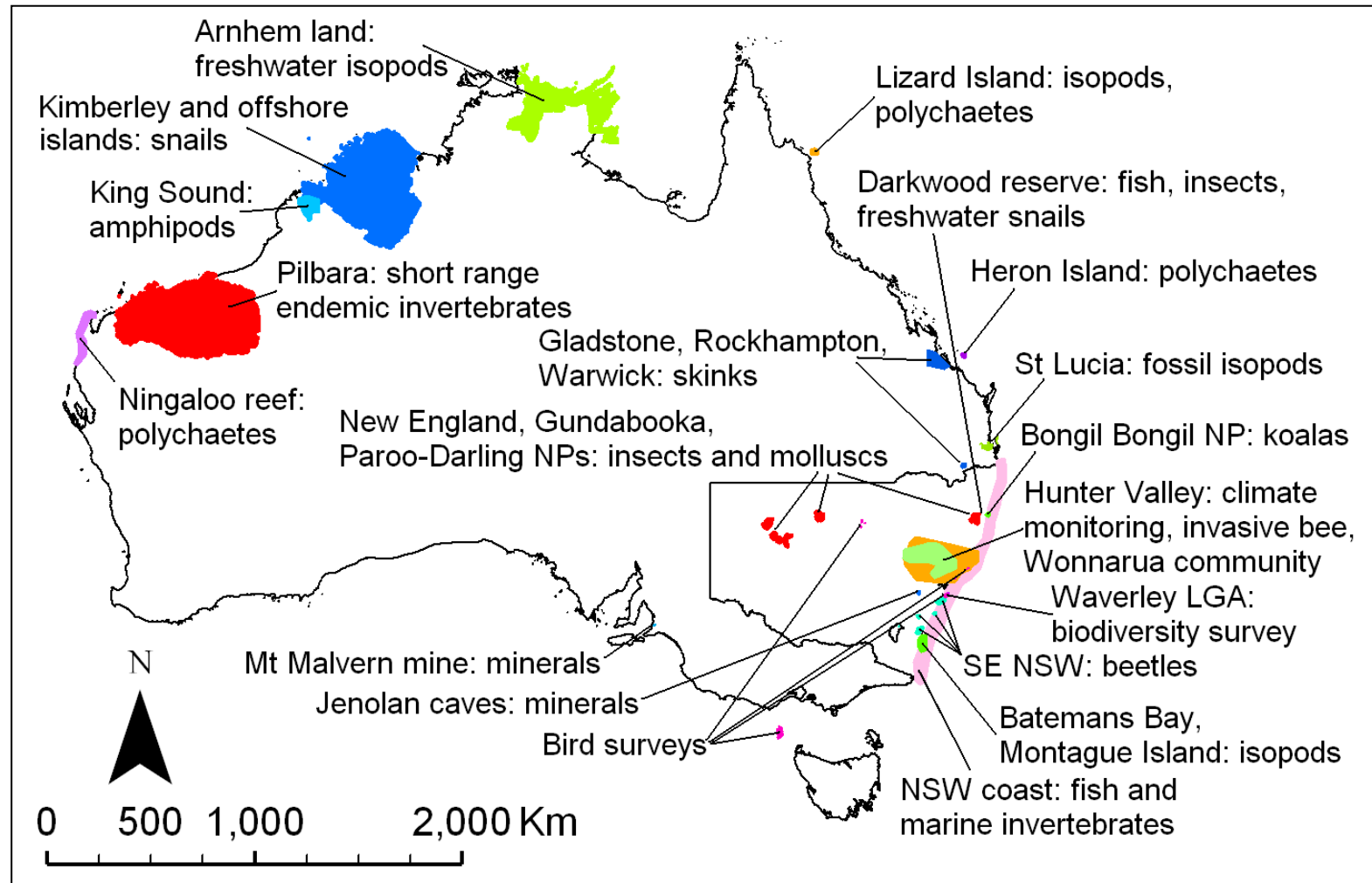
Notes:

Research branch includes research scientists, scientific officers and postdoctoral fellows employed on recurrent and grant funding; **Natural science collections** includes collections managers and scientific officers; **Cultural collections** includes cultural managers; **Informatics & DNA** includes the managers and scientific officers in the Collections Informatics Unit and DNA lab manager.

Technical and support staff are not included.

Amount of time spent on research will vary in each of the branches; only Research branch staff spend the majority of time on research.

Map: Location of fieldwork undertaken in Australia in 2009-10 by Museum researchers.



Note: additional cultural research was undertaken during the year involving members of various communities visiting the Australian Museum or staff making visits off-site that were not fieldwork *per se*.

Program 1

Addressing knowledge gaps and problems in understanding the biota in Australasian marine environments.

The research undertaken primarily addresses issues such as documenting biodiversity, invasive species and other environmental impacts in marine environments.

This program recognises that a key requirement for conserving and managing marine environments is a better understanding of the organisms comprising marine biological communities. Species groups studied include adult and larval fishes, gastropod (snails or univalves), bivalve and nudibranch (sea slugs) molluscs, polychaetes (segmented marine worms), crustacean amphipods (scuds and beach hoppers) and isopods (sea slaters), and asteroids (sea stars).

Key Drivers

Research is aligned with both State and Commonwealth initiatives designed to achieve an environmentally sustainable country with well managed marine ecosystems. Commonwealth Government, international and charitable research funding has been awarded to undertake many of the projects.

Groups studied draw on the specialist expertise of the research and collection staff to provide an improved understanding of current species diversity and distributions, and are used to inform marine planning. For example, amphipods, which are noted for their diverse ecological roles and as indicators of biogeographic and environmental change, were a key group investigated. Similarly, research on larval fish dispersal increased our understanding of the spatial scale at which marine populations operate, and is fundamental to management of them, both for fishery purposes and also for the design and operation of marine protected areas.

Many of these projects involve national and international collaborations to develop interdisciplinary teams. Some of the studies have been collection-based, using existing collection data but additional building of the collections has also been achieved.

Museum facilities which are integral to research in this program include Lizard Island Research Station and the DNA and Scanning Electron Microscope laboratories.

Key research goal a) Understanding Australia's marine biodiversity, emphasising species with key ecological roles and high sensitivity to human impact.

Significant progress was made in understanding the diversity, phylogeny and distributions of a number of important species groups, resulting in new publications, identification keys and enhanced collections.

A report on the amphipod fauna of the Kimberley Coast submitted in June 2010 is the final installment for the Circum-Australian Amphipod Project (CAAP) which has been providing distribution data to the Department of the Environment, Water, Heritage and the Arts (DEWHA) over the last four years. Involving identification of over 4,000 specimens from State museum collections, this project has made a major contribution to understanding the biodiversity and biogeography of Australian shallow-water fauna. The information generated has been utilised in the Australian Natural Heritage Assessment Tool (ANHAT) initiative (www.environment.gov.au/heritage/anhathat/index.html), a resource for conservation and management strategies.



Dr Lauren Hughes and Dr Jim Lowry, collaborators on amphipod studies.

The last field collection trip for this project was at Cygnet Bay, in King Sound north of Broome, Western Australia in May 2010. Working in collaboration with a local pearl farm and the Bardi-Jawi indigenous land owners, approximately 80 samples were collected, identified and deposited within the Australian Museum Marine Invertebrates Collection.

Following on from the CAAP project a new study of Australian shallow-water amphipod families has commenced. Funded by the Australian Biological Resources Survey (ABRS), the project is investigating the Australian amphipod fauna at a national scale, including offshore island territories. Over three years the project will describe more than 100 recently identified new species, as well as developing bioinformatic tools, online interactive keys and genetic barcodes to facilitate identifications.

A comprehensive study, 'Benthic Amphipoda (Crustacea: Peracarida) of the Great Barrier Reef, Australia', was published in *Zootaxa*, (Lowry and Myers, 2009), with contributions from 20 Australian and international authors. It describes about 240 species from the Reef, nearly half of which are new to science. Interactive keys to the 240 species of Great Barrier Reef amphipods form a CD supplement to the book.

Development of a web based catalogue of the marine molluscs of NSW continued (www.seashellsofnsw.org.au) utilising the Museum's mollusc collection and specialist malacology library. Information for 67 families has been completed. All representatives that occur in NSW are treated with a standardised description, at least one image, and information on geographical distribution, habitat, comparative data and synonymy.



SEM image of a new species of isopod from the northwest side of Tollgate Island in Batemans Bay, Janaira (scale bar 0.1mm). Image: S. Lindsay and G.D.F. Wilson

A detailed investigation of the systematics and ecological relationships of the isopod crustaceans that live on marine algae has been conducted in collaboration with a phycologist from the Royal Botanic Gardens Sydney and a visiting Research Fellow from Universidad de Buenos Aires, Argentina. Detailed light and scanning electron microscopic (SEM) studies were completed on three new species in three genera, all new records for Australia. Data were collected on the feeding preferences of the species and their distribution in the region from Montague Island to the Batemans Bay region, southern NSW. One of the surprising discoveries is that these tiny isopods are actually micropredators that feed on other animals living on the algae.

Continuing studies of polychaetes showed that phenotypic plasticity (the same species appearing differently due to variable life stages or in response to environmental conditions) and cryptic species (distinct evolutionary lineages with an unusually large amount of genetic

distinctness but showing no apparent



A cryptic species of fan worm (Sabellidae) Image M. Capa.

morphological diversity) are widespread. Analyses using DNA sequence data in several groups of fan worms (Sabellidae) have revealed a hidden diversity in Australia waters and highlight the presence of introductions which may represent a threat to native systems and species. This reinforces the importance of identifying biological diversity accurately and efficiently, and the need to establish diagnostic characters that define boundaries between closely related species. Funding from the ABRIS is being used to further investigate these findings.

Additional studies of Australian polychaetes have focused on the Ampharetidae, with descriptions of five new species and one new genus to be submitted to the journal *Zootaxa* for publication. Descriptions of six new species of the family Acoetidae are also in progress and new species were described in the families Trichobranchiidae and the Eunicidae (bait worms) with colleagues from the University of Bochum, Germany, and the Museum and Art Galleries of the Northern Territory.

A significant taxonomic contribution was made to understanding the diversity and distributions

of an important group, the Tripletail fishes (Lobotidae), with collaborators at the International Institute for Species Exploration, Arizona State University. Adult and larval characters were used to study relationships of the Tripletail fishes and as a result, three families will be combined. The work has also expanded to include a reassessment of the fish suborder Acanthuroidei and will result in a complete revision of the composition and phylogeny of this important group of largely tropical species, containing some of the most prominent and iconic coral-reef fish species.

Collaborative research has continued on the description of the larval fish of the tropical snappers, Family Lutjanidae, with the dual goals of documenting their development and assessing relationships. A large proportion of lutjanid species live on coral reefs, and support recreational and commercial fisheries throughout the world's warm waters. Other collaborative research examined the systematics of temperate Australian rocky reef fishes, particularly weedfishes of the family Clinidae. Taxonomy of small coral reef fishes has concentrated on a revision of geographically widespread groups of fishes of the genus *Trimma* in the family Gobiidae, which include the smallest vertebrate animals known, ranging in size from 10-30 mm.



The bivalve mollusc *Entovalva*. Image P. Middelfart

The first record of the bivalve mollusc *Entovalva* was published from the Great Barrier Reef, Australia, with descriptions of five new species.

Species of *Entovalva* live in the oesophagus of holothurians (sea cucumbers) and have previously been recorded from Asia, Africa and the Red Sea.

Key research goal b) Understanding the connectivity of marine populations.



Brachidontes rostratus survives in small numbers at Haycock Headland. Image D. Colgan.

Museum scientists have examined the geographic patterns of genetic variation and gene flow in intertidal gastropods and bivalves along the coasts of Australia. South eastern Australia in particular offers an opportunity to examine the effects of historical isolation, contemporary current flows and environmental tolerance. For example, isolation induced by the land bridge that once connected Tasmania to mainland Australia has been hypothesized to be the cause of geographic boundaries observed in a number of marine species.

In recent work, distribution data and DNA sequence information from a variety of molluscs including gastropods (*Siphonaria*, *Phallomedusa*, *Austrocochlea*) and two bivalves (*Brachidontes* and *Limnoperna*) have been analysed to better understand the historical processes that may be responsible for their contemporary geographic distributions – known as phylogeographic structuring – including any differences between marine and estuarine molluscs along the east coast region.

Results showed similar degrees of phylogeographic structuring in most species studied (except *Brachidontes rostratus*) whether marine or estuarine. Also, genetic relationships between estuarine and marine populations of both *Austrocochlea* and *Limnoperna* suggest that colonisations between the environments occur regularly along these coasts. The ranges of most molluscs along the eastern seaboard appear to be determined by their tolerance of environmental factors. Further, surveys of species ranges show that these are changing as the environment changes. Previously there has been evidence of warm adapted species intruding south (possibly due to increasing temperatures). It can now be shown that some cool-adapted species are also retreating south.

Research on larval fish dispersal has also increased our understanding of the spatial scale at which marine populations operate, and is fundamental to management for fishery purposes and also for the design and operation of marine protected areas (for example, to help determine boundaries). Dispersal processes are also important to understanding how invasive species spread.

In collaboration with the University of Miami an innovative device – the DISC (Drifting In Situ Chamber) – was used to discover that larval fishes can use polarized light to navigate and find reefs upon which to settle, and that groups of larvae are better at orientation in the ocean than are individual larvae. This research was supported by a Hermon Slade Grant and a Museum Visiting Research Fellowship.

Key research goal c) Understanding the biodiversity of coral reefs.

Research on coral-reef biodiversity focused on the systematics of fishes, polychaete worms and crustaceans.

Researchers have been studying extensive collections of selected polychaete families obtained during fieldwork as part of the Census of Coral Reefs (CReefs) program (<http://www.creefs.org/>). With colleagues from

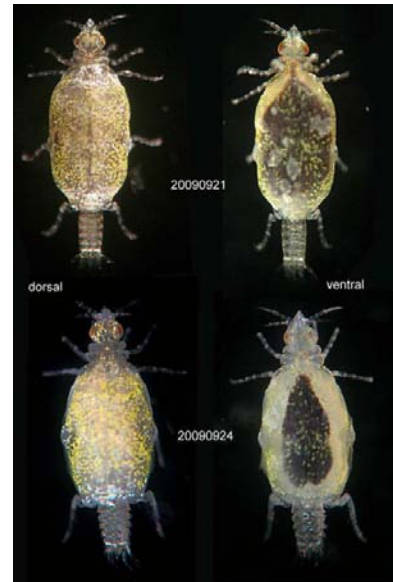
Charles Darwin University and Museum & Art Gallery of Northern Territory, researchers are documenting the diversity of these worms at Ningaloo Reef, and Lizard and Heron Islands using molecular and morphological techniques. These reefs are relatively undisturbed and will provide a baseline indication of the fauna of a 'healthy' reef against which impacted reefs can be assessed. In addition, numerous new species and records will be documented.

Research on the ontogeny of fish behavior has shown that larval dispersal is a biophysical process in which behavior plays a key role, unlike traditional assumptions that only currents need to be considered. The development of behavior in larval fishes was applied to the construction of a biophysical dispersal computer model for fish larvae on the Great Barrier Reef that will be of great use to management of this World Heritage Area. The project has shown that some larvae return to their natal reefs to settle, but others repopulate reefs tens of kilometres away from where they were spawned. Further, researchers were able to show that Green Zones on the Great Barrier Reef (those areas where no fishing is allowed) export 60-77% of their larval production to areas where fishing is allowed. Therefore, Green Zones can sustain themselves, and also help replenish fish populations outside their borders. This project was undertaken in collaboration with the Australian Maritime College, with Marine and Tropical Science Research Facility (MTSRF) support. With collaborators from James Cook University, the dispersal model was tested with transgenerational marking and genetic techniques, and showed a good match to empirical measures of dispersal.

Fish dispersal modelling in collaboration with the Australian Maritime College, predicts where fish larvae of the Flowery Rock Cod (*Epinephelus fuscoguttatus*) disperse.

A major review of bioerosion for a forthcoming Encyclopedia of Coral Reefs being produced by Springer Science & Business Media Publishers was completed. Further publications on the

effects of elevated nutrients on rates and agents of bioerosion at One Tree Island, Southern Great Barrier Reef are in progress in collaboration with students.



