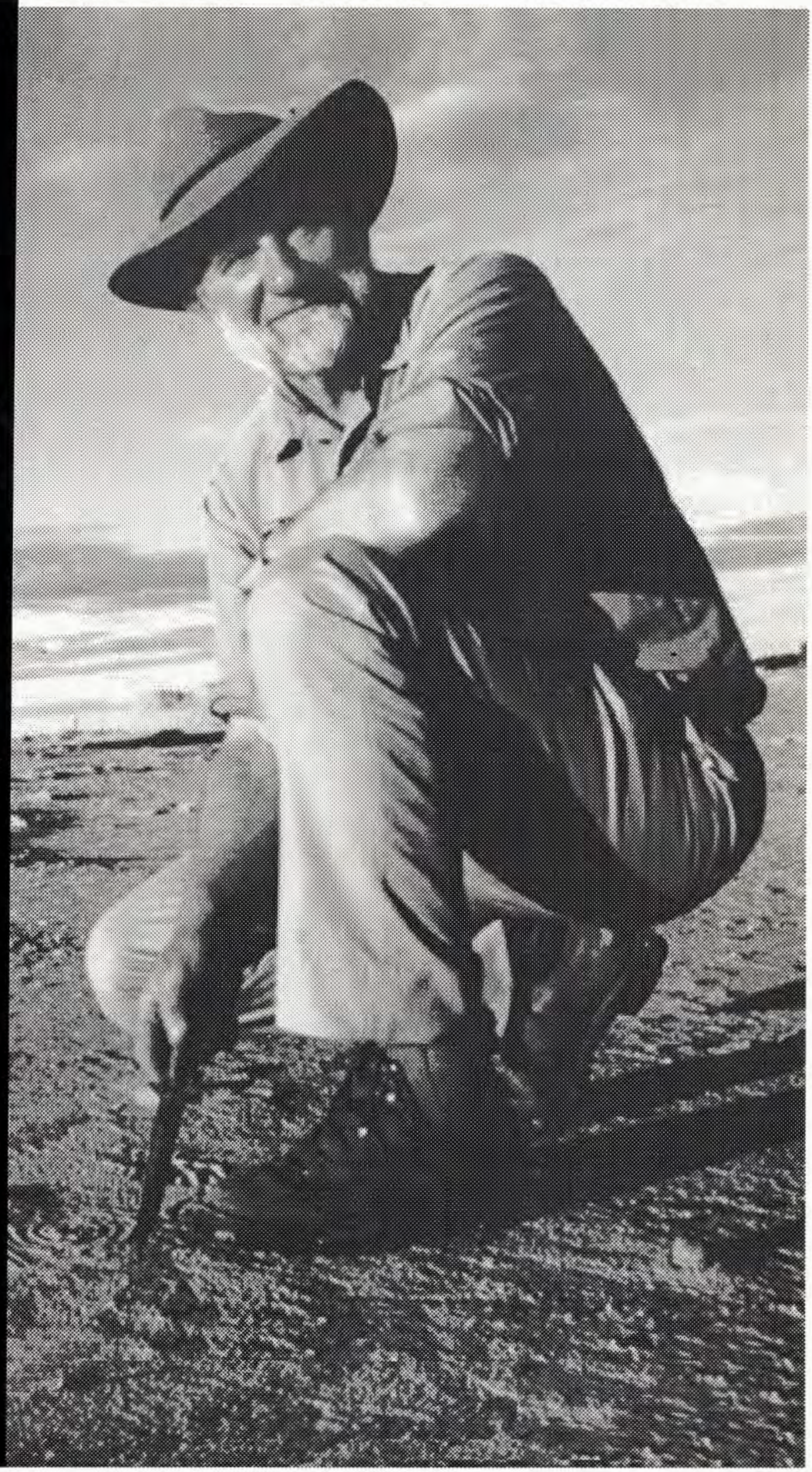
Quaternary Australasia

Volume 18 No 1 June 2000 ISSN 0811-0433



New dates from Lake Frome

Ecosystem changes in NSW pollen sequences as revealed by fuzzy analyses

The Newcastle Uni pollen digital collection initiative

The Quaternary at the University of Melbourne

The 2nd International Paleoflood conference

BIOME 300

The Inaugural Meeting of the IGCP Project 437

Book Review:
R.S. Bradley, Paleoclimatology: Reconstructing climates of the Quaternary

The Bowler Fest

...and much more.

