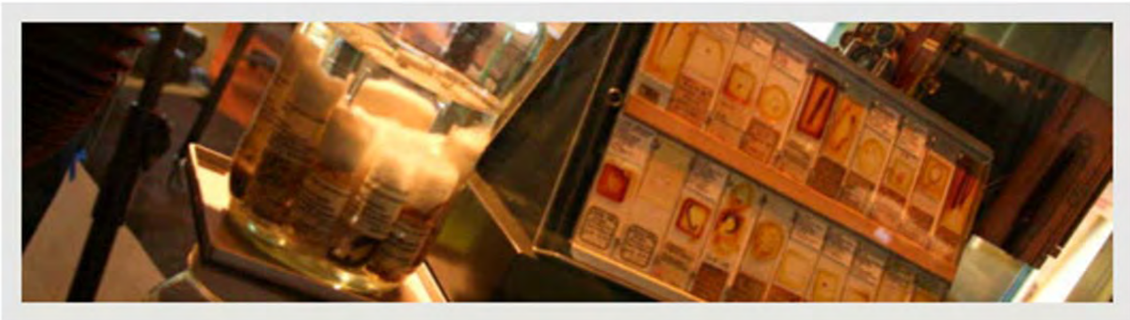
Understanding Museums:

Australian museums and museology

Des Griffin and Leon Paroissien (eds)



Museums and science

From the arrival of Europeans a fascination with the animals of the Australian continent and adjacent islands has generated scientific research. Since the nineteenth century Australia's natural history museums have been a principal site for the study of the diversity of animals, their relationships, and their distribution through the landscape and through time. The papers in this section explore natural history museums, science museums and science centres.

Contents

Online version: http://nma.gov.au/research/understanding-museums/Museums_science.html

Image credit: *Microscope slides and specimen jars of tropical parasites from the Anton Breinl Centre, James Cook University, Townsville. Photo: Jen Wilson.*

Contacts
National Museum of Australia
Canberra ACT 2601 Australia
T +61 (0)2 6208 5099
E feedback@nma.gov.au
www.nma.gov.au

Understanding Museums - Museums and science: introduction

Science museums: introduction

by Des Griffin

Natural history museums, science museums and science centres

From the arrival of Europeans a fascination with the animals of the Australian continent and adjacent islands has generated scientific research. Since the nineteenth century Australia's natural history museums have been a principal site for the study of the diversity of animals, their relationships, and their distribution through the landscape and through time. Taxonomy, a major function of natural history museums, requires substantial collections in order to understand the natural variation within species. Universities and government agencies such as CSIRO have pursued other aspects including physiology and ecology and, more recently, genetics.

Natural history museums have also accumulated large collections of fossils, minerals and rocks. State departments responsible for mines, being more active than museums in geological exploration, have accumulated large collections of minerals. These have seldom found their way into museum collections. A notable exception was Sydney's Geological and Mining Museum. Founded in the nineteenth century, the NSW government semi-privatised the museum in the 1980s — a failed experiment that led to its closure in 1996 and the dispersal of the collection (part of which went to the Australian Museum). The Australian government's Geoscience Australia holds significant collections of minerals and fossils accumulated originally by the Bureau of Mineral Resources. There are similar situations with collections of fish being retained by fisheries departments. Unlike many natural history museums in other countries, plants are held by state herbaria and by the CSIRO National Herbarium rather than by museums.

Museums' fossil collections — mainly of invertebrates — are substantial. Most research and exhibition interest in these has centred on bony fishes, reptiles, dinosaurs and mammals. Many museums have made displays of dinosaurs a centrepiece of their presentations, and recent discoveries of interesting reptiles and mammals in various parts of Australia have also been featured.

In spite of the increasing importance given to taxonomic information in environmental management, agriculture and business, support for research on taxonomy continues to decline, although the Australian Biological Resources Study — an Australian government initiative — has supported important research and publications since the 1980s. Doug Hoese reviews the major role that natural history museums may play in managing biodiversity by assisting government, industry and the wider community in their appreciation of the issues, and in shaping their contribution to securing the health of the natural environment.

Although the rapid decline of biodiversity is widely understood, state government funding for relevant research has been modest, and the little funding provided has been applied mainly to collection storage and maintenance. Research other than salary costs is funded by the Australian government that in 2010 — the International Year of Biodiversity — substantially reduced funding for biodiversity studies.

In the 1970s and 1980s there was a burgeoning of science centres in many countries. Acknowledging the importance of science to society and keen to adopt new forms of communication, these institutions provided 'hands-on' learning experiences. The growth of such centres peaked in Australia in the late 1990s, whilst other museums emulated this approach to exhibiting and interaction. However a number of science centres have since closed. Michael Gore and Sue Stocklmayer trace the history of the science centre museum movement in Australia.