Photograph of a live juvenile of *Gnathia aureamaculosa*, taken on two days. The dark area visible on the ventral side is fish blood being digested. Image G.D.F. Wilson

Research on external fish parasites in the isopod family Gnathiidae has commenced with colleagues and students at Queensland University. The impact of parasitic isopods on coral reef fish ecosystems is well known but many species have not been described and identification of the larvae is difficult. Different parasites have different host preferences and understanding their impact depends on the ability to identify the larvae in the field. The aim of this study is to create a system for the identification of the juvenile stages.

As a first step, SEM images of juveniles of a common species (*Gnathia aureamaculosa*) were obtained, and a manuscript is in progress describing the morphological development of the juveniles that feed on a wrasse as observed over a period of several weeks.

Areas for potential further development – research that supports decision-making in regional marine planning and the establishment of marine protected areas within both state and

offshore waters is recognized as particularly important.

The Australian Research Council has recently provided funding for a study that includes Museum staff as collaborators in a three year Linkage Project 'Do marine reserve networks work? Larval connectivity, sustainable harvesting and ecological resilience'. The project will examine the network of no-take reserves within the Great Barrier Reef Marine Park. While it is known that these reserves contain more and bigger fish, several key questions about how reserves contribute to sustainable harvesting, protecting biodiversity and resisting climate change remain unanswered. This project will use new technologies to measure the transport of fish larvae between reefs, to assess strengths and weaknesses of the reserve network, and examine ways to improve species protection and sustainable harvesting in a changing climate.

With the addition of four new marine research staff to take up appointments in mid 2010, the outlook for continuing to make a significant difference in addressing knowledge gaps and problems in understanding the biota in Australasian marine environments is particularly strong.

Contributing Staff

Ms Kate Attwood
Dr Penny Berents
Dr Maria Capa (Post-Doc Fellow)
Dr Don Colgan
Dr Francesco Criscione (Post-Doc Fellow)
Dr Rosemary Golding, Chadwick Biodiversity Fellow
Ms Amanda Hay
Dr Lauren Hughes (Post-Doc Researcher)
Dr Pat Hutchings
Dr Steve Keable
Mr Mark McGrouther
Dr Peter Middelfart
Ms Anna Murray
Dr Jeff Leis
Dr Jim Lowry

Ms Helen Stoddart
Mr Roger Springthorpe
Dr Buz Wilson
Ms Michelle Yerman

Senior Fellows

Mr Des Beechey
Dr Hal Cogger
Dr Doug Hoese
Dr John Paxton
Dr Winston Ponder
Dr Bill Rudman

Honorary/Research Associates

His Majesty the Emperor Akihito
Mr Neville Coleman
Mr Ken Graham
Dr Walter Ivantsoff
Ms Patricia Kailola
Mr Katsusuke Meguro
Dr Hiroyuki Motomura
Dr Hannelore Paxton
Dr David Pollard
Mr Roger Steene
Dr Brian Timms

Visiting Fellows

Dr Claire Paris, Rosenstiel School of Marine and Atmospheric Sciences, Florida
Dr Charles Oliver Coleman, Humboldt University, Berlin
Dr Michael Miller, University of Tokyo
Dr Lyda Rachel Castro-Garcia, Universidad del Magdalena, Columbia
Dr Brenda Liá Doti, Universidad de Buenos Aires, Argentina

Students Supervised

Ms Kylie Dixon, Uni of Newcastle
(by Pat Hutchings)
Mr Klaus Heubert, PhD, Uni of Miami completed PhD during 09/10 (by Jeff Leis)
Ms Samantha Bowers, 2nd year project, UTS (by Jeff Leis)
Ms Jessica Stellar, James Cook University (by Pat Hutchings)
Ms Lexie Walker, PhD, Queensland Uni,
(by Pat Hutchings)
Ms Michelle Yerman, PhD, Uni of New England,
(by Jim Lowry)

Volunteers:

Pam da Costa
Adrienne Gatt

Program 2

Addressing knowledge gaps and problems in understanding the biota in Australian terrestrial and freshwater environments

This program recognises that a key requirement for conserving and managing terrestrial and freshwater environments is a better understanding of the organisms comprising these biological communities. Contributions to this program encompassed a broad range of research methodologies and topics, from field-based ecological studies of interactions between species and their environment, to computer-based syntheses utilising over 200 years of accumulated taxonomic and collection data to analyse large scale patterns in biodiversity.

Systematics studies, using morphological and genetic approaches, were the core strengths of this program. As part of this research, field work was conducted in localities throughout Australia and overseas. Visits were made to significant natural history collections in other museums, while the vital detailed work of sorting, databasing, identifying and examining specimens, as well as analysing data continued.

Key Drivers

It is not possible to measure human impact on biodiversity, or understand the significance of this impact unless there is knowledge of what species are present in the NSW and Australian environments, and what their relationships are to each other. An important output from specimen-based biodiversity research at the Museum is tools to assist biodiversity assessments and to develop conservation priorities. These approaches use museum collections data and build on new technologies in genomics and evolutionary biology. Ongoing work in this area parallels international efforts of more than 70 nations and 50 participating organisations, such as The Group on Earth

Observations and the Global Earth Observing System.

Taxonomic and systematics research in this program provided keystone information required to identify, manage and ameliorate loss of biodiversity. This program also used taxonomic knowledge, collection-based distributional data and community/species-specific ecological and genetic data to assist land managers and policy makers in making informed conservation and management decisions, at both a landscape, and on a species-specific scale. Research also provided the rigorous and relevant framework required to identify potential and actual invasive species, as well as providing baseline data to enable the ongoing impact of climate change to be monitored, modelled and predicted. This program thus contributed to the achievement of a key goal of the NSW Government State Plan, 'Better environmental outcomes', as well as National Research Priorities, 'An environmentally sustainable Australia' and 'Safeguarding Australia'. Most of the research in Program 2 involved collaboration between Museum staff and external (often international) researchers and/or institutions and was largely funded from external sources. Most of these projects were specimen based, bringing together multidisciplinary teams including morphologists, ecologists, geneticists and information technologists and using key Museum research infrastructure (collections, computing, GIS, SEM, DNA lab).

Key research goal a) Understanding the species and places of high biodiversity significance in Australia

Australia boasts an incredibly rich and largely endemic biota, which is far from being completely known. Research projects undertaken by the Museum aim at improving our understanding of some of the most diverse regional faunas in Australia. Several research projects contributed to this aim, which have focussed on a large variety of groups of organisms, from land snails to spiders to kangaroos.

Ongoing efforts have been made to study minute land snails of the family Charopidae, which have great potential as models for understanding the species diversity and biogeography of eastern Australia. To realise this potential, an extensive morphological and molecular study of the genus *Gyrocochlea* was conducted. It revealed that this group has enormous diversity with more than 30 species. Many of these species are cryptic and can only be distinguished by performing anatomical studies of the reproductive organs. The distributional patterns within this group were found to be very informative about the biogeographic regionalization of eastern Australia, especially as many of the taxa have narrow ranges.

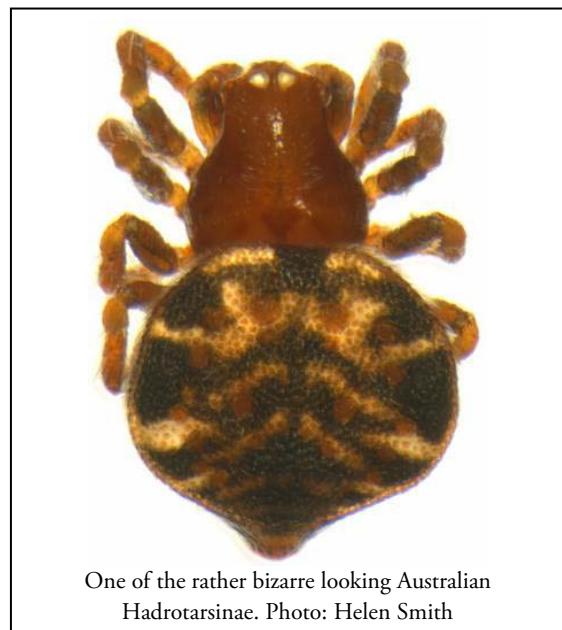


One of many new species of the genus *Amplirhagada* recently discovered during the Kimberley Island Survey (courtesy Mr Vince Kessner, Darwin).

Land snails are also providing intriguing insights into local patterns of endemism and biodiversity in an on-going survey of the Western Australian Kimberley region conducted by the Department of Environment and Conservation (WA) with participation by Australian Museum scientists. The spectacular ancient landscapes of the Kimberley region support incredible biodiversity and the present survey has revealed the Kimberley as a hotspot of land snail endemism and diversity. The work has resulted in the discovery of probably 140 new species and 6 new genera of camaenid land snails. A small fraction of these new taxa have been described

formally. However, understanding the evolutionary processes and the time frame that have caused this spectacular radiation requires further study.

Australia also has a diverse and unique fauna of ants. Current research suggests that this diversity is matched by a radiation of Hadrotarsine spiders. These spiders are one of the few groups that feed almost exclusively on ants. A Museum scientist has discovered 12 undescribed genera amongst Australasian Hadrotarsinae. In addition, a new genus and 19 species of goblin spiders, family Oonopidae, were also described. Many of these oonopid species were recorded only from one or two localities while the genus as a whole occurs across all of Northern Australia. This finding demonstrates the importance of maintaining a dense patchwork of reserves across large distances to conserve diversity in such dispersed taxa.



One of the rather bizarre looking Australian Hadrotarsinae. Photo: Helen Smith

Given the increasing focus on water resource issues in NSW and indeed across Australia, the Museum has recognised the significance of studies that address the taxonomy, biology and ecology of Australia's freshwater fauna. The diversity of research projects conducted by the Museum reflects that of freshwater habitats and their fauna.

Freshwater gobies are fishes that are frequently restricted to single lakes or river systems and therefore likely to be affected by human activities and climate change. Recent revisions have focused on completing descriptions of Australian gobies. Other research has focussed on the continuation of on-going systematic revisions of freshwater molluscs, such as minute species of hydrobiid snails from Queensland artesian springs as well as viviparid, lymnaeid and planorbid freshwater snails. In this context, a report on the aquatic macro-invertebrate fauna of the artesian springs of Edgbaston Station in central Queensland was completed.

Work on the freshwater isopods of the Northern Territory continued resulting in the discovery of a new species in Arnhem Land.

In a collaborative project by major state museums and CSIRO Marine and Atmospheric Research, the Australian Museum has contributed data on freshwater fishes to the development of the on-line database 'Fishes of Australia Online'. This database compiles information about the biodiversity and evolutionary relationships of Australian fishes. The information provided also includes identification tools, images and other resources for every fish species known from Australian waters.

Key research goal b) Understanding the distribution, interaction and evolution of key species in arid Australia

A number of projects mentioned under key research goals a) also contribute to the understanding of species of arid Australia. This reflects the biological reality that many animal groups have representatives both in arid and mesic (relatively moist) regions of Australia.

In 2009/10, Bush Blitz has been Australia's largest nature discovery project. In collaboration with the Australian Government, the Earthwatch Institute, State, Territory and Commonwealth institutions, Australian Rangeland Ecosystems and corporate partners, Bush Blitz has been developed as a national



Photo: *Diceratucha xenopis* by D. Britton

species discovery program to document the biota at over a hundred sites across Australia's National Reserve System, many of which are located in arid zones. As part of its commitment to document Australia's biodiversity, the Australian Museum participated in the official launch of the Bush Blitz program. It is expected that hundreds of new species will be uncovered and that Bush Blitz will provide baseline scientific data on the distribution of many taxa. Museum researchers participated in surveys in the New England, Gundabooka and Paroo-Darling National Parks in NSW, where they collected insects and molluscs, including the collection of an undescribed snail species.



The Pilbara bioregion

Surveys of terrestrial short-range endemic (SRE) invertebrate fauna were carried out in the Pilbara bioregion in Western Australia. Short-range endemism refers to taxa with restricted distributional ranges, poor dispersal powers and confinement to discontinuous habitats. SREs are considered among the most vulnerable

components of biodiversity, being particularly susceptible to habitat modification.

Other projects

Australian Museum researchers have been involved in a number of projects additional to those that fall within the key research goals.

In one of these projects, molecular-based research has revealed that the endemic Australian rock-wallaby genus, *Petrogale*, has apparently undergone a recent and rapid diversification. While the inter-relationships of many taxa still remain unclear, several highly divergent lineages were identified within the Short-eared Rock-Wallaby (*P. brachyotis*) which appear to represent cryptic species.



Biodiversity within urban areas has decreased in recent years and local councils are now looking for ways to preserve remaining species and their habitats. Vertebrate and invertebrate surveys, along with a wildlife habitat corridor study were conducted within Waverley local government area (LGA) in order to provide the Council with baseline biodiversity data and determine the extent of existing wildlife habitat corridors. It was found that Waverley LGA still contains pockets that provide habitat for a range of native species. Coastal remnants were identified as the best habitat and recorded a reasonably high diversity of native species that were not found elsewhere in the LGA. The condition of existing vegetation dictates that measures undertaken to improve habitat remnants and their potential linkages will need to be carefully targeted to

benefit all fauna, rather than aggressive species that exclude other animals.

A collaboration with the botanical consulting company Anne Clements Pty Ltd resulted in a list of insect taxa associated with the fruit of the endangered Magenta Lillipilly *Syzygium paniculatum* (Myrtaceae), along with an analysis of the insect community structure. The conservation significance of seed predation by insects on this plant is not clear, as even with high levels of predation there was still viable seed present. It was found that one of the most abundant seed predators is an undescribed species of weevil in the genus *Sigastus*.



Pterodunga mirabile guarding larvae. © Jack Hasenpusch

The unusual biology of a North Queensland species of beetle (*Pterodunga mirabile*) was newly described, allowing the authors to review two rare phenomena (i) maternal care in leaf beetles; (ii) leaf beetle herbivory on the plant family Proteaceae. The new discovery provided the first example of maternal care in leaf beetles from Australia, an occurrence which was shown to have evolved in isolation from other examples.

A new genus of leaf beetle was described from Australia, with three new, flightless species that were all found at single localities in south-eastern and south-western Australia. A second new genus was described for a species that is restricted to North Queensland and only known from two specimens. Two other leaf-beetle genera were revised, with seven new species described. The past involvement of the

Australian Museum with a pilot survey in Western Australia has initiated a revision of the moth genus *Diceratucha*, a small group of moths found mostly in semi-arid Western Australia.

Research on terrestrial isopods has addressed the biology of a common slater that can be found in leaf litter in natural settings in the Sydney region, which is surprisingly poorly understood. While the species has been tentatively identified as *Sphaerillo grossus*, the type locality for this species is in central Queensland. On-going study will ascertain whether the Sydney slater represents an introduction or a different but closely related species.

Another focus has been on detecting and identifying invasive species. Recent projects led to the discovery in south-eastern Australia of a well-established South American beetle species. Work has commenced recently on developing an evolutionary framework and diagnostic methods for many potentially invasive moth species of major economic importance.

The museum also collaborated with the Australian Quarantine Inspection Service (AQIS) to develop a DNA-based identification tool for apple snails which, as potential invaders of rice fields, are classified as 'Emergency Plant Pests'.

The BugWise team has developed a method called *Web-2-Spider* that allows non-specialists to assess web-building spider diversity using spider webs as surrogates. The method is likely to prove useful for student projects and assessments of local areas by local conservation groups.

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Program 3

Increasing our understanding of the genetic variation in key taxa (species) of the Australian and Indo-Pacific biota.

Projects previously listed under Program 3 are reported in other Programs where applicable.

Program 4

Origin, evolution and biogeography of the biota of the Indo-Pacific and Australasian region

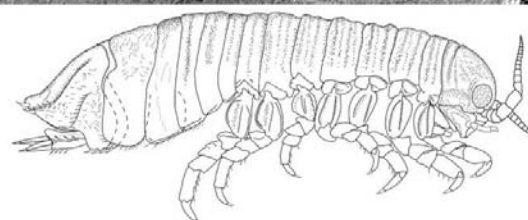
The Australian fauna is heterogeneous, some elements having survived little changed from Gondwanan times, some having recently crossed from South East Asia (for example humans), but much of it as large radiations of species with unclear relationships to other land masses, effectively evolving *in situ*. Most of the Museum's zoologists are addressing this issue in their systematic research. The two key research goals of this program overlap, as it is frequently not possible to isolate the Australian fauna from its neighbours in systematics studies. The Museum's research has focused on marine worms, snails, freshwater isopods, spiders, beetles, flies, fish, frogs, lizards, birds and macropod mammals.

