

## Recent Advances in Science in Western Australia

### Earth Sciences

U-series ages using thermal mass ionisation spectrometry (TIMS) are reported by researchers from the Australian National University for Last Interglacial fossil reefs along the stable coastal margin of Western Australia. Reliable ages range from 127 to 122 ka. These and other TIMS observations, combined with glacio-hydro isostatic sea-level models, indicate that the Last Interglacial period occurred from at least 130 to 117 ka. Globally, the main episode of reef growth appears to be confined to a narrow interval from 127 to 122 ka. This may indicate that the Last Interglacial was of short (127 - 122 ka) duration or reflected a major reef-building event in the middle of a longer (130-117 ka) interglacial event.

Stirling CH, Esat TM, McCulloch MT & Lambeck K 1996 High precision U-series dating of corals from Western Australia and implications for the timing and duration of the Last Interglacial. *Earth & Planetary Science Letters* 135:115-130.

Researchers from Western Mining (Melbourne), the University of Adelaide, and Queens University (Ontario) describe how numerous palaeovalleys formed extensive drowned estuaries during Eocene transgressions along the south-western part of the southern margin of Australia. The Norseman Formation in the Cowan palaeovalley was deposited during the Middle Eocene Tortachilla transgression. Initial deposition was of sands and gravels, followed by pure carbonates during the highstand, produced by a typical shallow temperate water assemblage of bryozoans, coralline algae, echinoids and molluscs swept into shoals by strong tidal currents. Spencer Gulf and Gulf St Vincent of South Australia provide close modern analogues of the Cowan palaeovalley, and the Norseman Formation is an excellent example of cool-water carbonate deposition in near-shore tide-dominated environments.

Clarke JDA, Bone Y & James NP 1996 Cool-water carbonates in an Eocene palaeoestuary, Norseman Formation, Western Australia. *Sedimentary Geology* 101:213-226.

An 'evaporative concentration-lateral groundwater flow' model is proposed by researchers from AGSO and CSIRO Division of Water Resources (Canberra) for the formation of Cu-(Pb-Zn) sulfides during a depositional cycle of carbonates in restricted marine environments using data from the Nilemah Embayment, Shark Bay. The model is constrained by; (i) the short time available for ore accumulation during a single depositional cycle, (ii) limitation of adequate rates of bacterial sulfate reduction for the formation of an ore deposit to near-surface sediments; (iii) restriction of the most favourable ore-forming sites to the intertidal zone and the littoral shelf; (iv) coincidence in these sites of *in situ* cyanobacterial mats and shallow erosional depressions containing detrital organic matter eroded from the mats. Under these conditions, the metalliferous fluid would have to contain about 1000 ppm Cu and flow for 1000 years at a rate of 5 m/a through the intertidal/littoral environment to produce an ore deposit.

Ferguson J & Skyring GW 1995 Redbed-associated sabkhas and tidal flats at Shark Bay, Western Australia: their significance for genetic models of stratiform Cu-(Pb-Zn) deposits. *Australian Journal of Earth Sciences* 42:321-333.

Four major plutonic episodes have been identified by researchers from the Geological Survey of Western Australia and Australian National University, at ca 2630 Ma, 1700-1600 Ma, 1300 and 1160 Ma. Orthogneiss, largely derived from the ca 2630 Ma and 1700-1600 Ma granitic precursors, forms a belt along the south-eastern margin of the Yilgarn Craton. These rocks, together with the gabbro of the Fraser Complex, were intruded by granitic magmas and metamorphosed in the granulite facies at ca 1300 Ma. They were then rapidly uplifted and transported westward along low-angle thrust faults over the south-eastern margin of the Yilgarn Craton. Between ca 1190 and 1130 Ma, granitic magmas were intruded throughout the eastern part of the orogen. Comparison with rocks on the Antarctic coast between Casey and the Bunger Hills shows that the southern part of the Albany-Fraser Orogen may be found here, and that the 1700-1600 Ma orthogneisses identified in the eastern Albany-Fraser Orogen may have originally formed part of an east Antarctic continent that was thrust onto the margin of the Yilgarn Craton during the collision of these two continents at 1800 Ma.