Museums offer vital links to the community's understanding of science, scientific research, the nature of theory, and the role of experimentation. Some of the most exciting and important science in the world is being pursued in Australia. However, the potential of science museums and science centres to contribute to the community's understanding of scientific developments in Australia and abroad remains to be fully realised.

Understanding Museums - Museums and science

Museums and the environment

by Douglass F Hoese

Natural history museums discover and document biodiversity – living organisms, their habitats and their genes – and communicate that information to the public, government and industry. This role involves collecting, identifying, describing known and previously unknown species and their evolutionary relationships to each other, and maintaining reference collections for future research. The term *biodiscovery* is used here for those activities, although the term is often used in a narrower framework in association with *bioprospecting*, specifically the discovery and exploitation of genetic and biochemical resources from plants and animals.

Most natural history museums in Australia are concerned only with animals (fauna), whereas some overseas museums also deal with plants (flora). In Australia the plant equivalents of natural history museums are the herbaria attached to major botanic gardens.

It is well recognised that biodiversity is declining worldwide. It is also recognised that for a robust biodiversity to survive, it will be necessary to manage biodiversity and the environment. Museums, which deal directly with identifying and documenting our biodiversity, have a major role in assisting the management of biodiversity. Museum collections form the basis for research documenting the fauna of the Australasian region.

Museums traditionally conduct extensive taxonomic (classification of organisms) and systematic research (study of diversity of organisms and their relationships over time), activities which are fundamental to our understanding of the environment and of evolution. Taxonomy establishes names for organisms, and thereby provides a central framework for all of biology, facilitating the organisation of biological knowledge. Without taxonomic research the biological collections would be merely a collection of curious objects, of limited value to our understanding of the natural world. The traditional focus of museum research is expanding to include genetic studies to facilitate identification of species and aid in determining relationships of animals.

The key role of natural history museums in auditing and conserving biodiversity has been documented in numerous reviews in many countries over the last 40 years; unfortunately the response has seldom seen significant additional support for the biodiversity research of museums. [1]

Unlike other countries, Australia does not have a national natural history museum with a national or worldwide focus in its collection, research and public programs. Instead the major state museums – Australian Museum, Museum Victoria, Queensland Museum, South Australian Museum, Western Australian Museum, Tasmanian Museum, Queen Victoria Museum and Art Gallery and the Museum and Art Gallery of the Northern Territory – hold collections from their state or territory and sometimes hold extensive collections from other states and other parts of the world. At Commonwealth level CSIRO maintains, in different divisions but within a single program, three important collections of animals built up in the course of the research programs fundamental to CSIRO's mission. These are modest collections, although the Australian National Insect Collection is of special significance because of its size and the substantial research conducted on it. A National Herbarium (also within CSIRO) maintains an important collection of plants. The state and Commonwealth collections together are considered to constitute the 'Distributed National Collection'.

In 2003 the Australian government employed only one per cent of Australian taxonomists specifically engaged in research on plants and animals, and seven per cent of those were involved in taxonomic research as a secondary activity. [2]

State museums in Australia hold almost 20 million records of animal distributions based on the collections, more than double the records held by the CSIRO collections. The total workforce in museums is small, with about 40–50 research scientists and a comparable number of technical and collection staff that provide direct or infrastructure support for the research. In 2006, according to an Australian Biological Resources Survey (ABRS) survey that year, approximately 60 per cent of the taxonomic workforce was employed in museums and herbaria specifically for research on or curation of biological collections in Australia. [3] The remaining 40 per cent was employed in universities or various other government agencies. Many museums rely heavily on volunteers to help maintain the collections, and in many cases research is conducted by unpaid or retired associates. While museums mainly employ taxonomists, some have employed ecologists; more recently some museums have created positions specifically focused on application of museum research to biodiversity conservation.

Much of the biological research in museums has focused on documentation of what species occur in the Australasian region. That research contributes to our understanding of the evolution of the unique organisms in the region and to improved conservation. Long-term benefits of that research are adequate documentation of a sufficient number of taxonomic groups to allow improved conservation and sustainability of the fauna, and an understanding of the evolution of the flora and fauna. A stable taxonomic nomenclature for the fauna is important to stakeholders. These benefits are achieved through research involving descriptions of new species, and revision of genera or families at a species level based on samples that are relatively comprehensive. Animals show considerable variability geographically, by sex, size or simply by random variation. Much of the work involves research on the variability to allow full identification of species from anywhere within Australia. Further stability is attained through studies of relationships of the animals. The modern aim of a nomenclature system is that it reflects the relationships of the animals and provides a basic standard for the scientific name of the organism.