Within this Program, Museum researchers are interested in answering a number of key questions. Is diversity driven by landscape and climate? Is this diversity recent or ancient? Is diversity congruent with patterns of diversity in other organisms? And, does the Australian fauna have a single origin or multiple origins?

Key drivers

The description, classification and status of its biodiversity are key issues in New South Wales. To understand the significance of the State's fauna its role must be known in a broader context, both nationally and within the Pacific region. Our research under Program 4 helps to inform environmental management policies, including those concerning climate change, for both State and Federal legislative bodies. In recognition of this, several projects were funded by State or Federal agencies.

Key research goal (a) Understanding the origins of the Australian fauna



A new species of *Protamphisopus* that shows a close relationship between Southern China and Australia 240 million years ago. Top, fossil. Bottom, reconstruction, scale bar 1mm.

Freshwater isopod crustaceans in this driest of continents are isolated in springs, aquifers and mound springs. All genera of freshwater isopods in the suborder Phreatoicidea have been surveyed using Scanning Electron Microscopy. This database was used for systematics studies on the evolution of the group, showing their early diversification in several unrelated lineages. By inference from their nearest living relatives outside Australia, three groups were identified, of at least 180, 120 and 80 million years in age. A fossil of a freshwater phreatoicidean (*Protamphisopus*) from the Triassic (c. 240mya), was collected from Sydney shales, suggesting an even greater length of relative morphological stasis for this group. A recent collaboration with colleagues from Beijing, China has discovered a close relationship between the Triassic Australian fauna and that of the Yunnan Province, China, with the description of a new species in the same genus (shown in figure). The preservation of the Chinese fossil is incredibly detailed, which will allow a direct comparison between modern and ancient species. Australia's freshwater diversity appears to have ancient and globe spanning origins.

Museum researchers are continuing to work on the evolution of Gastropoda. Three papers were published this year on the largest group of

gastropods – the Caenogastropoda. A study on the molecular phylogeny of the superfamilies Rissooidea and Cingulopsoidea is nearing completion.

A project which investigated conodont biostratigraphy is relevant to this Program. For further information on this research project see Program 8.



This ant mimicking *Anatea* sp. from New Caledonia has relatives in Australia. Photo H. Smith

Australian Museum research on the comb-footed spiders in the subfamily Hadrotarsinae has shown that this large group of taxa, most previously undescribed, is primarily restricted to the southern hemisphere. The closest relatives to Australian species are found in South America, New Caledonia and New Zealand. Another component of the hadrotarsine fauna in Australia is made up of species that can be placed in described genera with widespread distributions in the northern hemisphere. Preliminary phylogenetic diagrams suggest a single origin for the 'Austral' taxa as sister to two existing genera. More comprehensive sampling of the widely distributed taxa is being undertaken to confirm this observation.

Few studies have investigated the phylogeography of widespread Australian species. The western grey kangaroo (*Macropus fuliginosus*) is a large vagile (able to move about or disperse), marsupial inhabiting southern Australia. A phylogenetic examination of mitochondrial DNA variation from throughout the species' trans-continental distribution revealed a surprisingly complex evolutionary history. *M. fuliginosus* originated in the south-west of the continent with north- and south-

western populations subsequently diverging as a result of vicariance events during the mid-Pleistocene. Although increased aridity may be analogous to the movement of continental ice sheets in some respects, the heterogeneous semi-arid habitat of Australia appears more conducive to the persistence of biota during periods of aridification.

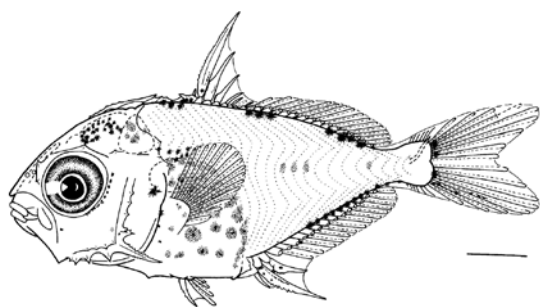
Key research goal (b) Understanding the biogeography and evolution of the Indo-Pacific

Museum scientists are assessing the relationships between the Asian and Australian faunas. The poorly-known amphibians of South East Asia are facing the highest deforestation rate on the planet. This year, teams of Vietnamese scientists, led by a Museum researcher, documented the distribution, diversity, biology and conservation status of amphibians of the forests of Vietnam. The first of several new species of frog identified during this research, Appleby's Asian Leaf-litter Toad (*Leptolalax applebyi*), has just been described. Captured amphibians are also tested for chytridiomycosis, the disease responsible for amphibian declines and extinctions in Australia and around the world, in an effort to assess the distribution and potential impacts of the disease in the region.



Leptolalax applebyi, a new species described by J. Rowley

The marine fauna of Australia occupies part of an enormous network of oceans and often reveals distribution patterns that are as enigmatic as their terrestrial counterparts.



Larva of reared *Leiognathus equulus*, size 7.2 mm

The Museum's research on larval development of fishes provides information that is the raw material for morphological assessment of relationships and evolution of Indo-Pacific fish species. Work continued on the tropical snappers (Lutjanidae), an important commercial group throughout the tropics, and in collaboration with Arizona State University, on the relationships of the tripletails (Lobotidae). The results of this project included the first description of larval development of many fish species, including members of Leiognathidae (ponyfishes), Ehippidae (batfishes) and Acanthoclininae (spiny basslets). Numerous collaborators and Museum scientists studied the dispersal of coral reef fish larvae, fundamental to the understanding of species dispersal and biogeography of Indo-Pacific fishes.

Sabellid marine worms have planktonic or free-drifting larvae. A morphological approach to their taxonomy has suggested that there is a high proportion of species that are exclusively native to Australian waters and there are species that appear to be broadly distributed in the Indo-Pacific. These hypotheses were confirmed with molecular techniques of about 20 species in five genera that also revealed the presence of cryptic taxa in south-east and north Australia that can be discriminated by DNA sequences but not by morphological features. Museum staff continue to study the morphology of the many species of marine worm in Terebellidae with the aim of understanding the phylogeny of this large polychaete family. Some of the Research this year was conducted in a joint study with Dr Joao Nogueira from Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo, Brazil, the recipient of an Australian

Museum Visiting Fellowship. The first major monograph reporting this research was recently published.

Museum malacologists are collaborating on a worldwide revision of the nearly one hundred genera of commensal bivalves belonging in the group Galeommatoidea. A phylogenetic analysis of the family using morphological and anatomical characteristics is being undertaken to provide a brand new hypothesis of the relationships within the group.

Another project on this family is seeking to explain 'Why are there so many Galeommatoidean clam species?' Possible causes of this extraordinary diversity will be investigated by examining how coevolutionary processes may influence diversification in certain taxa. The role of reproductive specialization in speciation will also be examined. Building upon an understanding of the southern Australian fauna as a model system, the project will be expanded to a global scale to test whether commensalism has played a significant role in promoting diversification in the superfamily as a whole.

The terrestrial environment has many clues to the origin of the Australian fauna. Museum entomologists have been active in the investigation of archipelago biodiversity in the Indo-Pacific, particularly the sampling of terrestrial invertebrates on the Samoan archipelago and a large scale, long-term study of beetles in the forest canopy in Sarawak. This latter study showed significant El Nino effects on the fauna, changes in leaf beetle assemblages being apparently caused by increased abundance of understorey weedy species of plants promoted by leaf-loss during more arid periods.

A large project using multiple nuclear and mitochondrial gene sequences to investigate the phylogenetic and biogeographic relationships of the *Simulium* (black fly) species of Thailand at the subgeneric, species group and species levels was finalized this year.

Research on New Caledonian lizards concentrated on a programme of collaborative field research to make an inventory of the fauna of reserve areas in the Southern Province. The discovery of a new species of skink in the genus *Sigaloseps* from the summit area of Mount Humboldt, the highest peak in the region, was particularly significant. The inclusion of this new species plus additional samples of other species in the genus into ongoing research on this group has identified a complex pattern of micro-endemism in the region, which includes a group of several species found only at high elevation (above 900 metres). Work on *Sigaloseps* and the scincid lizard genus *Marmorosphax* (previously reported) has now identified an extensive suite of species restricted to high elevation forests in New Caledonia, a very narrow niche that will retreat upwards in the face of increasing temperatures with global warming, and that is threatened by escalated nickel mining in the territory.

Museum ornithologists have investigated both living and fossil birds (see Program 8). They have investigated the relationships of two unusual and poorly known New Guinea genera in a study that melded molecular and morphological data.

Molecular systematics investigation by Museum scientists of the Christmas Island (CI) Shrew *Crociodura attenuata trichura*, the only member of the speciose family Soricidae recorded from Australia, is classified as an endemic island subspecies of the Asian grey or long-tailed shrew *C. attenuata*. The CI shrew is currently listed as 'endangered' under the Australian Federal *EPBC Act* but has not been recorded in the wild for several decades. New evidence suggests Museum specimens of the CI shrew collected in 1899 and 1985 should be regarded as a distinct species, *C. trichura*. If it is not yet extinct, the CI shrew is a highly endangered endemic Australian species. These results also highlight the value of Museum collections.

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Program 5

Understanding human impacts on the Australian biota.

Research was undertaken in twenty two research projects, including fifteen major ones, investigating human impacts on the Australian biota. This research addressed three key research goals directed towards increasing understanding of our impacts on freshwater and estuarine ecosystems, effects of climate change on the Australian fauna, and human impacts in the Sydney region.

Key Drivers

Research was conducted in a number of areas identified as State priorities. These priority areas include the loss of biodiversity (NSW Biodiversity Strategy 1999), climate change (NSW Biodiversity and Climate Change Adaptation Framework 2006-2008), invasive species (NSW State of the Environment Report) and better environmental outcomes for native vegetation, biodiversity, land, rivers and coastal waterways (NSW State Plan: Investing in a Better Future 2009).

Research carried out as part of this program provided important data on the evolution, ecology and genetics of a diverse range of native and introduced species. This information has been used in risk assessments to determine the level of threat faced by species listed under the Threatened Species Conservation Act as well as providing ecological information underpinning recovery actions. All research in this program will be invaluable in informing future conservation and management decisions related to human impacts on the Australian biota.

Key research goal a) Assessment of the vulnerability of Australia's freshwater and estuarine ecosystems to human impacts

Research this year built on 2009 results showing that a freshwater isopod species flock from

Kakadu National Park may be at risk from uranium mining and water extraction by humans. A genetic analysis of the freshwater isopod species (Crustacea; Isopoda) in the genus *Eophreatoicus* showed substantial species diversity in areas where mining is to take place. Many of these species may be exposed to risk, especially near Jabiru if planned mining projects are begun. New species currently under study have been found in East Arnhem Land, which suggests that these isopods may have an extensive distribution among the ancient sandstones of the Arnhem Plateau, thereby broadening the region of concern.

Key research goal b) Investigating the effects of climate change on the Australian fauna.

To investigate the vulnerability of benthic invertebrates to climate change, Museum researchers have mined databases to determine whether east coast invertebrates exhibit changes in geographical distributions over time. Preliminary results suggest that some species have changed distribution patterns over the past few decades, but work is ongoing to determine whether these records reflect changes in distribution which may be the result of increasing water temperatures.



During 2009/10, a network of 150 mini-weather stations was established in the Hunter Valley region of NSW to provide a better understanding of how climate measurements by the Bureau of Meteorology relate to the climate in the actual habitats of different species. Preliminary results suggest the magnitude of climate change may vary in different

environments. Twelve months' data has already been collected, and more rigorous analysis is ongoing.

Ongoing research on biodiversity surrogate models has shown that enhancing environmental classifications using museum data and biodiversity surrogates (such as vegetation maps) can improve assessments of the impacts of climate change and land-use change. New applications of a phylogenetic diversity measure, developed by a Museum researcher and inspired by microbial ecology and DNA barcoding, showed that new technologies, including genomics, could provide important new ways to monitor biodiversity impacts.

Key research goal c) Understanding human impacts in the Sydney environs.

Although sandy beaches are extremely valuable assets, they are under increasing threat from the 'coastal squeeze' of human development on the terrestrial side and climate change on the oceanic side. As a consequence, beaches are suffering erosion and their biota are threatened by human activities, increasing water temperature, acidity and storminess. Unfortunately, our understanding of beach biology is poorly developed by comparison with other coastal ecosystems, and thus the effects of these threatening factors on beaches are largely unknown. The demand for credible, scientifically-based management will grow as pressures on beaches intensify. In an attempt to assist managers, an international group of sandy-beach biologists has been synthesizing available research information, suggesting management strategies and identifying key research questions. Of most concern to both humans and the ecosystem is the worsening erosion of beaches. This has led to a need to undertake large-scale beach 'nourishment', whereby sand is imported from elsewhere. This process is currently being assessed for Sydney's beaches. As well, the effects of increased acidity may be large since many beach species have calcium carbonate-based shells which may dissolve in acidic water.

Most research investigating the effect of urbanisation on animals infers temporal change by comparing the species composition of present urban habitats with that of nearby 'natural' sites. In regions with long histories of human habitation, such as the Sydney region, museum collections can provide direct evidence of the distribution of animals present prior to urbanisation. By comparing the pre-1900 bird community determined from the ornithology databases with the *circa* 2000 bird community determined from volunteer bird surveys, research published this year established that the major difference in the bird community between the two periods was a shift in body size, with large bird species comprising a greater proportion of the recent bird community than small birds.



A bird in the hand – the White-fronted Chat.

Work continued this year on the conservation ecology of the White-fronted Chat, with the findings contributing to the listing of this species as vulnerable in NSW and the Sydney population as an endangered population. Museum collections and historical records reveal that this species was once known from more than 50 locations across the Sydney region, but Museum surveys this year indicate that the remaining two locations now support only 4 (all male) and 23 birds respectively. Feather samples were collected from 84 birds in 6 populations along the east coast of Australia to measure gene flow amongst these potentially isolated populations. This work is guiding recovery actions for this species.

Research on other human impacts

Humans can have an impact on the natural environment by deliberately or accidentally introducing species. In 2004, Museum scientists discovered a new exotic bee, *Halictus smaragdulus*, in the Hunter Valley region of NSW. The extent of the incursion was unknown, but a grant from the WV Scott Charitable Trust allowed further survey work to be conducted. The known extent of the incursion has since been expanded to include the region between Sydney, Tamworth, Wellington and Maitland.

It has been known with certainty since 2000 that Australian edible mussels include a local species and an introduced European species *Mytilus galloprovincialis*. Museum scientists have now genetically identified the presence of another European edible mussel, *M. edulis* during a survey of the possible effects of recent environmental changes on the distribution of marine bivalves along the coasts of NSW. This introduced species is likely to cause major damage to the intertidal ecosystems of southern NSW, especially as it has become adapted, possibly by interbreeding with the native species, to even the most exposed rocky headlands.

Roads can have a major impact on local wildlife. Potential negative impacts include habitat loss, fragmentation, alterations to gene flow, and direct mortality. The NSW Roads and Traffic Authority have funded an investigation into the impacts of a major road upgrade on a population of koalas within Bongil Bongil National Park, on the NSW mid-north coast. Surveillance cameras have been installed in two underpasses and one land bridge to monitor their use by local wildlife, with koalas the target species. A range of native fauna have used these 'fauna mitigation structures'. Monitoring of road kills suggests the fauna exclusion fencing has reduced but not eliminated road mortalities. The results suggest there is potential for the impact of roads on koalas and other native wildlife to be reduced if appropriate mitigation measures are included at the design stage.

The Museum's wildlife forensics program continued to develop, with staff from the DNA laboratory presenting a paper at the inaugural society for Wildlife Forensics meeting in Oregon on wildlife trafficking cases that the Australian Museum has been involved in, using DNA-based techniques to identify specimens. The DNA Laboratory also assisted with DNA-based identifications for cases involving birds, mammals, fish and reptiles for agencies including Industry and Investment NSW, Department of Primary Industries, Parks, Water and Environment Tasmania, Australian Fisheries Management Authority, Australian Customs Services, and Australian Quarantine and Inspection Service. The Museum's DNA-based identifications continue to be critical in many cases, including those brought against perpetrators of wildlife-based crime.

The Museum is increasingly becoming involved in assisting management decisions for threatened or endangered species. In collaboration with NSW Department of Environment and Climate Change, researchers completed work on genetic analysis of several populations of the Bush Stone-curlew, which is endangered in Southern Australia but which has large and healthy populations in Northern Australia. DNA analysis suggests that the Bush Stone-curlew has experienced severe contractions in the size of its south-east Australian populations, running the risk that these populations will soon become inbred and unviable. Release of captive birds from healthier northern Australian populations into many areas in south east Australia is now underway.