Editor
Kate Harle
Environmental Radiochemistry (Bld 34), ANSTO,
PMB 1, Menai, NSW 2234, Australia
ph: 61-2-9717-3880
fax: 61-2-9717-9270
e-mail: khz@ ansto.gov.au

Information Technology Editor
Tim Barrows
Research School of Earth Sciences
Australian National University
Canberra, ACT 0200
e-mail: Tim.Barrow@anu.edu.au

Material for the next issue should reach the editor by **28th September 2000 (papers)** and **30th November 2000 (other)**.

The **Australasian Quaternary Association (AQUA)** is an informal grouping of people interested in the manifold phenomena of the Quaternary. It seeks to encourage research by younger workers in particular, to promote scientific communication between Australia and New Zealand, and to inform members of current research and publications. It holds biennial meetings and publishes the journal *Quaternary Australasia* twice a year. *Quaternary Australasia* is edited by Kate Harle. The annual subscription is $A25 or $15 for students, unemployed or retired persons. To apply for membership please contact Professor Geoff Hope (address below). Members joining after September gain membership for the following year. Existing members will be sent a reminder in December.

All research papers published in Quaternary Australasia have been peer reviewed.

Committee Members

Cover Illustration - Professor Jim Bowler in the field. Photograph by John Magee

Of the GST, missed deadlines and Quaternary icons

The past few months have witnessed a frenzy of activity in AQUA. Christine has been working incredibly hard to sort through the bureaucratic red tape associated with the GST as well as producing a financial report for the organisation (see page 4). Her efforts as treasurer for the organisation have been monumental and I for one am deeply grateful to her for all her hard work on our behalf!

I have been frantically editing and collating material for this issue of QA in order to get it out, or at least printed, before the GST hit our nation of knowledge. However, despite Christine's pleas and my best intentions, I failed - obviously. A pity, as I am sure it would have been the only time I managed to produce an issue of QA ahead of time. Geoff Hope was so shocked at my request for labels in early June (I was at the time, optimistic) that he fled to Timor! Ah well, I console myself with the pretense that I didn't jump to Costello's timetable and that my late production is a silent protest at the ridiculous and retroactive thinking in adopting a taxation system that has been a demonstrated failure wherever it has been applied! .....Sorry Christine, I did try!

Paul, as usual has been busy organising us all, cajoling us for answers to his emails and entreating us to make decisions about matters such as the AQUA student prize (see page 18).

Geoff has been hard at work, scouting for potential members in the wilds of Irian Jaya, Timor and Europe! Not to mention surviving an apparent baby boom in his department (see page 18).

Simon and others have been planning the next AQUA field meeting, which is to be held in Port Fairy in January next year (see the Quaternary Diary, page 5). By all accounts it is set to be a huge affair. Field trips are being planned for both eastern and western Victoria, and there is even some talk of slipping across the border to sample the vines...er Quaternary of South Australia! It would be fantastic if more of our senior academic members managed to attend and experience what is consistently an excellent scientific meeting! Perhaps some of them could even report on the activities of international committees they are on as well as obtain a good taste of what young Quaternarists are doing? In my experience, the quality of AQUA student papers has always been extremely high, despite the often primitive conditions! I am sure such an exchange of information would be a valuable experience for both our newer and senior members! I will never forget my first AQUA meeting (Myall Lakes in 1989) and the thrill of meeting for the first time Quaternary greats, such as Thom, Singh, Hope, Colhoun, Galloway and various others. I found it a highly inspiring, as well as informative experience! It would be nice to think that AQUA today could provide the same experience for our students.

And speaking of Quaternary icons, who will not remember the millenium year without thinking of the "Bowler Fest". The brainchild of John Magee and Patrick DeDeckker, this extravaganza of science was organised to celebrate the contribution of one of the greats of Australian Quaternary Science, Jim Bowler. Timed to coincide with Jim's retirement (despite Jim and retirement apparently being mutually exclusive terms), it was by all accounts a huge and memorable success! For a more complete account, see Paul's scribblings on page 3.