History

Much of the early work on biodiscovery in Australia was carried out by scientists from overseas museums. For example, approximately one third of the species of fishes currently known from Australia were described prior to 1860, before collections and research programs were established in Australian museums. Today, extensive historical collections of Australian animals are held in the national natural history museums in Europe, with smaller collection in major museums in the United States.

Expansion of government funding allowed significant expansion in most museums after 1960. The number of curators approximately doubled between 1960 and 1980, and similar trends occurred in museums overseas. Many curators were recruited from overseas and the general level of training increased, with most curators having a PhD in zoology or a related field. Improved training and better resources provided by the museums led to an increase in the number and quality of descriptions of species. There was also a shift during this period from species descriptions to broader revisionary studies resolving issues confused by morphological variability. A considerable number of identification guides and popular books were produced. Genetic work was also incorporated into museum research during this period. During this time (1960–1980) a number of taxonomists were hired in universities, and taxonomists were trained in Australia.

Since 1991 the number of taxonomists employed in museums has declined, largely through retirement, the decline ranging between 10 and 30 per cent, depending on the museum. The overall decline in employed taxonomists in museums and herbaria over this period has been 17 per cent, [4] while technical staff numbers increased by 46 per cent. Many retired scientists are now working as associates within museums. In 1991, 73 per cent of the total taxonomic workforce (research and collections) were full-time paid employees. That number declined to 53 per cent in 2006, with an increase in part-time appointments. University trained taxonomists have also retired, resulting in relatively few taxonomists working in museums after being trained in Australia.

Federal and state governments have reduced research funding within many government agencies, which has impacted on research and collection funding. There was a 23 per cent decline in research funding as a percentage of GDP from government agencies' expenditure between 1996 and 2004, while higher education sector spending on research has increased by 14 per cent over the same period. [5] That reduction, and the general move to smaller government, have meant that museums have been unable to replace retiring scientists and fund research adequately. Similarly, universities have had little incentive to maintain small market subjects, such as taxonomy.

Factors influencing biodiscovery in museums

With increased concern for conservation of biodiversity and the impacts of anticipated climate change, it would seem logical that biodiversity programs in museums should receive more funds, not less. The 2006 State of Environment Report stated that 'One very important issue that continues to get worse is a national decline in capacity in biological taxonomy. The situation in this field has become critical.' [6] A number of factors, other than just budget reductions, appear to be contributing to the decline. [7]

Other difficulties facing museums include the absence of infrastructure support from the Australian government. Grants from the Commonwealth through schemes such as the Australian Research Council (ARC) provide administrative overhead funding only for salaries to museums, but provide infrastructure support and substantial overheads directly to universities. As indicated earlier, the bulk of the national natural history collections estate and the research conducted on that estate reside in the various state museums dealing with biodiscovery. In other countries, infrastructure support for museums is often available through a national funding scheme; for example, the National Science Foundation in the United States provides funding directly to major state and private museums.

For some funding schemes, such as ARC Linkage grants, museums in Australia can only act as an industry partner and must provide funding to a major collaborative research program. At the same time, state governments are moving to fund research that is more focused on immediate problem solving. There appears to be a lack of understanding that biodiscovery plays a fundamental role in underpinning a whole range of other applied research. The major source of funding for biodiscovery in recent years has been the Australian Biological Resources Study, which issues grants of less than $2 million per year throughout Australia.

Other issues include a lack of consultation between the Australian government and the states on research and collection issues in relation to museums. Another factor is that museums tend to be placed within arts ministries, whereas policy in biodiscovery tends to lie within environment, conservation and land management ministries. The lack of a national natural history museum also undoubtedly inhibits consultation between the Australian government and the states, particularly on research and collection issues. There appears to be better consultation between herbaria; this is likely to be related to the presence of a National Herbarium; and the fact that herbaria tend to be in environment or primary industry portfolios.

Bureaucratic protocols also can sometimes take precedence over access to knowledge. For example, Australia is a partner in the Global Biodiversity Information Facility (GBIF) and contributes funding to that program. One of its major goals is to make museum distribution records from the collections available via the Web. The Australian involvement is supported by various Australian government organisations, such as the Australian Research Council (ARC) and the Department of Science. However, no formal consultation was held with the state museums. When the Council of the Heads of Australian Faunal Collections approached the committee responsible for Australian involvement in GBIF, the response was that, as the agreement was an international program the Australian government had responsibility. The states on the other hand had no role in GBIF, even though two thirds of the Australian records were to be provided by state-based museums.

Although no formal consultation mechanism relating to biodiscovery in museums exists between the states and the Australian government, the Australian Biological Resources Study (ABRS) does provide a significant funding and communication channel. However it has a small budget, and is a small agency within a much larger portfolio (Department of Sustainability, Environment, Water, Population and Communities).