Discussion of goals under the broad theme of human impacts on biodiversity

It is clear that museums will play an increasingly unique and important role in addressing contemporary issues. The reason lies not just in our collections but also in the particular values and perspectives we promote – e.g. the intrinsic values of biodiversity and the importance of evolutionary history. Much of the research is integrative and multidisciplinary, and

increasingly works through a 'dialogue' with other workers internationally focusing on the same problems.

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None during the reporting period.

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Program 6

Investigating the history of human cultures and communities in the diverse and changing environments of Australia and the Pacific Region.

This Program's research focuses on Australia, Southeast Asia and the Pacific regions, where highly diverse societies inhabit many different environments. Over millennia, these regions underwent climatic and ecological changes. People adapted to and developed various strategies to cope with long-term changes and cataclysmic events such as volcanic eruptions and tsunamis. New results of anthropology research cast light on the indigenous cultural practices and adaptations to changing environments. The results help to better understand relationships between different societies and exchange of ideas and materials via long-distance trade as well as more immediate interactions between indigenous and non-indigenous societies. For many current research projects, ethnographic and archaeological collections are an integral component. Examples are: Tracking Exchange Systems in Southeast Australia; Cataloguing the Roth Collection from the Gulf Region of North Queensland; Tracing the History of Early Anthropology Collections; Tracing the History for Stone Tool Diversity in West New Britain.

Key Drivers

Research in this Program has broadly contributed to a number of areas identified as priorities by the NSW Government, including:

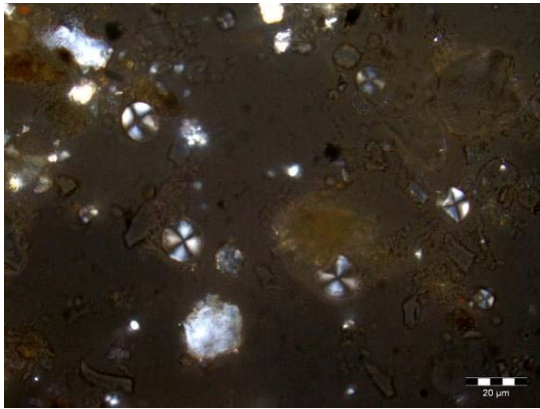
- contributing to building harmonious communities and strengthening Aboriginal communities, under the State Plan;
- supporting and affirming Aboriginal people's culture and heritage under the *Two Ways Together 2003-2012* policy; and

- contributing to the creation of a stronger multi-cultural society, which is relevant to policies set out in the Green Paper, *Cultural Harmony: the Next Decade 2002-2012* and the White Paper *Building on our Cultural Diversity: Ethnic Affairs Action Plan 2000*.

Research Goal (a) Understanding the history and diversity of Indigenous material culture

New research on ancient stone tools from Papua New Guinea is revealing a significantly more complex picture of past cultural diversity than previously suspected. A class of large, highly distinctive obsidian tools, made using a complex and sophisticated technology, provides important information about societies living 10,000-3,000 years ago. These 'stemmed tools' can be found across distances of over 2000 km, demonstrating that long-distance exchange and social networks began in this region much earlier than previously detected. Although large stemmed tools disappeared after a major volcanic eruption about ca 3000 years ago, production and use of smaller stemmed tools continued. Continuity of this tool type has important implications. It suggests the local population was not replaced by pottery-making immigrants from South East Asia as long argued by some scholars.





Obsidian stemmed tool (above)
Ancient starch on a stemmed tool (below)

Changes in the making of pottery at Wanigela in Papua New Guinea over the last hundred years were identified through a study of the extensive Australian Museum collection.

Aboriginal artefacts from the Gulf country, north Queensland, were collected by Dr Walter Edmund Roth, when he was surgeon at Boulia, Cloncurry and Normanton hospitals in 1894, and First Protector of Aborigines for north Queensland between 1898 and 1905. This collection and associated documentation are being researched for a catalogue, the fifth in a series that describes many of the more than 2000 objects Roth collected from northern Queensland. The catalogue will include about 400 artefacts assembled at a time when Aboriginal people had to contend with their lands being taken over by cattle stations, and later, a rush of prospectors to the gold fields. Items in the Gulf collection reflect this impact. For example, threads from government blankets were carefully picked out, sorted and woven into striped bags, in place of traditional hand-spun bark fiber string.



Woven bag, made with European threads in stripes of different colours. Handle made from European cloth. Inside the bag are plant material, probably pituri (native Australian stimulant), feathers and human hair. Collected Boulia 1894. Size 57x22 cm

The use of stone tools was rarely recorded by early European colonists in south eastern Australia, and the use of stone tools known as backed artefacts has been open to much speculation. A microscopic use-wear and residue analysis, which is part of a current study, demonstrates backed artefacts were typically part of composite tools used in numerous ways. These uses included making and maintaining objects of wood, non-woody plants, bone, hide and feathers, as well as animal and plant food preparation. This study also showed that different tasks were undertaken in different locations within the study area. For example, wood was more commonly worked at one site, bone at another site and skin at a third. Such spatial variation in the use of stone tools has not previously been identified in archaeological research.



Backed artefacts showing front, back and side views. Small flakes that were removed along one side (known as backing) create their distinctive shape. The tip from the specimen on the left has broken off during use. The scale bar is 1 cm long.

Research Goal (b) Tracking the history of human interaction with the natural environment

Early studies of human interaction with the natural environment in the Pacific region largely overlooked significant impacts of rapid-onset of natural hazards. A long-term study is investigating the creative ways that societies in West New Britain, Papua New Guinea, coped

over 40,000 years with a disastrous history of volcanic eruptions. International collaborative research between archaeologists and geologists has identified over 20 major volcanic events and analysed their ongoing effects on local landscapes and ecology. Archaeological and palaeobiological studies demonstrate that despite these perturbations, human populations were extremely resilient over tens of thousands of years, probably because they developed methods for coping with extreme fluctuations. In contrast, some social groups displaced by volcanic activity capitalised on environmental instability to effect cultural changes that previously were thought to be imported into the area by new immigrants.

Humans have not been passive players in long-term environmental change, as results achieved during the New Britain vegetation history project illustrate. This project has made a major contribution to understanding human impacts on the region's vegetation, from before the Late Glacial Maximum (~35,000 years ago) to the present. It has produced important new data on the history of potential crops and cultivation practices through analyses of phytoliths (plant micro-fossils) from three archaeological sites in the interior of New Britain, Papua New Guinea.

Research Goal (c) Understanding the origin and functions of social exchange

Current Museum research concerns the movement and exchange of Aboriginal stone hatchet (axe) heads and raw materials in late Holocene south eastern NSW, using non-destructive Portable X-ray Fluorescence Spectrometry (PXRF). This collaborative project is a key methodological innovation in provenancing studies both within Australia and internationally. Almost all previous comparable studies have been most successfully applied to obsidian. Results of a recent pilot study showed PXRF could successfully discriminate between basaltic artefacts from distinct geological sources, otherwise difficult to differentiate visually, and also had sufficient sensitivity to match geological source with artefact. Further work is currently underway to determine whether focusing on the polished blade surfaces of hatchets can further improve the discriminatory power of the PXRF. This inter-disciplinary research project combining the expertise of archaeologists and geologists will significantly advance knowledge of how exchange systems and networks become embedded in ceremonial life, and will make a major contribution to our understanding of how exchange is expressed in the archaeological record of south eastern Australia.

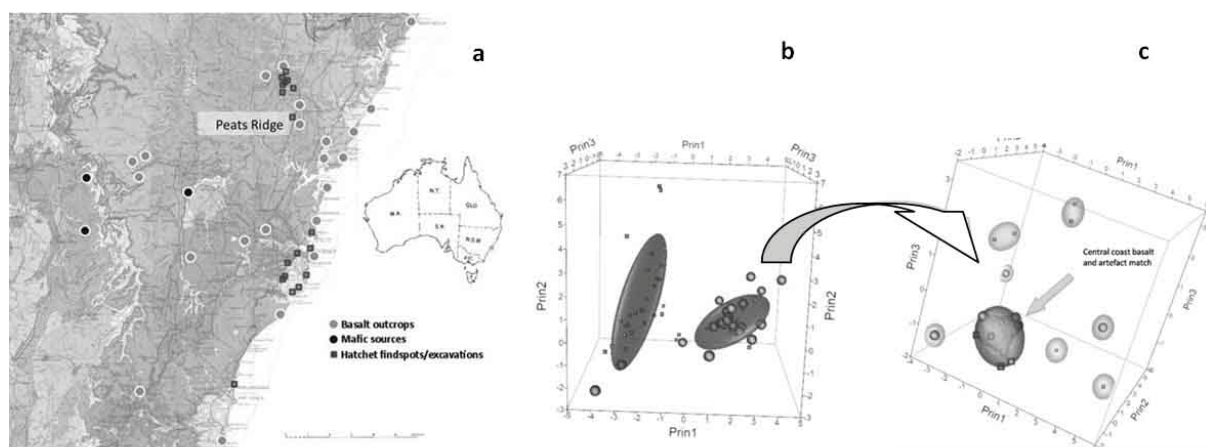


Figure 2: PXRF Pilot study of hatchets and geological sources in the Sydney Basin. Left a: locations of hatchet findspots, basalt outcrops and mafic sources; centre b: 3 dimensional projection of Principal Components results for the combined dataset (hatchets squares, geological samples circles; mafics left, basalts right); right c: 3 dimensional projection of Principal Components result for basalt subset showing compositional match between central coast basalt source (Peats Ridge) and hatchets from this area.

Research Goal (d) Other research into human cultures

Tracing early anthropology collections in the Australian Museum reveals that one of the earliest to be made was about 50 artefacts from Torres Strait in 1836 by the Commander Charles Lewis and Phillip Parker King, the latter then a Trustee of the Australian Museum. The collection was assembled during a rescue expedition to gather the evidence on the victims and survivors of shipwreck *Charles Eaton* in 1834. For over one hundred years it was assumed that this collection was totally lost in the Garden Palace fire in 1882. Current research shows that only five artefacts were destroyed in the fire, while 19 are still present in the Australian Museum collections. It was discovered that an additional eight artefacts were shipped to Denmark as part of one of the early collection exchanges in 1859 and are still kept by the National Museum in Denmark. The fate of the remaining 18 artefacts is not yet known.



Mask and the detail of two arrows collected in Torres Strait in 1836 held in the National Museum of Denmark and the Australian Museum respectively.

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Program 7

Linking intangible and tangible heritage

Productive collaborations between Museum staff, Indigenous communities and university scholars are making new connections among the objects in the ethnographic collections, their makers, and traditional knowledge. These innovative research projects are bringing the collections back into the center of research and providing new perspectives on the entwined histories of European and Indigenous communities within Australia and the Pacific region.

Research on Balinese paintings and historic ethnographic collections and auction catalogues is producing an intimate picture of the active roles of local communities in Papua New Guinea and Indonesia in the creation of the Australian Museum ethnographic collections.

The results of collaborative research with the Wonnarua Aboriginal community is presented on a website providing extensive, rich information about the Australian Museum collections from the region together with digital stories.

New techniques are being developed to harness the capabilities of the internet for returning information about the ethnographic collections to descendant groups across the Pacific region as well as to open the collections up to a vast international audience.

Key Drivers

The research in this program has encouraged a wide variety of collaborations to employ multiple methods and theoretical concepts. The research responded in direct ways to a number of key priorities at State, national and international levels including:

- NSW Two Ways Together Policy (supporting Indigenous Australian culture and heritage);

- The Green and White papers on cultural diversity;
- the National Research Priority of 'Frontier Technologies' and 'Safeguarding Australia'; and
- the international research issue of the loss of cultural diversity in the Australian-Pacific region.

Key research goal a) Investigating the history of creativity in human cultures and communities in Australia and the Pacific region.

A collaborative project between the Australian Museum and the University of Sydney is uncovering the creative ways in which communities in Central Province and Wuvulu Island in Papua New Guinea have used trade in ethnographic artefacts to negotiate relationships with European explorers, traders, missionaries, and colonial government officials. New research shows that opportunities for collecting ethnographic material were often determined by the needs of the Indigenous communities, rather than only the desires of outsiders. The concept that local people were robbed of valuable goods is shown to be largely false. A microscopic usewear study of turtle bone cleavers from Wuvulu reveals them to be heavily used and probably worn out and useless. The research has identified a number of items previously thought to be 'traditional' but that were specifically made for trade, as early as the first few decades of interaction. The decorations used on these objects show how the Indigenous community created opportunities to assert their local identity within their negotiations with outsiders. The major impacts of New Guineans in shaping the kinds and quantities of objects that now comprise ethnographic collections around the world is only beginning to come to light through this innovative research. In addition, research on artefacts in private collections that has examined the production of goods for sale to tourists by Wuvulu Islanders over the past 50 years has identified consistency in the remarkable level of skill, flexibility and creativity in the manufacture of objects to attract the changing tastes of the potential buyers. Not all

artefacts were made for sale; old worn-out objects were also converted into highly desirable metal tools through trade.

Key research goal b) Understanding the roles of material culture and traditional knowledge in Indigenous cultures

New technology has been used to enhance the research potential of new acquisitions. Extensive recordings and filmed interviews with the collector of an extensive new donation of objects from the Southern Highlands of Papua New Guinea provide invaluable information about the important social background to the events in which the objects were acquired.

Key research goal c) Understanding the collecting process.

As we approach the 40th anniversary of the initiation of the repatriation of objects and ancestral remains to traditional owners in Australia, a comprehensive history of this landmark process is a high priority. It is especially critical to capture the experiences of the pioneers of repatriation before they pass away.

Museum researchers are investigating changes in the nature of interaction between museums and indigenous peoples and changing power relationships between academics and Aboriginal communities. It questions the success of repatriation in achieving indigenous cultural objectives and looks to future directions. The collaborative project, involving an edited book and a website, will comprise the first history of repatriation in Australia but, as importantly, is also documenting the personal experiences of academics and community members involved in the process. This year over 20 oral histories focusing on academics' and community members' experiences and views about the process and the outcomes have been recorded. The web site will be operational by the end of the year.

A new research project focused on the highly significant Balinese paintings collected by

Antony Forge in the 1970s seeks to understand the artistic and scholarly processes which guided their journey from Balinese temples to the Australian Museum. A field project is exploring the local social relations between artists and collectors that structured the collection process as well as studying the significance of the paintings to contemporary Balinese communities. The extensive documentation provided by Forge has been catalogued. Scanning and reproduction of material from the Forge photographic archive has provided high quality images to assist fieldwork. Community access is assisted by 20 narratives about specific paintings posted on the Australian Museum website together with supplementary contemporary images.



Painting on European cloth, painted in 1920s. Scene depicting 'The Fire Ordeal of Sita', attributed to artist Nyoman Laya, Kamasan, Bali. It was used as a curtain with Chinese coins attached at the top for hanging. Size 225x91cm.

Differences in the types of artefacts on sale from Polynesia and Melanesia highlight variations in the social organisations of the two regions which were played out in their negotiations with Western visitors. A more detailed study of British Papua has revealed clear choices in the objects withheld or offered for sale as well as strategies for attracting commerce through creating objects that dazzled European eyes. Changes through time in the composition of the catalogues have also provided innovative insights into social processes during the colonial period.



Auction catalogue: a representative selection of items from Papua. The area blocked off (in white at top) represents a human skull, a common object on Oldman's plates of objects from this region (Oldman 19076: January, 1905, vol. 22 plate 2) (Photo by James King, courtesy of the Australian Museum Research Library).

Auction catalogues from Britain published during the peak period of museum expansion in the late 19th and early 20th centuries provide a fascinating source of data about the quantities and variety of objects in circulation, a sample of which ended up in the Museum's ethnographic collections. A detailed study of changes in sources of the objects, their types and prices provides a fascinating picture of how Indigenous artefact producers and traders made creative responses to market opportunities.

Key research goal d) Engaging with creator communities to better understand the significance of our collections.