Nelson DR, Myers JS & Nutman AP 1995 Chronology and evolution of the Middle Proterozoic Albany-Fraser Orogen, Western Australia. *Australian Journal of Earth Sciences* 42:481-495.

The distribution of mafic/ultramafic sills described by W K Witt of the Geological Survey of Western Australia is consistent with models that envisage the Kalgoorlie Terrane (abundant komatiitic and MORB-like tholeiitic volcanics and intrusive equivalents) as an ancient continental marine basin. Plagioclase-rich (leucodolerite) sills in the Melita area (Gindalbie Terrane) have alumina-rich TiO<sub>2</sub>-poor compositions comparable to island-arc tholeiites and were derived by partial melting of an enriched mantle source. The geochemistry and distribution of sills is not compatible with a simple, craton-scale plume model for the formation of the greenstone belts.

Witt WK 1995 Tholeiitic and high-Mg mafic/ultramafic sills in the Eastern Goldfields Province, Western Australia: Implications for tectonic settings. *Australian Journal of Earth Sciences* 42:407-422.

Deformation documented by a team of scientists from the Geological Survey of Western Australia, BHP Minerals and the University of Western Australia, for the Upper Devonian carbonate rocks of the Lennard Shelf shows a complex history involving synsedimentary structures and faults. In the Pilbara Range-Limestone Billy Hills region, a corridor of north-east-trending deformation is associated with dextral offset of the reef margins, and is interpreted as an accommodation zone comprising an echelon of sinistral oblique-slip faults, probably above basement faults at depth. The distribution of lithofacies is controlled by basement-hosted faults, with the reef and platform facies confined to palaeo-highs. The gross structural architecture of the Lennard Shelf appears to be of strike-extensive north-west-trending listric normal faults that parallel the basin margin and which show apparent offset on north-east-trending zones of accommodation structures. There is no

evidence for compressional tectonics nor penetrative deformation as suggested by some earlier workers.

Dörling SL, Dentith MC, Groves DI, Playford PE, Vearncombe JR, Muhling P & Windrim D 1996 Heterogeneous brittle deformation in the Devonian carbonate rocks of the Pilbara Range, Canning Basin: Implications for the structural evolution of the Lennard Shelf. *Australian Journal of Earth Sciences* 43:415-429.

## Life Sciences

The relative growth rate, mortality and stem form of individual trees in mixed stands of planted *Pinus radiata* and regenerated *Eucalyptus obliqua* were investigated by foresters, from the State Forests of NSW and the University of Melbourne. Relative growth rate increased with tree size and decreased with higher neighbourhood leaf area, and increased with higher neighbourhood density as a result of release from competition. The growth, mortality and changes in stem form led to changes in density-dependent stand characteristics such as mean height-to-diameter ratio and size-distribution patterns.

Bi H & Turvey ND 1996 Competition in mixed stands of *Pinus radiata* and *Eucalyptus obliqua*. *Journal of Applied Ecology* 33:87-99.

Field-screening of cucumber mosaic virus (CMV), which is seed-transmitted in narrow-leaf lupin *Lupinus angustifolius*, was developed by researchers from the Plant Industries Division (WA Department of Agriculture), based on spreader rows, where a susceptible Wandoo cultivar was grown on either side of each test row. Ten lines of lupin were categorised into moderately-resistant, moderately-susceptible, susceptible and very susceptible categories; no lines were highly resistant. Breeding for low CMV seed transmission rates is recommended, and advanced breeding lines with unacceptably high intrinsic transmission rates (>20%) should be culled out.

Jones RAC & Cowling WA 1995 Resistance to seed transmission of cucumber mosaic virus in narrow-leaved lupins (*Lupinus angustifolius*). *Australian Journal of Agricultural Research* 46:1339-1352.