While the expertise and collections are largely held by state museums, Australian government funding tends to remain within the CSIRO. The Taxonomic Research Information Network established within CSIRO offers some promise. It was established with the stated goals to: (1) reinvigorate taxonomy within Australia, (2) evaluate and road test new methodologies for research and delivery of taxonomic information for a wide range of end users, and (3) create and maintain a modern collaborative national electronic framework for taxonomic knowledge delivery. However it has funding for only a few years and has not been involved in much consultation with state institutions.

Another inhibiting factor is that museums tend to have a local or state-based focus, but the organisms being studied in museums are often widely distributed. For example, 75 per cent of Australian fish species occur outside Australia.

International agreements

Australia has played a major role in the development of international initiatives on the environment, particularly the Convention on Biodiversity, the Convention for the Protection of World Cultural and Natural Heritage, Convention of the International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Global Taxonomic Initiative (GTI) and the Global Biodiversity Information Facility (GBIF). Australia played a leading role in the establishment of GBIF, which seeks to increase access to data about the world's biodiversity. In addition, Australia helped to establish the GTI as a program within the Convention on Biodiversity. That initiative seeks to ensure that an adequate taxonomic framework exists to help manage biodiversity. The program seeks to have taxonomic input into major economic development projects. To achieve this goal there needs to be an effort to train taxonomists in the developing world, and to improve collaboration with taxonomists from the developed world. While it is a valuable program, Australia has not provided any major funding to ensure an adequate taxonomic workforce within Australia to meet those objectives.

The recently completed 10-year program called the Census of Marine Life was established in 2001 with the cooperation of 70 nations and considerable private funding of $US650 million. The program was established to determine what once lived in the oceans, what now lives in the oceans, and what will live in the oceans. That program involved surveys of large areas of the ocean; Australian taxonomists, however, were involved only in a few of the programs. There is little evidence that the program has actually increased knowledge significantly as to what species of animals actually occur in the sea around Australia; much of the focus has been on documenting what is already known to occur here. There has been some involvement internationally by taxonomists, but to some extent it was a missed opportunity for the taxonomic community. Unfortunately, the taxonomic community tends to be fragmented and is not sufficiently geared up to capitalise on these types of initiatives. Taxonomists generally collaborate with workers in their own discipline and are not used to working in large multidisciplinary programs.

The future

Pressure in some quarters to focus on 'socially relevant' studies relating to issues such as climate change and conservation have caused conflict between traditional research and new priorities. Often the conflicts stem from fear of change rather that from genuine differences over desired outcomes. Resolution of that conflict is critical to the overall future of biodiscovery research. The distinction between scientific relevance and social relevance can be blurred, as research programs seek to have an impact both in the field of science and in future directions for society.

Critical to those efforts is increased collaboration between museums, government, non-governmental and industry organisations. Traditionally, many of these other organisations have treated museums as taxonomic service providers, to be called up at the end of a project for identification of specimens. While provision of service to the broad public and private community is still a high priority, museums are seeking to become partners in scientific discovery and the resolution of major environmental problems facing society. Early involvement of taxonomic expertise will produce the best outcomes for those programs. To help achieve increased partnerships, museums need to overcome the stereotype that they are dark, dusty, unchanging places, and that researchers in museums are out of touch with reality. Those perceptions are far from the reality of modern museums.

Despite numerous articles and representations to government about the importance of taxonomy and of museums conducting this research, there continues to be an ongoing reduction in permanent positions in taxonomy funded by governments. [8] Museums in Australia are increasingly moving to a strategy of temporary appointments, using various grant-funded fellowship programs to attempt to compensate for the reduction in permanent positions. The underlying strategy is efficiency: whether viable research is the result remains to be seen.

The museum community is divided on how to develop strategies to ensure a strong future for biodiscovery research. Optimists tend to argue that economic policies and reduction in size of government are cyclical trends, and museums should wait for better times. The main strategy is simply to tell people how important the work is. Reformists argue that there is a need for a cultural change within the research community in museums: strategies should focus on short-term goals and include identification of research priorities; employment of staff who can raise essential funds; and a focus on problem solving, rather than knowledge generation and increased reliance on contract work and temporary appointments. It is likely that a more pragmatic approach is needed that will promote better communication and advocacy about the importance of biodiscovery, attention to national issues and breaking down state-Commonwealth and state-state rivalry. What is clear is that each of these approaches sees the need for improved communication within the research community, and between the community and management, that will lead to genuine mutual understanding of the issues and possible solutions.

In 1995 the Australian Museum established a Centre for Biodiversity and Conservation Research. That Centre focused on the needs of various stakeholders, including government, and was successful in significantly increasing funding for research in the Australian Museum. The centre concept is now common in many overseas museums.