Each year many people of Indigenous heritage visit the ethnographic collections and share their knowledge and views of the material (now often recorded on our website within vivid digital stories), but they represent only a handful of the descendant communities who have ties to the

artefacts. It is therefore important to seek ways to increase the visibility of the material in order to encourage wider collaborations. This aim lies behind the Virtual Museum of the Pacific project conducted in collaboration with Wollongong University. A pilot website has been launched that incorporates high-quality images and background information for 400 items selected from across the Pacific ethnographic collections. Interviews with potential users and stakeholders formed the basis for an assessment of the project prior to expansion of the database and the incorporation of a social media component, where community members, researchers, and others can add comments, discuss objects and upload their own stories, images and videos.



Members of the Wonnarua community visit the Australian Museum's Aboriginal collections. Photo F. Mahony, 2009.

Anthropology researchers and collection managers at the Museum have an extensive history of successful collaborations with descendant communities aimed at sharing knowledge about historical practices enshrined within the ethnographic collections. This year a new long term partnership has been forged with the Wonnarua Community in the Hunter Valley, NSW. The initial outcome has been a website incorporating the results of historical research by Richard Mulvaney on the collections from that region along with history of the Aboriginal missions where the collections were made. The website also includes a powerful digital story documenting the community's visit to the Museum and their vision for the project.

The Museum's ethnographic collections have often been instrumental in regenerating cultural practices or stimulating innovative designs and uses among modern groups. Recent research in Vanuatu and West Papua is examining the diverse ways that people have revived and recreated traditional practices for making and decorating bark cloth as part of conscious efforts to reinvigorate contemporary culture and assert local identity. A documentary film, 'Nelokompne Rises Again,' made in collaboration with communities in Erromango, was presented to the Vanuatu Culture Centre.

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Program 8

Investigating extant and extinct faunas and environmental systems in the context of recent geological history to better forecast future changes.

Projects involving Australian and international collaborations have provided new information on the origins of Australian and South East Asian bio-and geo-environments through studies of insects preserved in Cape York fossil amber; conodont biostratigraphy (spatial and temporal distribution of fossil organisms) of Australia, New Zealand and South China; Avian Palaeontology; fossil isopod scavengers, unusual Jenolan Caves minerals, and alluvial gem deposits in recent palaeodrainage systems.

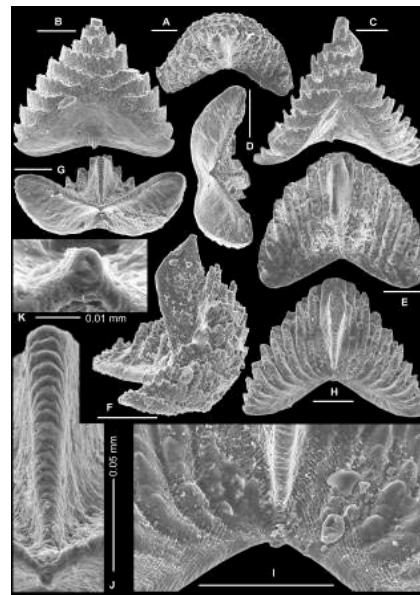
Key drivers

Australian and international collaborations have been vital. The conodont study has led to international benefits – improved Ordovician biostratigraphic control for reconstructing palaeogeography, palaeoclimate and ecosystems. The Cape York amber study addresses National Research Priorities in relation to *an Environmentally Sustainable Australia*, by providing new data on recent climate change in Australia. The gem deposit studies attract significant international collaboration and industry interest, and detail Eastern Australian palaeodrainage systems. Studies of fossil birds and isopods provided new information on the palaeoecology of these groups.

Key research goal a) Studying animal groups that leave good fossil records to help forecast future change.



Palaeontological reconstruction of a conodont animal



The conodont fauna of the Honghuayuan Formation is characterized by the occurrence of *Serratognathus* a morphologically distinctive genus with a geographical distribution confined to eastern Gondwana and peri-Gondwana.

Conodonts are Palaeozoic marine chordate animals (see reconstruction). Conodont biostratigraphy assists the reconstruction of palaeogeography, palaeoclimate and ecosystems in the Ordovician world (~ 488 - 444 million years ago).

Studies of the Honghuayuan Formation of Guizhou, South China, provided important new data for conodont-based correlation and biostratigraphy, and established a close biogeographical tie between Australia (eastern Gondwana) and several peri-Gondwanan plates and terranes, which now form parts of China and South East Asia. A well-preserved Middle Ordovician (Darriwilian) shelly fauna including conodonts, brachiopods and trilobites from the South Island of New Zealand was also documented jointly with colleagues from New Zealand. This fauna shows strong biogeographical linkage to contemporaneous faunas from New South Wales, and from the peri-Gondwanan terranes, such as Kazakhstan.

Collaborative research about conodonts, in progress with Chinese and American colleagues, is likely to provide crucial new data for dating

and calibrating climatological and oceanographical events, and for better understanding their impact on the Late Ordovician ecosystem and biota, including mass extinctions and other biodiversification events.



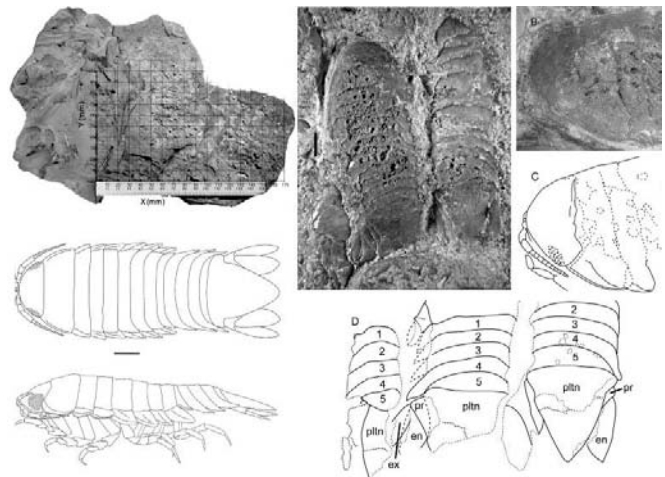
Chaetogonopteron bethnorrisae © Beth Norris

A paper was published describing the first species from Cape York amber, Australia's newly discovered and only significant amber deposit, from the coast of far north Queensland. The extinct species is a long-legged fly, *Chaetogonopteron bethnorrisae*. The presence of this genus in amber, which is probably 30 million years old, indicates it was not part of the original Gondwanan biota but arrived from the Old World tropics (Africa, Orient, Australasia) as the Australian continent drifted slowly northward. The ABC television program 'Catalyst' recently featured Cape York amber and the Museum scientist working on the project.

The amber project is funded by a 3-year ARC Discovery Grant and is a collaboration between the Australian Museum, University of NSW, Queensland Museum and the original discoverers. Approximately 250 specimens collected so far are being described and compared to modern counterparts.

A study was undertaken of the Eocene-Oligocene (56 -23 million years ago) Baltic amber fauna of the long-legged fly family Dolichopodidae. This material, borrowed from European collections, has revealed interesting biogeographic patterns, where genera currently known only from Australasia are seen to have been once present in ancient Europe.

Isopod scavengers, important in marine ecosystems, are well-known consumers of dead creatures in many habitats, e.g. the tropics, where they can comprise a substantial part of the scavenging guild. A Museum researcher and colleagues at Universities of New England and Uppsala have found the first incontrovertable evidence of scavenging in isopods from the Mesozoic Era (250-67 million years ago). The researchers investigated fossil isopods on a fish skull fragment (*Pachyrhizodus marathonsensis*). The high number (> 130) of cirrolanid isopod fossils present and soft matrix in which they occurred enabled the researchers to expose some of the fossils to make a detailed description of a new species of *Brunnaega*. The reconstruction (image lower left) shows that these isopods are similar to modern cirrolanid isopods.



Upper Left and Right: fish skull fragment, dots indicating positions of specimens studied. Right side, example of a group of fossils preserved on the slab.
Lower left, reconstruction of the new species of *Brunnaega*.

Contributions to avian palaeontology were also made. Proceedings of the VII international meeting of the Society of Avian Paleontology and Evolution, hosted by the Museum in 2008,

were published in the Records of the Australian Museum. Museum ornithologists contributed papers reassessing the fossil cormorants named by C.W. De Vis. Also, a new fossil eagle was named and the morphology and systematics of an early dromornithid bird investigated.

Key research goal c) Sedimentary Mineralogy

Museum researchers studied unusual mineral formations (aragonite and ‘moonmilk’) from Jenolan Caves, NSW, with colleagues from Sydney University. Their distribution, morphology, chemistry and genesis were studied using X-ray diffraction and chemical analysis. Aragonite (calcium carbonate) has attractive spiky, or branching, twig-like forms. Its presence at Jenolan assisted the case for World Heritage listing of the Greater Blue Mountains region. Aragonite formation has been linked to presence of magnesium in cave waters, and at Jenolan aragonite was found near beds of dolomite (calcium, magnesium carbonate), a source of magnesium. Previously unrecognised dolomite deposits near aragonite were located and investigated.



Aragonite, Chevalier Cave, Jenolan

Photo: Ted Matthews, Jenolan Caves

‘Moonmilk’ grows on porous cave mud and other cave formations. One type, resembling ‘fairy floss’ (e.g. in Wilkinson Branch of Chifley Cave), is mostly calcite, calcium carbonate. SEM images show masses of overlapping crystal needles. Its formation may involve bacterial action, so samples are being cultured to reveal any microbiological activity. Another type, (e.g. in Ribbon Cave), has a soft, ‘cottage cheese’ texture. Analyses identified calcium, magnesium

carbonates, huntite and hydromagnesite (with calcite, aragonite and silica). SEM images show only poorly-formed crystal plates. Their origins are being investigated, but like aragonite, they appear to form where cave waters are magnesium-rich and dolomite-derived. The project findings will give cave tour guides more accurate information for visitors and will assist in cave management, conservation, and environmental monitoring.

Other Research

Successful collaborations with Research Associates, Senior Fellows and Australian and international institutions and researchers were carried out. New mineral species and mineral group nomenclature studies involved the International Mineralogical Association. Comparative studies of Australian and New Zealand zeolite minerals are in progress. The internal mineral inclusions of Australian and South East Asian gemstones are being studied to pinpoint their genesis.

Gemstone deposit studies along East Australia, New Zealand and Asian-Russian Pacific margins are providing new concepts for exploration, with economic benefits. Many are alluvial concentrates from eroded sources, now in recent palaeodrainage systems. Sapphire, ruby, zircon and diamond studies have involved international collaborations and world-leading studies.



Sedimentary gem concentrate, Yarrowitch, NSW.

East Australian volcanic landscape studies have traced geomorphic developments since Tasman and Southern Ocean break-up. Age-dating assists assessment of future volcanism, climatic effects and natural hazards. Australia's understory is being studied from deep rocks and minerals brought up in volcanic eruptions. They outline thermal changes and structures under the continent in its evolution to its present dynamic state.

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Program 1. Addressing knowledge gaps and problems in understanding the biota in Australasian marine environments.

Key research goals	Researcher to add title of Research Area that addresses goal	Name of Researcher(s)	Major or Minor contribution to goal
a) Understanding Australia's marine biodiversity, emphasising species with key ecological roles and high sensitivity to human impact	Research Area = Taxonomy. Project title = Taxonomy of Australian Cirolanidae (Crustacea: Isopoda) from Australian Museum collections	S Keable	minor
	Research Areas = Taxonomy; Biodiversity Assessment; Biogeography; Ecology. Project title = Targeted collecting, checklist and guide to starfish (Echinodermata: Asteroidea) of the Sydney region	S Keable, H Stoddart, R Springthorpe, A Murray, K Attwood	minor
	Defining evolutionary stability in southeastern Australia: (1) Phylogeographic studies of marine and estuarine mollusca	D Colgan	major - relevant 5 b) also
	Systematics of Cerapus and related genera (Crustacea: Amphipoda)	J Lowry and P Berents	minor
	Taxonomy of fish larvae occurring in NSW	A Hay & J Leis	major
	Larval-fish systematics - Family Lutjanidae	J Leis	major (also applies to C below)
	Larval-fish and adult systematics - Lobotes, Haplogeny and Datnioides	J Leis	major (also applies to C below)
	Biodiversity of Algal Substrates	GDF Wilson, AJK Millar (Royal Botanic Gardens Sydney)	major
	Structure of Deep-sea Invertebrate Assemblages, especially Isopoda	GDF Wilson	major
	Systematics of Ampharetids	P Hutchings, D Garner	minor
	Systematics, toxinology, ecology and biogeography of laticaudid sea snakes	H Cogger (SF)	major
	Reviews of various fish taxa (gobies, clinids)	D Hoese (SF)	major
	Review of the Acoetidae polychaetes of Australasian region	A Murray & P Hutchings	minor
	Web-based catalogue of the marine molluscs of NSW	D Beechey (SF)	major
	Circum-Australian Amphipoda	J Lowry & L Hughes	major
	Great Barrier Reef Amphipoda	J Lowry	major
	Taxonomy of Australian lysianassoid Amphipoda	J. Lowry & H. Stoddart	major
	Taxonomy of Australian talitrid Amphipoda	J. Lowry & R. Springthorpe	major
	Systematics and phylogeny of Sabellida	P Hutchings, M Capa	major
	Taxonomy of poorly understood marine gastropods including Clenchiellidae and Assimineidae	W. Ponder (SF), H. Fukuda	major
	Revision of the rissoid genus <i>Merelina</i>	W. Ponder, F. Criscione	major
	Biology and taxonomy of nudibranchs	W Rudman (SF)	major
	Deep sea biodiversity ARC Linkage	P Hutchings et al	major

APPENDIX 1

b) Understanding the connectivity of marine populations.	Defining evolutionary stability in southeastern Australia: (1) Measures of gene flow in marine and estuarine Mollusca, and investigations of shell elemental compositions as an indicator of provenance	D Colgan	major - relevant to 5 b) also
	Larval-fish ecology - behaviour in relation to dispersal	J Leis	major
	Larval-fish ecology- biophysical dispersal model for GBR	J Leis	major
	Larval-fish ecology -Orientation in the pelagic environment: how do larval marine fish find their way home?	J Leis	major (also applies to c, below)
	Larval-fish ecology - Connectivity and biodiversity in coral reef systems	J Leis	major (also applies to c, below)
	Larval-fish ecology - OWNFOR project on larval-fish orientation	J Leis	major (also applies to c, below)
	Molecular phylogenetics of Risssooidea and Cingulopsoidea	W. Ponder, F. Criscione	major
	Taxonomy, biology and evolution of deep-sea fishes	J Paxton (SF)	major (also applies to a, above)
c) Understanding the biodiversity of coral reefs.	Larval-fish ecology -Orientation in the pelagic environment: how do larval marine fish find their way home?	J Leis	major (also applies to b, above)
	Larval-fish ecology - Connectivity and biodiversity in coral reef systems	J Leis	major (also applies to b, above)
	Larval-fish ecology - OWNFOR project on larval-fish orientation	J Leis	major (also applies to b, above)
	Larval-fish systematics - Family Lutjanidae	J Leis	major (also applies to a, above)
	Larval-fish and adult systematics - Lobotes, Hapalogenys and Datnioides	J Leis	major (also applies to a, above)
	Bioerosion of coral substrates	P Hutchings	minor
Other research on biota in Aust marine environments	Reproductive anatomy of the Isopoda	GDF Wilson	minor

Program 2. Addressing knowledge gaps and problems in understanding the biota in Australian terrestrial and freshwater environments.