Examination of the canopy arthropod communities of eucalypt trees in eastern and western Australia, determined at 3 month intervals using chemical knock-down procedures, revealed that arthropods were more common in eastern Australian trees and that there was a different seasonal pattern. The phenological patterns of canopy arthropods appear to be related to the condition of the host trees and/or climatic factors. Detection of variability in seasonal and annual patterns of canopy invertebrate communities by long-term sampling is required to evaluate the impact of disturbances on forest communities.

Recher HF, Majer JD & Ganesh S 1996 Seasonality of canopy invertebrate communities in eucalypt forests of eastern and western Australia. *Australian Journal of Ecology* 21:64-80.

Volume 4 of *Monographs on Australian Lepidoptera*, *The Checklist of the Lepidoptera of Australia*, provides the first complete documentation of this taxon, including nomenclature and classification for all of the entire named Australian lepidopterans. Generated from a computer database compiled with strict protocols, it includes over 24660 names. There is an introduction to each fam-

ily. It records over 850 significant misspellings, over 1250 new synonymies and over 1500 new combinations. A CD-ROM of all text files is included.

Nielsen ES, Edwards ED & Rangsi TV (eds) 1996 Checklist of the Lepidoptera of Australia. Vol 4. *Monographs on Australian Lepidoptera*. CSIRO Publishing, East Melbourne.

Resource partitioning within an assemblage of seven species of insectivorous birds, inhabiting remnant *Melaleuca* woodland on Rottneest island, was examined by researchers from Murdoch University. Foraging habits of birds were found to be both species-specific and associated with the month of observation, indicating that foraging partitioning occurred but the pattern varied temporally. The diversity of foraging habitats of each species varied widely in each foraging dimension, although species which were generalists in one foraging dimension tended to also be generalists in other dimensions.

Wheeler AG & Calver MC 1996 Resource partitioning in an island community of insectivorous birds during winter. *Emu* 96:23-31.

Assessment of the growth and yield of 97 seedlots of Gungurru narrow-leaf lupins, for seed size, percentage germination, cucumber mosaic virus (CMV) seed infection, and several seed nutrients, showed that plant density, shoot dry weight at 6 weeks, and grain yield varied significantly among seedlots. Seed size influenced stand density and shoot dry weight, but not grain yield. No seed nutrient was strongly associated with grain yield. There was no association of seedlot with the geographical source of the seed. High germination percentage and low CMV infection were the main predictors of high grain yield, but accounted for only 40% of the variance among seedlots in yield.

Tapscott HL & Cowling WA 1995 Predictors of yield of *Lupinus angustifolius* (cv. Gungurru) seedlots from different sources in Western Australia. *Australian Journal of Experimental Agriculture* 35:745-751.

Evidence of the natural fire frequency to which *Banksia hookeriana* was best adapted, was sought through analysis of its seed demography. Plants begin flowering at 3-4 years, but storage of viable seeds in the canopy was rare for plants less than 5 years old. Cones contained an average of 12 follicles, holding 2 seeds; 62% of seeds were estimated to be viable. Cone production increased with age, to about 17 cones per year at an age of 15 years. Seed was lost by spontaneous follicle rupture, granivory, and decay. A seed bank computer model predicted continued seed accumulation to at least 25 years of age, but by this time more seeds had been lost than were stored. Over many generations, the likelihood of successful recruitment occurs for an average fire frequency of 15-18 years. Recent fires have recurred within 7-11 years, indicating a human impact on the natural fire regime which may ultimately threaten *Banksia hookeriana*.

Enright NJ, Lamont BB & Marsula R 1996 Canopy seed bank dynamics and optimum fire regime for the highly serotinous shrub, *Banksia hookeriana*. *Journal of Ecology* 84:9-17.

Cooperative research between the University of Western Australia and the Western Australian Museum used allozyme and morphometric variability to provide a genetic perspective of the Indonesian fruit bat genus *Cynopterus*. The genetic distance between populations of

*C. nusatenggara* was strongly correlated with both the contemporary sea-crossing distance between islands, and the estimated sea-crossing distance at the last Pleistocene glacial maximum. This, and the low levels of population substructure within islands, indicates that the sea is a primary and formidable barrier to gene exchange. Morphometric variability did not show any of the main effects seen in the genetic data, suggesting that genetic and morphometric variability were not associated at the level of individuals.