A critical strategy for the future will be making biodiscovery more visible to a broader community. One mechanism is for museums to act collaboratively, particularly on issues of national importance. Museums in Australia recently trialled a program called Networks of Excellence developed by Professor Mike Archer. Two networks were formed, one relating to biosecurity and a second aimed at developing an Atlas of Australian Fishes. Both achieved some success and the fish network (OZFishNet) is now developing an online atlas with the help and support of the ABRS and the National Oceans Office.

The use of new and emerging technologies is also critical to the future of biodiscovery. [9] Estimates indicate that only about 10 per cent of the world's organisms have been named in the last 250 years, suggesting completion could take hundreds if not thousands of years. Indeed, the rate of description of new species is possibly lower than the rate of extinction of existing species. However, applications of new technologies, such as publication on the internet, genome sequencing and high resolution digital photography, can dramatically reduce the time to completion to a single generation – assuming all the species can be discovered in that time.

Web-based programs are being established worldwide. [10] One of the major international programs, GBIF, seeks to make available records of species distribution, including those held in museums. It also seeks to generate a world list of all known species of plants and animals, and to help find funding to allow databasing of existing museum collections. Currently, only about one third of the records held in museums in Australia are in electronic databases.

One major advantage of using museum collections is that the identity of the species can always be confirmed by reference to a specimen (the type) held in a museum. Owing to rapid change in our knowledge of the identity of species in recent years, identifications in electronic databases often become out of date. This is a major problem in some groups, such as fishes, reptiles, amphibians, and invertebrates, where what was thought to be a single species turns out to be a composite of two or more species with overlapping distributions. In those cases, the discovery of the new species makes electronic databases based on observations obsolete for those records. Providing time and money to update such records is an issue that is receiving little attention.

In Australia, museums dealing with biodiscovery now have some of their collection records available on the Web, in a project called On Line Zoological Collections of Australian Museums (OZCAM). The program was developed through the Council of the Heads of Australian Faunal Collections (CHAFC). Currently, information is available directly from the OZCAM website or through one of the growing number of programs dealing with data, including GBIF and the Oceanographic Biological Information System (OBIS), an initiative of the Census of Marine Life.

The major priority identified by museums is to obtain funding to database all of their collections. The value of the information held by museums varies with various stakeholder groups. OZCAM and other distributional databases using museum records generally only meet some stakeholder needs. Recently many museums have made more information available to meet a greater range of stakeholder needs. Presently museum records are of limited value in comprehensive distribution pattern analysis used in geographical information systems (GIS). These analyses require high levels of accuracy of identification and locations, but museums have generally placed a higher priority on getting more data digitised than in improving the quality of their existing data. Ultimately both activities will be essential to ensure utility of the data.

Another limiting factor for the value of the data is that Australia is a big country and has a very large economic marine zone. The 22 million records of terrestrial animals means an average of three records per square kilometre, and for terrestrial vertebrates it equals about one record per eight square kilometres. Observation databases held by Australian government, state and non-government organisations (mainly for birds) hold 10 to 100 times the records held by museums. As a result, modelling of overall distributions is now using specimen and observational records. That modelling will be increasingly important in predicting effects of climate changes. It must be recognised, however, that the absence of voucher records (based on specimens) can make some observational data of no value. Most of this work is being done in universities and various government agencies, but only in some museums. Museum databases and the taxonomic expertise behind those databases will become increasingly important in that modelling work. Information on which species are sufficiently well known for use in environmental and conservation assessment is particularly important. That expertise can best be provided by museum research workers, and museum databases will be used increasingly to aid quality control of observational databases.

A major initiative that is attempting to address many of the problems identified here is the Atlas of Living Australia, established as part of the National Collaborative Research Infrastructure Strategy and funded by the Super Science Initiative from the Education Investment Fund until June 2012. It is a program which is establishing an infrastructure to delivery information about the biodiversity of Australia. It was established as a partnership between the CSIRO, Australian museums, herbaria and other biological collections. It has gone a long way to overcome some of the communication problems between the states and Commonwealth organisations mentioned above and recognises the importance of the state collections. Organisation of the Atlas will follow a taxonomic framework provided by research conducted largely in museums and herbaria.

Many museums, along with the CSIRO, are contributing to the Barcoding of Life (COBOL) project, an international initiative established in 2004 and devoted to developing DNA barcoding as a global standard for the identification of biological species. Barcoding uses a short DNA sequence from a standardised and agreed-upon position in the genome as a molecular tool for species-level identification. The project is driven largely by the scientific community and funded by a mixture of private and government funding. The technique will be invaluable for many groups of organisms, particularly microorganisms, and will allow identification of a species from blood, hair or other tissue samples. These techniques, however, will not help to understand relationships, and will be of little use to a birdwatcher, fisherperson or ecologist who needs visual cues to identify animals, but it will aid taxonomists in better defining species. The costs of obtaining adequate specimens of every known species and sequencing even a single gene would run into billions of dollars. Consequently the project is planned over a number of years, with an initial goal of sequencing a gene from 500,000 species in five years. Improvement in technology is reducing the overall costs.