<i>Key research goals</i>	<i>Researcher to add title of Research Area that addresses goal</i>	<i>Name of Researcher(s)</i>	<i>Major or Minor contribution to goal</i>
a) Understanding the species and places of high biodiversity significance in Australia.	Revision of Spilopyrinae (fiery leaf-beetles)	C Reid	major
	Morphological and Molecular Investigations of the Systematics and Phylogeography of the Speciose Landsnail Genus Gyrocochlea (Mollusca: Charopidae)	D Colgan, J Staniscic, E May	major
	Evolutionary & conservation genetics of marsupials	M Eldridge	major
	The systematics of Australian comb-footed spiders in the subfamily Hadrotarsinae (Araneae: Theridiidae)	H Smith	major
	Investigations of Australian web-building spiders	H Smith, J Gollan	minor
	Systematics of spiders in wet forests of SE Aust.	G Milledge	minor
	Revision of Australian Lichen Moths (Lepidoptera: Arctiidae, Lithosiinae).	D Britton	major
	Revisions of Australian Dolichopodidae -various genera	D Bickel	major
	Revisions of australian Empididae - Hilarini- Dance flies	D Bickel	major
	Dolichopodidae of Trans-Fly/ Cape York	D Bickel	minor
	Alps to Atherton	D Faith	major
	conservation planning for key biodiversity places; new global hotspot	D Faith	major
	insect plant linkages eastern Aus.	D Faith	major
	GBIF 2010 Campaign	D Faith	major
	PD phylogenetic diversity analyses, methods	D Faith	major
	Diversity and conservation of rainforest dependent lizards in eastern Australia	R Sadler	major
	Review of freshwater fish species	D Hoese (SF)	major
	Modelling biodiversity distribution in terrestrial environments for conservation planning	P Flemons, A Ranipeta, M Elliott, M Ashcroft	major
	Morphological and molecular systematics of the funnel-web spiders	M Gray (SF)	major
	Systematics of the Australasian Badumniae	M Gray (SF)	major
	Ecology and sustainability of estuaries and sandy beaches	A Jones (SF)	major
	Distribution patterns of terrestrial arthropods in Pilbara	J Gollan, M Ashcroft	major
	Phylogeny and phylogeography of Planorbidae (Pulmonata)	W Ponder (SF)	major
	Phylogeny and phylogeography of Australian Viviparidae (Caenogastropoda)	W Ponder (SF)	major

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a) Understanding the species and places of high biodiversity significance in Australia. cont.	Arid-zone artesian spring biota - faunal composition, endemism and conservation	W Ponder (SF), E Jefferys, R Fensham	major
	Australasian freshwater mollusc fauna - composition, distribution, conservation	W Ponder (SF)	major
	Taxonomy, behaviour and ecology of Diptera	D McAlpine (SF)	major
	Taxonomy and systematics of cicadas	M Moulds (SF)	major
	Population biology of endangered frogs	G Pyke (SF)	major
	Taxonomy and systematics of Psocoptera	C Smithers (SF)	major
	A species flock of <i>Eophreatoicus</i> from Kakadu Nat. Park	GDF Wilson, C Humphrey (ERISS), D Colgan, R Johnson, K Gray	minor
	DNA barcoding of Australian fauna	R Johnson, R Mason, M McGrouther, D Bickel, G Theischinger	major
	Forensic DNA-based identification of wildlife	R Johnson, A King, R Mason	major
	Diversity and systematics of land snails in the Kimberley, Western Australia	F Köhler	major
b) Understanding the distribution, interaction and evolution of key species in arid Australia.	Revision of Sagrinae (kangaroo beetles)	C Reid	major
	Evolutionary & conservation genetics of marsupials	M Eldridge	minor
	Systematics of Australian mantid fauna	G Milledge	minor
	Dolichopodidae & Empididae of Great Western Woodlands, WA	D Bickel	minor
	GBIF 2010 campaign	D Faith	minor
	Phylogeny and phylogeography of hydrobiids associated with arid-zone artesian springs	W Ponder (SF)	major
Other projects addressing knowledge gaps in biota in Aust terrestrial and freshwater environments	Insect damage to fruit of endangered Lillipillies <i>Syzgium</i> sp. and an endangered <i>Quassia</i> sp.	D Britton, A Clements	minor
	Eastern Australian landsnails book	O.Griffiths (RA), M.Shea, J.Stanisic, D.Potter	major
	Biodiversity and habitat corridor study of the Waverley Local Government Area	G Muir, M Semeniuk, S Ginn, H Smith, D Bickel	minor
	Biodiversity monitoring of the Coleambally Irrigation Area	G Muir, E Whiting, J Gollan, M Beatson, J Bevan, L McCaffrey	minor
	Urban ecology study, City of Sydney Local Government Area	G Muir, T James, L Kelly, M Semeniuk, J Bevan	minor
	Investigation of 'short-range endemic' invertebrates in the Pilbara	J Gollan, G Muir	minor
	Catalogue of the Scoliidae (Hymenoptera) of Australia	M. Elliott	minor

Program 3. Increasing our understanding of the genetic variation in key taxa (species) of the Australasian and Indo-Pacific biota.

<i>Key research goals</i>	<i>Researcher to add title of Research Area that addresses goal</i>	<i>Name of Researcher(s)</i>	<i>Major or Minor contribution to goal</i>
a) DNA Barcoding of taxonomic groups that are of economic, social or environmental concern.	A DNA library for the New Caledonian lizard fauna	R Sadlier	major
b) Genetic approaches to monitoring biodiversity and assisting resource-use planning for biodiversity conservation.			

Projects in this Program have been moved to other Programs where applicable.

Program 4. Origin, evolution and biogeography of the biota of the Indo-Pacific and Australasian region.

Key research goals	Researcher to add title of Research Area that addresses goal	Name of Researcher(s)	Major or Minor contribution to goal
a) Understanding the origins of the Australian fauna.	Conodont Biostratigraphy and reconstruction of palaeogeography, palaeoclimate and ecosystems in the Ordovician world	Y Y Zhen	major
	Revision of Spilopyrinae (fiery leaf-beetles)	C Reid	major
	Revision of Sagrinae (kangaroo beetles)	C Reid	major
	Understanding gastropod phylogeny, particularly the basal Pulmonate and basal Heterobranchia, that are particularly characteristic of Australian waters	D Colgan, C Lydeard, B Dayrat, W Ponder (SF)	major - see goal b of this program and Program 5, research goals a and c
	Molecular systematics of New Guinean macropods	M Eldridge, C Helgen	major
	Evolutionary & conservation genetics of marsupials	M Eldridge	major
	The systematics of Australian comb-footed spiders in the subfamily Hadrotarsinae (Araneae: Theridiidae)	H Smith	major
	Systematics of Australian mantid fauna	G Milledge	minor
	Systematics of spiders in wet forests of SE Aust.	G Milledge	minor
	Cape York Amber fauna -insect inclusions -origins	D Bickel	major
	Systematics of Australian Agamid Lizards	R Sadler	minor
	Systematics of the Egernia striolata group	R Sadler	minor
	Systematics of the Gondwanan group, Phreatoicidea (Isopoda; freshwater)	GDF Wilson	major
	Analysis of the population genetic structure of the Bush Stone Curlew (<i>Burhinus grallarius</i>)	W Boles, R Johnson, R Mason, K Gray, C Price (DECCW)	major
	Phylogenetic analysis of molluscs from the families Viviparidae, Planorbidae, Hydrobiidae	W Ponder (SF), R Mason, K Gray, R Johnson	minor
	Systematics and biogeography of Australo-Pacific avifauna (ABRS)	W Boles, L Christidis	major (also b), below)
	Description and systematics of Australian Tertiary avifauna	W Boles	major
b) Understanding the biogeography and evolution of the Indo-Pacific fauna.	Revision of Spilopyrinae (fiery leaf-beetles)	C Reid	minor
	Understanding heterobranch (a major gastropod clade) phylogeny, particularly the basal pulmonate and basal Heterobranchia, that are particularly characteristic of Australian waters	D Colgan, C Lydeard, B Dayrat, W Ponder (SF)	major - see goal a of this program and Program 5, research goals a and c
	Publication of <i>Emballonura</i> phylogeography (Indo-Pacific Bat genus)	D Colgan, S Soheili	minor
	Molecular systematics of New Guinean macropods	M Eldridge, C Helgen	major
	Systematics and biogeography of Australo-Pacific avifauna (ABRS)	W Boles, L Christidis	major (also a), above)

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	Larval-fish ecology - behaviour in relation to dispersal	J Leis	major
	Larval-fish systematics - Family Lutjanidae	J Leis	major
b. cont	Larval-fish and adult systematics - Lobotes, Hapalogenys and Datnioides	J Leis	major
	Reviews of various Indo-Pacific fish species	D Hoese (SF)	minor
	Taxonomic studies of signal flies (New Caledonia, PNG, Australia)	D McAlpine (SF)	minor
	Fiji Arthropod survey - Co-PI	D Bickel	major
	Dolichopodidae (Diptera) of Fiji and mid-Pacific	D Bickel	major
	Dolichopodidae (Diptera) of New Caledonia	D Bickel	major
	Systematics and biology of New Caledonian Lizards	R Sadlier	major
	Systematics & phylogeny of sabellida	Pat Hutchings	major
	Caenogastropod phylogeny	W Ponder (SF), D Colgan, R Golding, E Strong, J Healy	major
	Phylogeny and phylography of hydrobiid gastropods in the Australasian region	D Colgan, W Ponder (SF), M Haase	major
	Crustacean phylogeny, relationships within the Arthropoda	GDF Wilson	minor
	Phylogeny of the Isopoda and the Peracarida	GDF Wilson	minor
	Comparative morphometrics in three large lizard or lizard-like ecological analogues - NZ tuatara, Australian agamid, Fijian iguanid	H Cogger (SF)	minor
	Molecular Systematics of the Christmas island Shrew	M Eldridge, R Johnson	minor
Other research on origin, evolution and biogeography of the region	Guide to the reptiles and amphibians of the Western Pacific	H Cogger (SF), R Sadlier	minor
	A Conservation Assessment of the New Caledonian Lizard Fauna. A WEB based assessment of the conservation status of the New Caledonian lizard fauna funded by the territory national government	R Sadlier	

Program 5. Understanding human impacts on the Australian biota.

Key research goals	Researcher to add title of Research Area that addresses goal	Name of Researcher(s)	Major or Minor contribution to goal
a) Assessment of the vulnerability of Australia's freshwater and estuarine ecosystems to human impacts.	Understanding gastropod phylogeny, particularly the basal Pulmonate and basal Heterobranchia, that are particularly characteristic of Australian waters	D Colgan, C Lydeard, B Dayrat, W Ponder (SF)	minor - major relevance to program 4.
	A species flock of <i>Eophreatoicus</i> from Kakadu National Park	GDF Wilson, C Humphrey (ERISS)	major
	Overview of integrative tools and methods in assessing ecological integrity in estuarine and coastal systems worldwide	P Hutchings, A Borja, S Bricker, D Dauer, A Forbes, R Kenchington, J Marques, P Qian	major
	Reviews of various freshwater fish species	D Hoese (SF)	minor
b) Investigating the effects of climate change on the Australian fauna.	Defining evolutionary stability in southeastern Australia: (1) Phylogeographic studies of marine and estuarine mollusca	D Colgan	major - relevant to 1 a) also
	Defining evolutionary stability in southeastern Australia: (1) Measures of gene flow in marine and estuarine Mollusca, and investigations of shell elemental compositions as an indicator of provenance	D Colgan	major - relevant to 1 b) also
	Ecology of Australian White Ibis (also included in[c])	R Major, J Martin, K French	major
	Vulnerability of climate on benthic invertebrates of the GBR	P Hutchings, S Ahyong, M Byrne, R Przeslawski, G Wörheide	major
	Assessing impact of ocean acidification on coral reefs	P Hutchings, S Dove	major
	Fine-scale climate data collection in the Hunter Valley	J Gollan, M Ashcroft	major
	Population biology of endangered frogs and use as bio-indicators	G Pyke (SF)	major
c) Understanding Human Impacts in the Sydney environs.	Bird-habitat relationships in urban areas	R Major, H Parsons, K French	major
	Ecology of Australian White Ibis (also included in[b])	R Major, H Parsons, K French	major
	Historical Changes in the Birds of Sydney	R Major, H Parsons	major
	Assessment of Hill-topping sites for Butterflies in the Hawkesbury-Nepean CMA	D Britton, S Ginn, L Holme	major
	Human Climate and Fire Nexus in the Sydney Basin	V Attenbrow with S Mooney, UNSW	major
	Ecology of a recently discovered exotic bee in Australia	J Gollan, M Ashcroft, M Batley	major
	Forensic DNA-based identification of wildlife	R Johnson, A King, R Mason	minor
Other Human Impacts on Australian Biota	The role of eucalypt plantations in biodiversity conservation.	R Major, T Hsu, K French	minor

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Other Human Impacts on Australian Biota	Impacts on invertebrates in the Pilbara	J Gollan, M Ashcroft	minor
	Invasive species analysis of port surveys	P Hutchings & M Bishop	major
	Investigation of the impacts of roads on Koalas	G Muir, M Semeniuk, R Close (subcontractor to AMBS)	major

Program 6. Investigating the history of human cultures and communities in the diverse & changing environments of Aust. & the Pacific region.

Key research goals	Researcher to add title of Research Area that addresses goal	Name of Researcher(s)	Major or Minor contribution to goal
a) Understanding the history and diversity of Indigenous material culture	Tracing the history of stone tool diversity in West New Britain, Papua New Guinea	R Torrence, N Kononenko (University of Sydney), P Rath (University of Sydney PhD student)	major
	Indigenous agency and museum collections	R Torrence, A Clarke (Uni of Sydney), J Philp (Uni of Sydney), N Kononenko (U of Sydney), E Lilje (PhD student, Uni of Sydney). A Hennell (Honours student, U of Sydney)	major
	Evolution of Technology and Tool Use in 10,000 years of Aboriginal Prehistory	V Attenbrow, P Hiscock (ANU), G Richardson (UQ)	major
	Land use patterns and the role of rockshelters in coastal Sydney during the Holocene	V Attenbrow, H Watts (UNE)	major
	Ground-edged implements of the Sydney-Central Coast region of NSW - their distribution, sources and use-histories	V Attenbrow, T Corkill (MusAssoc), N Kononenko (SydUni)	middling
	Stone tools and potters of New Britain, PNG	J Specht (SF)	major
	Prehistoric Occupation of Lizard Island, Queensland.	J Specht (SF), M Felgate (NZ), J Charley (Hopevale Mission), C Lentfer (Qld Uni), S Haberle (ANU)	major
	Bismark Archipelago, PNG - Archaeological Review	J Specht (SF), J Terrell (Field Museum, Uni of Chicago), T Denham (Monash), J Goff (Uni NSW), M Donahue (ANU), M Richards (Leeds Uni), S Oppenheimer (Uni Oxford)	major
	Change in Wanigela pottery over the past hundred years	L. Bonshek (VRF)	minor
	Papunya Permanent Collection Monograph	K Khan (SF)	major
	Cataloguing Roth collection from the Gulf region of North Queensland	K Khan (SF)	major
b) Tracking the history of human interaction with the natural	Impact of natural disasters on cultural change with special reference to West New Britain, Papua New Guinea	R Torrence, V Neall (Massey Uni), B. Boyd (Southern Cross Uni), C.	major

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environment incl. effects of urbanisation, industrialisation, tourism, environmental changes & disasters.		Lentfer (Uni QLD), C. McKee (Mineral Resources, PNG)	
	Evolution of Technology and Tool Use in 10,000 years of Aboriginal Prehistory	V Attenbrow, P Hiscock (ANU), Gail Robertson (UQ)	major
	New Britain Vegetation History	J Specht (SF), C Pavlides (La Trobe Uni), C Lentfer (Qld Uni)	major
	New Britain Plant Remains	J Specht (SF), L Hosoya (National Institutes for the Humanities, Kyoto), P Matthews (Nat Museum of Ethnology, Osaka),	major
	Marine resource use during the Holocene in the coastal Sydney region	V Attenbrow, Sarah Colley (SydUni)	major
c) Understanding the origin and functions of social exchange	Prehistoric obsidian exchange in Melanesia	R Torrence, G Summerhayes (U of Otago), P Rath (PhD student, U of Sydney)	major
	Social history of early exchange in Papua New Guinea	R Torrence, N Kononenko (U of Sydney), P Swadling (ANU)	major
	Ancient obsidian exchange in Far East Russia and NE China	R Torrence, T Doelman (U of Sydney), P. Jia (U of Sydney), N. Klugev, I. Sleptsov, V. Popov (Russian Acad of Sci)	major
	Application of Laser Ramon technique to characterisation of obsidian and analysis of microscopic residues	R Torrence, E Carter (U of Sydney), N Kononenko (U of Sydney), S Kelloway (U of Sydney PhD student)	major
	Stone tools and potters of New Britain, PNG	J Specht (SF)	major
	Southeast Australian ground-edged hatchets - Tracking exchange systems using PXRF technology	V Attenbrow, P Grave (UNE), Lin Sutherland, Ross Pogson	major
	Exchange in the acquisition of human remains from the Torres Strait Islands.	P Gordon, R. Torrence, RVS Wright, F Petchley (Waikato C14 lab), L Matisoo-Smith (U of Auckland)	major
d) Other research into human material culture	Tracing early anthropology collections at the Australian Museum	S. Florek	minor

Program 7. Linking intangible and tangible heritage.