Schmitt LH, Kitchener DJ & How RA 1995 A genetic perspective of mammalian variation and evolution in the Indonesian Archipelago: Biogeographic correlates in the fruit bat genus *Cynopterus*. *Evolution* 49:399-412.

The present environment of Australia represents a palimpsest that records a history of past climates, nutrient poor soils, burning and increasing aridity, but these details of history are not easily disentangled. Present observations cannot be readily used to interpret the past environments, and to infer these it is necessary to consider geological, climatic and weathering histories, as well as the physiological development of the structures being used as evidence. It is argued that the origins of fire-adaptation may predate the arrival of Aborigines, whose use of fire in cultural and hunting practices has only influenced the biota for about 50000 years. This is too short a time to have influenced the biota, other than to eliminate or winnow out those elements unable to cope with the new fire regimes.

Main AR 1996 Ghosts of the past: Where does environmental history begin? *Environment & History* 2:97-114.

Change in the number of red kangaroos in the pastoral zone of South Australia is related by a researcher from the University of Melbourne to rainfall and population size. Because of uncertainty about the responses of red kangaroo populations to rainfall, it is difficult to analyse the effects of harvesting on the kangaroos. The effects of rainfall and population size depend on the scale of observation; the previous year's rainfall is closely related to population changes over large areas, but summer and autumn rainfall is more critical over smaller areas.

McCarthy MA 1996 Red kangaroo (*Macropus rufus*) dynamics: Effects of rainfall, density dependence, harvesting and environmental stochasticity. *Journal of Applied Ecology* 33:45-53.

The authoritative volumes on Protura, Collembola and Diplura (Volume 22), and Echinodermata (Volume 33) of Australia are part of the Zoological Catalogue of Australia, a computer database of taxonomic and biological knowledge of the Australian Fauna. This 90-odd volume Catalogue, produced as a public inquiry database, serves as a comprehensive directory to recent information on each species of the Australian fauna. Information on each species includes synonymy, literature citation, location and status of type material and type locality, a brief summary of geographical distribution, ecological attributes, and important references including basic biology.

Houston WWK & Greenslade P 1994 Protura, Collembola and Diplura. Volume 22. Zoological Catalogue of Australia. Australian Biological Resources Study, Canberra.

Rowe FEW & Gates 1996 Echinodermata. Volume 33. Zoological Catalogue of Australia. Australian Biological Resources Study, Canberra.

Papers from the Sixth International Theriological Congress have been published in the March issue of Volume 21 of the *Australian Journal of Ecology*:

Oates JF 1996 Habitat alteration, hunting and the conservation of folivorous primates in African forests. *Australian Journal of Ecology* 21:1-9.

Cork SJ 1996 Optimal digestive strategies for arboreal herbivorous mammals in contrasting forest types: Why koalas and colobines are different. *Australian Journal of Ecology* 21:10-20.

Braithwaite LW 1996 Conservation of arboreal herbivores: The Australian scene. *Australian Journal of Ecology* 21:21-30.

Smith AP & Ganzhorn JU 1996 Convergence in community structure and dietary adaptation in Australian possums and gliders and Malagasy lemurs. *Australian Journal of Ecology* 21:31-46.

### Physical Sciences

*Note from the Hon Editor:* This column helps to link the various disciplines and inform others of the broad spectrum of achievements of WA scientists (or others writing about WA). Contributions to "Recent Advances in Science in Western Australia" are welcome, and may include papers that have caught your attention or that you believe may interest other scientists in Western Australia and abroad. They are usually papers in refereed journals, or books, chapters and reviews. Abstracts from conference proceedings will not be accepted. Please submit either a reprint of the paper, or a short (2-3 sentences) summary of a recent paper together with a copy of the authors' names and addresses, to the Hon Editor or a member of the Publications Committee:

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P C Withers, *Honorary Editor, Journal of the Royal Society of Western Australia*.

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