Biosecurity is another major area where biodiscovery is becoming important. Australia has a long history of introduction of overseas animals with negative consequences for native fauna and agriculture. With increased trade and speed of transportation, it is becoming much easier for animals to be introduced accidentally. Museum biodiscovery workers are often the first to confirm the identification of an introduced animal. Conversely, taxonomic expertise can show when a suspected pest is not a real threat. For example, fungal spores found in Australian wheat exports were thought to be from a diseased strain, which threatened to close a $4 billion export trade. However, taxonomic identification showed the spores were not from a disease causing fungus, and export trade resumed. [11]

A number of museums have engaged in commercial operations in the environment area to increase general revenue, to better understand environmental decision making, and to provide high levels of expertise to inform that decision making. Environmental planning and conservation management and assessment are areas where biodiscovery expertise can contribute to commercial operations. Museums have had some success in that area, particularly as sub-consultants to larger environmental commercial operations. However, there are limitations to their ability to operate in a commercial environment, since government employment practices prevent museums from employing staff on comparable terms to commercial organisations, such as provision of financial incentives and other contract options.

Commercial organisations operate with very low profit margins of less than five per cent which smaller organisations, such as museums, often cannot offer. Consequently museums have tended to be successful only in providing their unique expertise. Government accounting and budgeting practices also make it difficult for museums to benefit significantly from commercial operations. Policy changes to improve development and general reductions in government funding have also led to reduced funding for conservation assessment; in some states commercial work now is primarily in the environmental assessment area, which requires less museum expertise than does conservation assessment.

Constitutionally, Australian states have responsibility for more ‘applied’ issues such as fisheries and agriculture. Over time, however, the need for research to underpin the quality of these collections is not necessarily seen as a state responsibility. Nevertheless research within museums is critical to determining the conservation status of species.

Critical to the future of all of these programs is the need for a national training and recruitment plan to ensure that broad taxonomic expertise is available to deal with issues such as biosecurity and conservation, key challenges for Australia's future. Ultimately there needs to be recognition by the Australian government that the national estate for biodiversity is a distributed one that lacks adequate infrastructure.

Footnotes

[1]Joel Cracraft, 'The seven great questions of systematic biology: an essential foundation for conservation and sustainable use of biodiversity', *Annals of the Missouri Botanical Garden*, Vol. 89, 2002, pp. 127–144; House of Lords, *What on earth? The threat to the science underpinning conservation: the government's response and the committee's commentary with evidence*, Third Report, HMSO, London, 2003; RM May, 'Tomorrow's taxonomy: collecting new species in the field will remain the rate-limiting step', *Philosophical Transactions of the Royal Society of London B*, Vol. 359, 2004, pp. 733–734; C. Pettitt, 'What Price Natural History Collections, or 'Why do we need all these bloody mice?'' *Museum Journal*, Vol. 91, 1991, pp. 25–28; QD Wheeler and AG Valdecasas, 'Ten challenges to transform taxonomy', *Graellsia*, Vol. 61, 2005, pp. 151–160; QD Wheeler, PH Raven and EO Wilson, 'Taxonomy: impediment or expedient?', *Science*, Vol. 303, 2004, p. 285; QD Wheeler, 'Invertebrate systematic or spineless taxonomy?' *Zootaxa*, No. 1668, 2007, pp. 11–18.

[2] Australian Biological Resources Study, *Survey of Australian Taxonomic Capacity*, Department of Environment and Water Resources, Canberra, 2007.

[3] For international considerations see GW Hopkin and RP Freckleton, 'Declines in the numbers of amateur and professional taxonomists: implications for conservation', *Animal Conservation*, Vol. 5, 2002, pp. 245–249.

[4] Figures from the 2003/2006 Australian Biological Resources Study.

[5] FASTS, 'Proceeding of the National Taxonomy Forum', Federation of Australian Scientific and Technological Societies, Canberra, 2008.

[6] RJS Beeton, KI Buckley, GJ Jones, D Morgan, RE Reichelt and D Trewin, *Australia State of the Environment 2006*, Department of the Environment and Heritage, Canberra, 2006.

[7] KC Kim, AE Loren and B Byrne, 'Biodiversity loss and the taxonomic bottleneck: emerging biodiversity science', *Ecological Research*, Vol. 21, 2006, pp. 794–810.