Key research goals	Researcher to add title of Research Area that addresses goal	Name of Researcher(s)	Major or Minor contribution to goal
a) Investigating the history of creativity in human cultures and communities in Australia and the Pacific	Indigenous agency and museum collections in Central Province, PNG	R Torrence, A Clarke (U of Sydney), J Philp (U of Sydney), E Lilje (PhD student, U of Sydney)	major
	Indigenous agency in the history of Wuvulu Island, PNG	R Torrence, A Hennell (Honours student, U of Sydney)	major
b) Understanding the roles of material culture and traditional knowledge in Indigenous cultures	Fiji pottery	M Van Olffen	minor
	Shearston Project	Y Carrilo-Huffman, E Aholelei, F Mahoney	major
c) Understanding the collecting process	Indigenous agency and museum collections in Central Province, PNG	R Torrence, A Clarke (U of Sydney), J Philp (U of Sydney), E Lilje (PhD student, U of Sydney)	major
	Understanding Balinese paintings: collections, narrative, aesthetics and society	V. Daniel, S. Florek, A. Vickers (Uni of Sydney), P. Worsley (Uni of Sydney, research associate), Siobhan Campbell (Uni of Sydney)	major
	The history of Repatriation within Australia	P Gordon, M Green (Museum Victoria), M Pickering (National Museum of Australia)	major
d) Engaging with creator communities to better understand the significance of our collections		V Daniel, M van Olffen, P Dadswell, D Peita; P.Eklund, A.Lawson, P Goodall (Uni of Wollongong)	major
	Erromango and Sentani, barkcloth dynamics: revival and identity	Y Carillo-Huffman	minor
	Intellectual property and traditional knowledge for digital cultural collections	V. Daniel, S. Singh (RMIT), A. Dockerty (Smart Services CRC)	
	Wonnarua community website	P Gordon, A Gray, F Mahoney	major

Program 8. Investigating extant & extinct faunas and environmental systems in the context of recent geological history to better forecast future changes

Key research goals	Researcher to add title of Research Area that addresses goal	Name of Researcher(s)	Major or Minor contribution to goal
a) Studying animal groups that leave good fossil records to help forecast future change	Conodont Biostratigraphy and reconstruction of palaeogeography, palaeoclimate and ecosystems in the Ordovician world	Y Y Zhen, I Percival(Geol. Surv. NSW), J.Pickett (Geol. Surv. NSW), T.Wright(Univ. Wollongong), R.Cooper (Geol. Surv. NZ), J.Liu (Dept. Geology, Peking Univ.) Y.Zhang (Nanjing Inst. Geol. & Palaeontology), Z.Zhou (Nanjing Inst. Geol. & Palaeontology)	major
	Cape York Amber fauna - insect inclusions	D Bickel	major
	Baltic amber Diptera Dolichopodidae	D Bickel	major
	Devonian fossil fish	A Ritchie (SF), Z Johanson, Natural History Museum London; R Carr, Ohio USA	major
b) Analysing dynamics of contemporary and recent reef systems.			
c) Sedimentary Mineralogy	Distribution,origin, and mineralogy of Australian limestone cave formations (speleothems) and sediments in a former continental shelf reef system, featuring Jenolan Caves NSW, with implications for palaeoclimate, cave conservation, environmental management and tourism in a World Heritage area.	R Pogson, D Colchester, A Osborne (USyd), B England, D. Cendon (ANSTO)	major
	Placer gemstone origins, Australia/Pacific margins: Distribution and origin of gem placer deposits in Australian drainages provide data on past and present alluvial processes to forecast future networks.	L Sutherland (SF), G Webb, L Barron, I Graham, K Zaw, S. Meffre (U Tas)	major
Other Geosciences Research	Triggers for volcanism, Australasia/Antarctica	L Sutherland (SF), R Pogson, I Graham, S. Meffre (U.Tas)	major
	Post-Gondwana geochronology, eastern Australia	L Sutherland (SF)	major
	Landscape evolution, central NSW	L Sutherland (SF), R Pogson, L Barron, A. Warren (Geo Surv NSW)	major
	Fossil Birds of Australia	W Boles	major
	Eastern Australian zeolites - distribution and origins	R Pogson, L Sutherland, I Graham, D Colchester, B England	major
	New Australian mineral species	R Pogson, I Graham, D Colchester, P.Williams	major

1. Grant funded projects administered by the Australian Museum, 1 July 2009 - 20 June 2010

Principal Investigator(s)	Title of Project	Granting Body	Amount Awarded 09/10 (ex GST)	Total Value of Grant (ex gst)	Years Funded	Res Strategy Program
P Berents	NW NSW Reserve Survey 2010	Dept of the Environment, Water, Heritage and the Arts - Caring For Our Country	\$40,000	\$40,000	2010	Coll strat
D Bickel	Taxonomic and nomenclatural data for major groups of Diptera	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$48,270	\$60,000	2010-2013 (2 yrs)	2a, 4b
D Britton	Biodiversity Survey Darkwood Reserve NSW	Department of the Environment, Water, Heritage and the Arts (Caring for our Country - Natural Heritage Trust)	\$4,000	\$4,000	2010	coll strat
D Britton	Biodiversity Blitz on Charles Darwin Reserve - Pilot	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$0	\$6,000	2009	2b
D Britton	Taxonomic and nomenclatural treatments of Lepidoptera	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$19,110	\$25,000	2010-2013 (2 yrs)	4b 2other
Colgan	Monitoring the response of NSW bivalves to changed environments	NSW Environmental Trust - Research Grant	\$0	\$17,800	2009	5a,b,c
P Flemons, J Tann	ALA Sensitive Data Policy	Atlas of Living Australia (CSIRO)	\$38,450	\$38,450	2009	1 other 2 other 4 other 5 other
P Flemons	ALA Geospatial Portal Scoping	CSIRO	\$13,703	\$27,412	2010	1 other 2 other 5 other
P Flemons	Web Biodiverse Project	Florida University	USD \$19,990	USD \$19,990	2009-2010	1 other 2 other
R Golding, W Ponder	Exploring the diversity and biogeography of Australasian mangrove snails	James N Kirby Foundation	\$0	\$15,600	2009-2010	1a 4a 5a

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J Gollan, M Ashcroft	Piloting Fine-Scale Climate Data Collection in the Hunter Valley (GER Pilot)	Dept of Environment and Climate Change, NSW	\$0	\$10,000	2009-2010	2 other 5b
P Gordon	RICP 2009 - Return of Indigenous Cultural Property (RICP) Program	Dept of Environment, Water, Heritage and the Arts Dept of Arts, Sport and Recreation, NSW	\$31,823	\$109,323	2009	7b, 7 other
P Gordon, A Reynolds	Engaging with Indigenous communities in regional NSW through new media technologies	Dept of the Environment, Water, Heritage and the Arts - Indigenous Heritage Program	\$19,240	\$19,240	2009-2010	7a,c
D Hoesse	Taxonomic and nomenclatural treatments of Fishes	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$23,135	\$30,000	2010-2013 (2 yrs)	1 other 4b 2 other
L Hughes	GenCAAP: Applying genetic techniques to marine amphipod fauna as part of the Circum-Australian Amphipod Project	ARC Environmental Futures Research Network	\$2,500	\$2,500	2009	1a,b,c 3a coll strat
P Hutchings	Systematics and Phylogeny of Sabellida: Polychaeta	Australian Biological Resources Study (ABRS)	\$41,750	\$150,167	2007-2011	2 other 4a
P Hutchings, M Capa, C Glasby, C Watson, V Wei, K Gibb	Polychaete fauna of coral reefs: morphological and molecular characterisation and keys to species	Dept of the Environment, Water, Heritage and the Arts - ABRS (Research/Creefs 2009)	\$90,000	\$270,000	2009-2012	1a 3a 5a
P Hutchings	Taxonomic and nomenclatural treatments of Polychaeta	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$5,534	\$7,500	2010-2013 (2 yrs)	4b 2 other
F Koehler	Kimberley Camaenid	Dept of the Environment and Conservation Western Australia	\$8,205	\$8,205	2010	2
J Leis, C Paris, C Guignad	How Baby Fish Find a Home: orientation by reef-fish larvae in the pelagic environment.	Hermon Slade Foundation	\$8,000	\$59,000	2007-2010	1b

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J Lowry	Description of the Australian Lysianassoid Amphipod Fauna (Crustacea: Malacostraca)	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$48,850	\$146,550	2008-2011	1 a,b
J Lowry	Kimberley Amphipod Data - extension of the the Circum Amphipoda Australia Project	Dept of Environment, Water, Heritage and the Arts - Natural Heritage Trust	\$0	\$30,000	2008-2009	1a,b,c
J Lowry	Tasmanian Amphipod Data - extension of the Circum Australia Amphipoda Project	Dept of Environment, Water, Heritage and the Arts - Natural Heritage Trust	\$0	\$28,182	2009-2010	1a,b,c 8 other coll strat
J Lowry	Taxonomic and nomenclatural treatments of Crustacea: Amphipoda, Cumacea, Mysidacea.	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$24,549	\$33,000	2010-2013 (2 yrs)	1 other 4b 2 other
R Major, R Johnson	Conservation ecology of the White-fronted Chat - a declining bird in an endangered ecological community.	Hermon Slade Foundation	\$27,797	\$79,165	2009-2012	3b 5c,other
R Major, R Johnson	The Importance of Lake Macquarie to the conservation of the White-fronted Chat: a saltmarsh bird at risk	Lake Macquarie Research City Council Grants	\$8,000	\$8,000	2009-2010	3b 5b,c
W Ponder	Training in Molluscan Systematics - Capacity Building Grant	Australian Biological Resources Study - Capacity Building 2009 funding round - Non Salaried Research Grant	\$0	\$5,000	2009-2010	1a 2a 5a
W Ponder	Australian Museum Aquatic Invertebrate inventory for Edgbaston Reserve, Qld	Bush Heritage Australia	\$8,000	\$8,000	2009-2010	2 other

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W Ponder	Provision of Taxonomic and Nomenclatural Treatments of Selected Mollusca Groups	Department of Environment, Water, Heritage and the Arts (ABRS)	\$265,010	\$289,700	2010-2013 (2 yrs)	1 other 2 other 4 other
W Ponder	Provision of taxonomic and nomenclatural treatments of Lower Heterobranchia	Dept of the Environment, Water, Heritage and the Arts - ABRS	\$10,000	\$17,000	2010-2013 (2 yrs)	1other
C Reid	Taxonomic and nomenclatural treatments of Coleoptera: Chrysomelidae	Dept of the Environment, Water, Heritage and the Arts (ABRS)	\$23,135	\$30,000	2010-2013 (2 yrs)	1 other 4b 2 other
J Rowley	Amphibian Conservation in Vietnam	Ocean Park Conservation Fund, Hong Kong	\$8,232	\$19,845	2008-2009	4b
J Rowley	Amphibian Conservation in Indo-Burma	ADM Capital Foundation (Hong Kong)	USD 30,000	USD 55,000	2008-2010	4b
H Smith	The systematics of Australian comb-footed spiders in the subfamily Hadrotarsinae (Araneae: Theridiidae)	Australian Biological Resources Study (ABRS): Dept of Environment & Water Resources	\$60,000	\$180,000	2007-2011	2 other

2. Grant funded projects administered by another research institution, 1 July 2009-30 June 2010

Principal Investigator(s)	Title of Project	Granting Body	Amount Awarded 09/10	Total Value of Grant	Years Funded	Res Strategy Program
P Hiscock, V Attenbrow	Evolution of technology and tool use in 10,000 years of Aboriginal History	Australian Research Council - DP 2007	\$21,500	\$134,000	2007-2010	6a
S Hand, M Archer, D Bickel , ME Dettmann	Precious time-capsule: discovery of fossil-rich amber from Australia	Australian Research Council - DP 2008	\$21,750	\$245,000	2008-2011	2 other 8other 5b 4other
A Vickers, P Worsley, V Daniel , S Florek , S Diamond	Understanding Balinese paintings: collections, narrative, aesthetics and society	Australian Research Council - LP 2008	\$76,629	\$227,739	2008-2011	7b, other

APPENDIX 2

A Lawson, V Daniel , B Lassig , P Eklund	The application of concept lattices to digital museum collection management and access	Australian Research Council - LP 2008	\$82,618	\$246,239	2008-2011	7 other, coll strat
T Flew, B Kummerfeld, C Morley, M Salomon, V Daniel	New Business Models for Revenue Generation	Sub-project of Smart Services CRC	\$25,000	\$50,000	2009-2011	7
S Singh, V Daniel , M Jackson, S Bellamy,	Digital Cultural Collections: Copyright and Traditional Knowledge	Sub-project of Smart Services CRC	\$50,000	\$100,000	2009-2011	7
D Faith , S Ferrier, C Brown, J Soberon, T Peterson, D Yeates, C Slatyer, J West, V Savolainen	GBIF for 2010	Global Biodiversity Information Facility (GBIF)	\$0	30,000 Euro	2007-2010	2a 4b 5other
R Beaman, R Guralnick, A Hill, A Stewart, P Flemons	BiogeoBIF: A system for increasing the georeferencing quantity and quality of all GBIF-mediated occurrence records.	Florida Museum of Natural History	\$2,088	\$6,851	2009-2010	2a
S Dove, W Leggat, D Yellowless, J Lough, P Hutchings , K Caldeira	Assessing the risk of ocean acidification for the Great Barrier Reef	Australian Research Council - LP 2007	\$62,825	\$476,950	2007-2009	1a,c
J Marshall, S Collin, R McCauley, K Fritsches, N Hart, B Degnan, S Degnan, M Norman, J Hooper, P Hutchings et al	Deep Downunder: designing a deep-sea exploration and discovery capability for Australia	Australian Research Council - LP	0	\$1,093,000	2007-2010	1

APPENDIX 2

J Leis	Behaviour, ontogeny, dispersal and connectivity in marine fish populations	Australian Academy of Science	\$10,500	\$10,500	2010	1b
J Leis, G Jones, T Hughes	Resilience and connectivity: Development and test of realistic larval-fish dispersal models for the Great Barrier Reef	Marine and Tropical Science Research Facility (MTSRF), administered by the Reef and Rainforest Research Centre Ltd (RRRC).	\$38,840 (to AM)	\$492,000	2007-2010	1 b,c 5b
G Closs, J Leis	How do larval fish find their way home?	University of Otago Standard 2010 Research Grant	\$NZ 30,000	\$NZ 30,000	2010	1a 2 other
C Taylor, R Major, A Davies	Challenges in a Changing World: Protecting Sydney's Parrot Diversity	WV Scott Foundation	\$0	\$99,000	2008-2010	5b,c
C Simon, M Moulds, T Buckley, J Cooley, P Ritchie	Systematics and biogeography of Australian Cicadettini and their relatives worldwide	National Science Foundation	USD \$180,000	USD \$540,000	2007-2010	2, 4
B Stuart, R Bain, J Rowley	Amphibian and Reptile Biodiversity in the Lower Mekong: Synthesizing Knowledge and Building Capacity	North Carolina Museum of Natural Sciences subaward of grant from John D & Catherine T MacArthur Foundation	\$36,000 USD (to AM)	\$320,000 USD	2009-2011	4b, other
M Felgate, W Dickinson, J Specht, W Ambrose, S Bedford, R Caldwell	The Distribution, Abundance and Diversity of the Lapita Cultural Complex along the Great Barrier Reef Coastline in the Third Millennium BC	The Australia & Pacific Science Foundation	\$17,500	\$45,000	2009-2013	6a
R Torrence, N Kononenko, E Carter	Valuing Stones: obsidian stemmed tools in the creation of social complexity in PNG	Australian Research Council - DP 2009	\$124,500	\$457,000	2009-2013	6a, c
R Torrence, T Doelman	Reconstructing Prehistoric Exchange of Volcanic Glasses in Far East Russia	Australian Research Council - DP 2004 (project extended)	\$0	\$230,002	2005-2010	6a,c, other