[8] AV Suarez and ND Tsutsui, 'The Value of Museum Collections for Research and Society', *Bioscience*, Vol. 54, No. 1, 2004, pp. 66–74; L Krishtalka and PS Humphrey, 'Can natural history museums capture the future?' *Bioscience*, Vol. 51, 2000, pp. 611–618; PH Raven, 'Taxonomy: where are we now?', *Philosophical Transactions of the Royal Society of London B*, Vol. 359, 2004, pp. 729–730; Rex Dalton, 'Natural history collections in crisis as funding is slashed', Nature, London, Vol. 423, 2003, p. 575; N Williams, 'Biodiversity challenge to funding priorities', Current Biology, Vol.12, No. 12, 2002, R405–R406.

[9] EO Wilson, 'Taxonomy as a fundamental discipline', Philosophical Transactions of the Royal Society of London B, Vol. 359, 2004, p. 739.

[10] V Gowin, 'All living things, online', *Nature*, London, Vol. 418, 2002, pp. 362–363.

[11] Gerry Cassis and Pauline Ladiges, 'Classify species or face extinction', *The Australian*, In Focus, Higher Education Section, 31 October 2007.

Douglass F Hoese joined the Australian Museum 1971 He worked as a research scientist and manager, becoming Head of Science in 1999.

Cite as: Douglass F Hoese, 2011, 'Museums and the environment', in Des Griffin and Leon Paroissien (eds), *Understanding Museums: Australian Museums and Museology*, National Museum of Australia, published online at nma.gov.au/research/understanding-museums/DHoese_2011.html
ISBN 978-1-876944-92-6

Understanding Museums - Museums and science

Interactive science centres in Australia

by Michael M Gore and Susan M Stocklmayer

The early history of Australia's interactive science centres shows that all were started in the early 1980s by people keen to share their passion for science. Many of the founders were university academics. Their stories tell of vision, determination, frustration and, in some cases, triumph. All achieved their initial goals but some of the first science centres came to a disappointing end.

One of the possible reasons behind the establishment of interactive science centres was falling enrolments in tertiary science courses. In particular, physics needed a more attractive image; it is no coincidence that many Australian physicists were influential in the early science centre movement. In common with science centres in other parts of the world, most of those in Australia were inspired by the Exploratorium in San Francisco developed by Frank Oppenheimer. The Exploratorium made its exhibits 'available' by providing a 'cook book' that showed how to construct and operate various exhibits they had developed.

Advocates of science centres in the 1980s saw them as fundamentally different from museums. Museums of science, including natural history, were considered to be concerned with scholarly research based on collections and with exhibiting those collections, but in a static and unchanging manner. Interactive science centre enthusiasts, however, encouraged experimentation: they made much of the fact that the visitors could actually handle the exhibits. Their early founders were driven by a sense of excitement, recognition that interactivity could bring 'their' science into the public domain. One advocate asserted that science centres were 'minds on', not just 'hands on'.

This belief in the value of experiment was paralleled by developments in formal and informal science education. The movement known as 'constructivism' placed a high value on experiential learning, the recognition that knowledge was developed by individual people based on their own experiences and was not simply something that was taught or learned from books. [1] Although early science centre research was based on museum methodology, it gradually moved to a different framework that acknowledged this different philosophical base and view of the nature of learning.

At much the same time, however, increasing attention was being paid to the 'failure' of a broader public to understand science. Surveys [2] found that the public lacked an adequate understanding of science. This so-called 'deficit model' of public knowledge [3] of the late 1980s considered that enhanced general science literacy would result in greater economic prosperity, greater appreciation of scientific research, and greater participation in democratic decision-making. [4] Science centres fortuitously provided a means of taking scientific ideas to a broader public, to foster such understanding.

There were problems from the start. The emerging science centres had little money and few people to construct exhibits. Fortunately, physics provides a vast source of ideas from which to make cheap, simple interactives. Chemistry is labour-intensive and poses problems of safety. In biology, living things need constant care and attention. Even for physics-based exhibits, there was the ongoing problem of maintenance. It was recognised at the outset that science centres must have technical people to build and fix exhibits, despite the expense. In the beginning therefore, science centres concentrated on physics activities that were simple, cheap to construct and easy to maintain.

Advocates for science centres also saw an important difference from museums in the 1980s, in that the former often engaged explainers in the exhibit areas. The need for explainers placed a further staffing burden on early science centres.

The first interactive science centre was the Questacon in Canberra, with just a few hands-on exhibits in rented premises. An Innovation Grant was obtained from the Australian Schools Commission and in 1983 it opened to the general public. Student 'explainers' were recruited to give science shows, and that group became the 'Science Circus' which now tours rural Australia. Questacon evolved into a major popular attraction in a purpose-built building sited in Canberra's parliamentary triangle. The new Questacon opened in 1988 during Australia's Bicentenary, jointly funded by the Australian and Japanese governments, the latter providing half the capital cost.

A number of other science centres developed in various parts of Australia. The Supernova Science Centre, established in Newcastle in 1986, is now a centrepiece of the Newcastle Regional Museum. It began as a number of interactive exhibits for the Newcastle show of 1980. The Musbus travelling museum and hands-on science program was conducted during the 1970s and 1980s out of the Tasmanian Museum and Art Gallery. Experilearn operated from 1983 to 1989 in the Museum of Victoria.

The Powerhouse Museum within the former powerhouse in the inner Sydney suburb of Ultimo housed traditional exhibits and others more characteristic of science centres, as did Scienceworks which opened in 1992 as an arm of the Museum of Victoria. This was a new project and not derived from Experilearn.

In Western Australian the Scitech Discovery Centre opened in 1988 in Perth. Scitech is one of Australia's most successful science centres. The Investigator Science and Technology Centre opened in Adelaide in 1991 but after years of struggling without adequate recurrent funding, it closed in 2007.

A Planetarium and Science Centre opened in 1989 within the Wollongong Botanic Gardens and moved into a purpose-built building as the new Science Centre and Planetarium in 2000. It continues to be a strong centre for informal education in the Illawarra region. The Queensland Museum Sciencentre opened in Brisbane in 1989.

Since the appearance of science centres in the 1980s, two more have opened, one in Bendigo, Victoria and the other in Devonport, Tasmania. They are officially linked and are very successful. Some centres, however, no longer exist, closing for a mix of reasons, including changing leadership, lack of funding, or declining government interest.

All science centres in Australia, however, are critically under-funded. In the past 10 years the goal of 'public understanding of science' has been substantially discredited. A major factor has been a growing awareness that 'teaching' science to an indifferent public has accomplished very little. Since the UNESCO World Conference on Science in 1999, there has been worldwide recognition of the significance, not only of science education, but of public engagement. [5]

Society's relationship with science is in a critical phase. It is clear that increasing 'scientific literacy' means more than just bringing science and technology to people's attention, or teaching them more scientific facts. Science 'awareness' is dependent on a general appreciation of what science is, how to use it, and its role in the economy. Moves to 'dialogue' are fundamental to a more equal relationship between the Australian public and its science.

It is important to understand the needs of the public, including school students, and how to address those needs. This constitutes a broader role for science centres, which are in a unique position to 'translate' the science so that the general public can understand, appreciate and use it to the benefit of themselves and the nation. It is no longer enough just to present traditional science through classical interactives. The challenge science centres face in the twenty-first century is to engage with current issues and develop techniques for reaching this broader public.

Unlike traditional museums, which usually have a core collection of intrinsic value and interest, the interactive science centre depends to a very high degree on personal interpretation of the science. This in turn requires dedication, understanding and excellent communication skills.

However, any distinction may be ephemeral. If the principal distinguishing feature of museums generally is seen to be the collections, then science centres are clearly a different entity altogether. But if museums are considered to be first and foremost about ideas, and as places of learning in the broadest sense, then science centres and museums have much to learn from each other.

Footnotes

[1] E Von Glasersfeld, *Cognition, Construction of Knowledge and Understanding*, National Science Foundation, Washington, 1988; RE Yager, 'The constructivist learning model', *The Science Teacher*, Vol. 58, No. 6, 1991, pp. 52–7.

[2] JR Durant, GA Evans and GP Thomas, 'The public understanding of science', *Nature*, Vol. 340, 1989, pp. 11–

14.

[3] B Wynne, ‘Knowledges in context’, *Science, Technology and Human Values*, Vol. 16, 1991, pp. 111–121.

[4] For a discussion of this see SM Stocklmayer, MM Gore and C Bryant (eds), *Science Communication in Theory and Practice.* Kluwer, Dordrecht, 2001. See also *UNESCO World Conference on Science for the Twenty-First Century: a New Commitment*, 26 June to 1 July 1999, Budapest, Hungary, online at: UNESCO World Conference on Science

[5] *UNESCO World Conference on Science for the Twenty-First Century: a New Commitment*, 26 June to 1 July 1999, Budapest, Hungary, online at: UNESCO World Conference on Science

Michael Gore AM was the foundation director of Questacon – the National Science and Technology Centre in Canberra.

Susan Stocklmayer AM is the Director of the Australian National Centre for the Public Awareness of Science at the Australian National University in Canberra.

Cite as: Michael M Gore and Susan M Stocklmayer, 'Interactive science centres in Australia', in Des Griffin and Leon Paroissien (eds), *Understanding Museums: Australian museums and museology*, National Museum of Australia, published online at nma.gov.au/research/understanding-museums/MGore_SStocklmayer_2011.html ISBN 978-1-876944-92-6