APPENDIX 2

A Clarke, J Philp, R Torrence	Producers and Collectors: Uncovering the Role of Indigenous Agency in the Formation of Museum Collections	Australian Research Council - LP 2006	\$0	\$103,950	2006-2010	6a,c
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PUBLICATIONS 2009- 2010	Prog 1	Prog 2	Prog 4	Prog 5	Prog 6	Prog 7	Prog 8
Ashcroft, M.B. , L.A. Chisholm & K.O. French, 2009. Climate change at the landscape scale: predicting fine-grained spatial heterogeneity in warming and potential refugia for vegetation. <i>Global Change Biology</i> . 15: 656-667.				✓			
Ashcroft, M.B., J.R. Gollan, D.P. Faith , G.A. Carter, S.A. Lassau, S.G. Ginn , M.W. Bulbert & G. Cassis, 2010. Using Generalised Dissimilarity Models and many small samples to improve the efficiency of regional and landscape scale invertebrate sampling. <i>Ecological Informatics</i> , 5: 124-132.		✓					
Attenbrow, V. , 2009. Aboriginal placenames around Port Jackson and Botany Bay, New South Wales. Sources and uncertainties. In H. Koch & L. Hercus. <i>Aboriginal Placenames. Naming and Re-naming the Australian Landscape</i> . (Aboriginal History Monograph 19, pp 9-54. Canberra: Aboriginal History Inc and ANU E Press.					✓		
Attenbrow, V. , G. Robertson & P. Hiscock, 2009. The changing abundance of backed artefacts in south-eastern Australia: a response to Holocene climate change? <i>Journal of Archaeological Science</i> 36: 2765-2770.					✓		
Attenbrow, V.J. , 2010. Sydney's Aboriginal Past. Investigating the Archaeological and Historical Records. (2 nd edition – soft cover). Sydney: UNSW Press.					✓		
Azman, B.A.R. & J.K. Lowry , 2009. Bolttsiidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 285-327.	✓						
Baehr, B., M.S. Harvey & H.M. Smith , 2010. The goblin spiders of the new endemic Australian genus Cavisternum (Araneae, Oonopidae). <i>American Museum Novitates</i> 3684: 1–40.		✓					
Beechey, D.L. 2009. Seashells of New South Wales. Family Pendromidae. Internet publication http://seashellsofnsw.org.au/Pendromidae/Pages/Pendromidae_intro.htm	✓						
Beechey, D.L. 2009. Seashells of New South Wales. Family Seguenziidae. Internet publication http://seashellsofnsw.org.au/Seguenziidae/Pages/Seguenziidae_intro.htm	✓						
Bickel, D. J. , 2009. Family Dolichopodidae, with annotated key to the New World genera, pp. 671–694. In B. Brown, ed., <i>Manual of the Diptera of Central America</i> , Vol. 1. National Research Council Press, Ottawa.		✓					
Boles, W. B. & H. F. Recher , 2009. Obituary: James Allen Keast 15 November 1922-8 March 2008. <i>Emu</i> 109: 272-274.							
Boles, W.E. & T.H. Worthy (eds), 2010. Proceedings of the VII International Meeting of the Society of Avian Paleontology and Evolution. <i>Records of the Australian Museum</i> 62 (1). 212 pp.							✓
Boles, W.E. 2010. A revision of C.W. De Vis' fossil cormorants (Aves: Phalacrocoracidae). In Proceedings of the VII International Meeting of the Society of Avian Paleontology and Evolution, ed. W.E. Boles and T.H. Worthy. <i>Records of the Australian Museum</i> 62: 145–155.							✓

PUBLICATIONS 2009- 2010	Prog 1	Prog 2	Prog 4	Prog 5	Prog 6	Prog 7	Prog 8
Britton, D.R. 2009, Lepidoptera of the Charles Darwin Reserve, May 2009. Final Report for ABRs. 19pp.		✓					
Britton, D.R. 2010, Darkwood Survey, Bush Blitz, February 2010. Data Summary report for ABRs. 3pp.		✓					
Capa, M. & A. Murray , 2009. Review of the genus <i>Megalomma</i> (Polychaeta: Sabellidae) in Australia with description of three new species, new records and notes on certain features with phylogenetic implications. <i>Records of the Australian Museum</i> 61(2&3): 201-224.	✓		✓				
Cardoso, M.J., M.D.B. Eldridge , M. Oakwood, B. Rankmore & W.B. Sherwin, 2009. Effects of founder events on the genetic variation of translocated island populations: implications for conservation management of the northern quoll. <i>Conservation Genetics</i> 10: 1719-1733.		✓					
Carrillo-Huffman, Y. , 2009. Painting with the Ancestors: Barkcloth Revival and Identity. Indigenous Perspectives on Maro Paintings from West Papua, (Irian Jaya), Indonesia and Nemas, Erromango, Vanuat. In <i>Moana: Culturas Insulares de los Mares del Sur</i> . Catalogue, Museum Nacional de las Culturas, Mexico pp 12.						✓	
Coleman, C.O. & J.K. Lowry , 2009. Cheirocratidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 333-338.	✓						
Coleman, C.O. & J.K. Lowry , 2009. <i>Iphimedia poorei</i> , a new species of Iphimediidae (Crustacea, Amphipoda) from the New South Wales Australian coast. <i>Memoirs of Museum Victoria</i> . 66: 61-69.	✓						
Colgan, D. J., P. Middelfart, R. Golding, & F. Criscione , 2009. Monitoring the response of NSW bivalves to climate change. Final report by the Australian Museum to the Environmental Trust for Grant 2008/RD/0071. 85 pp.	✓			✓			
Colgan, D.J. & P.da Costa, 2009. The mitochondrial DNA haplotypes of snails of the estuarine hydrobiid genus <i>Tatea</i> cross species and biogeographic boundaries. <i>Marine and Freshwater Research</i> 60: 861-872.	✓		✓				
Colgan, D.J. , D. O'Meally & R.A. Sadlier , 2009. Phylogeographic patterns in reptiles on the New England Tablelands at the southwestern boundary of the McPherson Macleay Overlap. <i>Australian Journal of Zoology</i> 57: 317-328.			✓				
Coulson, G.M. & M.D.B. Eldridge . (eds), 2010. <i>Macropods: the biology of kangaroos, wallabies and rat-kangaroos</i> . CSIRO Publishing: Melbourne.		✓					
Davis, W. E., Jr. & H.F. Recher , 2009. Use of native cherry (<i>Exocarpos aphyllus</i>) (Santalaceae) by birds in the Great Western Woodlands, Western Australia. <i>W. A. Naturalist</i> 26: 278-283.		✓					
Doelman, T, Torrence, R. , Kluyev, N., Sleptsov, I., Popov, V., 2009. Innovations in microblade core production at the Tigrov-8 late Palaeolithic quarry in eastern Russia. <i>Journal of Field Archaeology</i> 34: 367-384.					✓		
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Eldridge, M.D.B. , M.P. Piggott & S.L. Hazlitt, 2010. Population genetic studies of the Macropodoidea: a review. Pp. 35-51 in <i>Macropods: the biology of kangaroos, wallabies and rat-kangaroos</i> . G.M. Coulson and M.D.B. Eldridge (eds). CSIRO Publishing: Melbourne.		✓					
Faith D.P. , C.A. Lozupone , D. Nipperess & R. Knight, 2009. The Cladistic Basis for the Phylogenetic Diversity (PD) Measure Links Evolutionary Features to Environmental Gradients and Supports Broad Applications of Microbial Ecology's "Phylogenetic Beta Diversity" Framework. <i>International Journal of Molecular Sciences</i> , 10: 4723-4741.			✓				
Gaff, P. & W.E. Boles , 2010. A new eagle (Aves: Accipitridae) from the Mid Miocene Bullock Creek Fauna of northern Australia. In Proceedings of the VII International Meeting of the Society of Avian Paleontology and Evolution, ed. W.E. Boles and T.H. Worthy. <i>Records of the Australian Museum</i> 62: 71–76.							✓
Glasby, C.J., & P.A. Hutchings , 2010. A new species of <i>Marphysa</i> Quatrefages, 1865 (Polychaeta: Eunicida: Eunicidae) from northern Australia and a review of similar forms from the tropical Indo-west Pacific. <i>Zootaxa</i> , 2352: 29-52.	✓						
Golding, R.E. & W.F. Ponder , 2010. Homology and morphology of the neogastropod valve of Leiblein (Gastropoda: Caenogastropoda). <i>Zoomorphology</i> , 129: 81-91.	✓						
Golding, R.E., W.F. Ponder & M. Byrne, 2009. The evolutionary and biomechanical implications of snout and proboscis morphology in Caenogastropoda (Mollusca: Gastropoda). <i>Journal of Natural History</i> 43: 2723-2763.			✓				
Gollan JR , Lobry de Bruyn L, Reid N, Smith D, Wilkie L , 2010. Can ants be used as ecological indicators of restoration progress in dynamic environments? A case study in a revegetated riparian zone. <i>Ecological Indicators</i> . doi: 10.1016/j.ecolind.2009.09.007.		✓		✓			
Gollan, J.R., Smith, H. , Bulbert, M., Donnelley, A. & L. Wiklie . 2010. Using spider web types as a substitute for assessing web-building spider biodiversity and the success of habitat restoration. <i>Biodiversity and Conservation</i> . 15p. DOI: 10.1007/s10531-010-9882-1.		✓		✓			
Guerra-García, J.M. & J.K. Lowry , 2009. Caprellidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 290-131.	✓						
Harvey, K.J., D.R. Britton & T.E. Minchinton, 2009. Insect diversity and trophic structure differ on native and non-indigenous congeneric rushes in coastal saltmarshes. <i>Austral Ecology</i> . DOI: 10.1111/j.1442-9993.2009.02061.x.				✓			

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Hazlitt, S.L., M.D.B. Eldridge & A.W. Goldizen, 2010. Strong matrilineal structuring in the brush-tailed rock-wallaby confirmed by spatial patterns of mitochondrial DNA. Pp. 87-95 in <i>Macropods: the biology of kangaroos, wallabies and rat-kangaroos</i> . G.M. Coulson and M.D.B. Eldridge (eds). CSIRO Publishing: Melbourne.		✓					
Hendry, A., L. Lohmann, E. Conti, J. Cracraft, K. Crandall, D.P. Faith , C. Hänni, C. Joly, K. Kogure, A. Larigauderie, S. Magallán, C. Moritz, S. Tillier, R. Zardoya, A. Prieur-Richard, B. Walther, T. Yahara, & M. Donoghue, 2010. Evolutionary biology in biodiversity science, conservation, and policy: a call to action <i>Evolution</i> , Volume: 64 Issue: 5 Pages: 1517-1528.			✓				
Hill, A.W., R. Guralnick, P. Flemons , R. Beaman, J. Wieczorek, A. Ranipeta , V. Chavan, & D. Remsen, 2009. Location, location, location: utilizing pipelines and services to more effectively georeference the world's biodiversity data. <i>BMC Bioinformatics</i> , 10: S3.	✓	✓	✓	✓			
Hoese, D.F. & H. Motomura, 2009. Descriptions of two new genera and species of ptereleotrine fishes from Australia and Japan (Teleostei: Gobioidae) with discussion of possible relationships. <i>Zootaxa</i> 2312: 49-59.	✓						
Hoese, D.F. & H.K. Larson, 2010. Description of two new species of the genus <i>Priolepis</i> from the Indo-Pacific, with redescription of <i>P. psygmophila</i> and <i>P. profunda</i> . <i>Ichthyological Research</i> 17 pp.	✓						
Hughes, L.E. & J.K. Lowry , 2009. Oedicerotidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 746-758.	✓						
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Hughes, L.E. , 2009. Exoedicerotidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 430-433.	✓						
Hughes, L.E. , 2009. Megalurotidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 708-712.	✓						
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Hughes, L.E. , 2009. <i>Parelasomus poorei</i> A New Species of Maeridae from Southern Australia. <i>Memoirs of the Victorian Museum</i> , 66, 77-80.	✓						
Hughes, L.E. , 2009. Platyischnopidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 828-835.	✓						
Hughes, L.E. , 2009. Synopiidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 880-891.	✓						

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Jia, P., T. Doelman, Q. Chen, H. Zhao, S. Lin, R. Torrence & M.D. Glascock. 2010. Moving Sources: a preliminary study of volcanic glass artefact distributions in Northeast China using PXRF. <i>Journal of Archaeological Sciences</i> 37: 1670-1677.					✓		
Johnson, D.H. & W.E. Boles . 2009. Owls in the fossil record. Pp. 21-24. In Debus, S. <i>The Owls of Australia</i> . Envirobook, Canterbury, NSW.							✓
Jones, A. , F. Scapini & A. McLachlan. 2008. Sandy beach ecosystems: key features, sampling issues, management challenges and climate change impacts. <i>Marine Ecology</i> 29 s1:70-90. (Advances in sandy shore ecology: Proceedings of the fourth International Sandy Beach Symposium Pages 1-194).				✓			
Jones, A.R. 2010. Proposed Beach Nourishment in the Sydney Region – Review of its Ecological Effects and Recommendations for Future Monitoring. Report Prepared by Australian Museum Business Services for AECOM. 23pp.				✓			
Khan, K. , 2010. Aboriginal Dress in north Queensland. In <i>The Encyclopaedia of World Dress and Fashion</i> . Berg Publishers, UK. Volume 7.					✓		
Kelloway, S., N. Kononenko, R. Torrence & E. Carter. 2010. Assessing the viability of portable Raman spectroscopy for determining the geological source of obsidian. <i>Vibrational Spectroscopy</i> 53: 88-96.					✓		
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Kirsch, J.A.W., O. Gauthier, A. Campeau-Peloquin, M.D.B. Eldridge & F.-J. Lapointe, 2010. Phylogeny of the rock-wallabies, <i>Petrogale</i> (Marsupialia: Macropodidae). II. Detection of hybridisation among macropodines. <i>Australian Mammalogy</i> , 32: 67-75.		✓					
Köhler, F. , 2010. Three new species and two new genera of land snails from the Bonaparte Archipelago in the Kimberley, Western Australia (Pulmonata, Camaenidae). <i>Molluscan Research</i> , 30: 1–16.		✓					

PUBLICATIONS 2009- 2010	Prog 1	Prog 2	Prog 4	Prog 5	Prog 6	Prog 7	Prog 8
Köhler, F. & M. Glaubrecht , 2010. Uncovering an overlooked radiation: molecular phylogeny and biogeography of Madagascar's endemic river snails (Caenogastropoda: Pachychilidae: <i>Madagasikara</i> gen. nov.). <i>Biological Journal of the Linnean Society</i> , 99: 867–894.		✓	✓				
Kononenko, N., J. Specht & R. Torrence , 2010. Persistent traditions in the face of natural disasters: Stemmed and waisted stone tools in Late Holocene New Britain, Papua New Guinea. <i>Australian Archaeology</i> 70: 17-28.					✓		
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Lane, D.J.W. & F.W.E. Rowe , 2009. A new species of <i>Asterodiscides</i> (Echinodermata, Asteroidea, Asterodiscididae) from the tropical southwest Pacific, and the biogeography of the genus revisited. <i>Zoosystema</i> 31(3): 419-429.	✓						
Lowry, J.K. & R. Peart, 2010. The genus <i>Microrchestia</i> (Amphipoda: Talitridae) in eastern Australia. <i>Zootaxa</i> , 2349: 21–38.	✓						
Lowry, J.K. & H.E. Stoddart , 2010. The deep-sea scavenging genus <i>Hirondellea</i> (Crustacea: Amphipoda:Lysianassoidea: Hirondelleidae fam. nov.) in Australian waters. <i>Zootaxa</i> , 2329: 37–55.	✓						
Lowry, J.K. & L.E. Hughes, 2009. Iciliidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 453-57.	✓						
Lowry, J.K. & L.E. Hughes, 2009. Melitidae, <i>Elasmopus</i> group. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 643-702.	✓						
Lowry, J.K. & Myers, A.A., 2009. Foreword. In: Lowry, J.K. & Myers, A.A. (eds), Benthic Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 17-108.	✓						
Lowry, J.K. & R.T. Springthorpe , 2009. The genus <i>Floresorchestia</i> (Amphipoda: Talitridae) on Cocos (Keeling) and Christmas Islands. <i>Memoirs of Museum Victoria</i> 66: 117-127.	✓						
Lowry, J.K. & R.T. Springthorpe , 2009. Melitidae, <i>Melita</i> group. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 718-735.	✓						
Lowry, J.K. & H.E. Stoddart , 2009. Amaryllididae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 128-131.	✓						
Lowry, J.K. & H.E. Stoddart , 2009. Lysianassidae. In: Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 561-597.	✓						

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Lowry, J.K. & H.E. Stoddart , 2009. Uristidae. <i>In</i> : Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 908-918.	✓						
Lowry, J.K. & H.E. Stoddart , 2009. Wandinidae. <i>In</i> : Lowry, J.K. & Myers, A.A. (eds), Amphipoda of the Great Barrier Reef, Australia. <i>Zootaxa</i> , 2260: 927-930.	✓						
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