In addition to those items I have mentioned above, this issue contains two research papers - one by Luly and Jacobsen on the new MAS dates from Lake Frome, and another by Cupper and Ward on fuzzy analyses of pollen assemblages from southwestern New South Wales. Shimeld, Hopf and Pearson report on their digital pollen reference collection whilst Cupper provides an update on Quaternary studies at the University of Melbourne. Jansen, Mooney and Chagué-Goff report on conferences they each attended. There is a review of Bradley's latest book by Colin Pain and thesis abstracts from Hope, Moss and Brooke. There are photos of the Bowler Fest, courtesy of Pearson, and for the first time there is a section on Letters to the Editor! I would like the latter to continue, so if there are issues either presented in QA or elsewhere that you would like to comment on, please write! For prospective paper authors, I have finally managed to produce some guidelines on format etc. - see the back inside cover. Also, I have finally put a statement in the issue to say that all research papers published in QA have been peer reviewed (see inside front cover).

Well, that's it for this issue. Please keep on sending papers, reviews, reports, letters and anything else you think might be of interest to the AQUA membership.

Kate Harle
Editor

Terminology and timescales

In 1964 George Dury and Trevor Langford-Smith submitted a paper to the Australian Journal of Science (vol. 27, pp. 171-175) on the use of the term peneplain. Their thesis was that peneplain should be discontinued as a landform identifier. The difficulty was not that the term would create confusion in identification but that it carried connotations of causality along with it. They believed that in the mind of the reader a particular set of processes would be associated with the landform due to past usage in association with Davisian cyclic geomorphology. Peneplain is still with us today while sadly George and Trevor have left.

At the recent (Feb, 99) workshop held at the Geology Dept, ANU on Quaternary Long Records I was struck by the apposite nature of that paper in reference to Kate Harle's concluding talk of the proceedings. Harle suggested that the use of Glacial/Interglacial, Oxygen Isotope Stages and less certainly pluvial/interpluvial were invalid in the Australian context and should be replaced with a less externally driven nomenclature such as Wet/Dry Phases. The rationale behind this can be examined in her paper.

It was the arguments used against the suggestion that truly became reminiscent as they represented the reason that the term peneplain has not yet lost all currency. Here I paraphrase the comments of John Chappell, Gifford Miller, Rainer Grun particularly among others. The need to communicate globally and efficiently will see the continuation of the use of relatively simple and well known systems such as Isotopic Stages and glacial/interglacial cycles come what may. Regional terminologies like those described by John Chappell and Chris Turney for NZ and Britain are unlikely to gain international recognition but can still represent useful tools amongst local researchers. As Kate pointed out the use of such zonation is a regular part of discussions between researchers in a given area.

While I agree with these themes and that the Isotope Stages form a chronology which can be useful to block out the Quaternary it too can be accused of having an association in our perceptions. For while the chronology is based on a physical record that can be repeated across the oceanic portion of the globe it is directly related to climatological processes. Mike Macphail pointed out to me that such a principle went directly against the chronologies otherwise set up for the geological record (although fossils are of creatures which were in some fashion responsive to climatic conditions). I would challenge anyone to truthfully claim that any given Isotopic Stage/Substage (e.g. the topical 5e) is only perceived as a time period and has no associated climatic impression.

Now that the advent of new and more accurate and/or precise dating techniques have extended the geochronological record beyond the radiocarbon limit we are less reliant on correlative age estimates in the Quaternary. Such estimates lead to the forcing of site records to match some related baseline which may obscure differences existing between sites. If no chronology at all is available barring extrapolation we may end up with dubious results whatever chronological method. The precise Lake George chronology of Gurdip Singh extrapolated beyond radiocarbon dating limits is a useful example.

I would not wish to claim the geochronological methods are free of error or difficulty. The validity of much early radiocarbon work where ages approach 30 ka BP is a case in point.

Such correlative records are tantalising but not particularly useful for palaeoclimatic applications where finer resolution is necessary. The need for such references to external chronologies has been diminished and it would be more effective to refer to the geochronological age estimates during the body of the paper and only dabble in correlation in interpretative or correlative sections.

Yours sincerely
Geoff Hunt

Editor's note:
My apologies to Geoff for not printing this in the last issue of QA!

The Oscar of Dirt

It's not often we take time out specifically to acknowledge the achievements of our colleagues. This February, however, a very large number of people took time to attend a workshop in Canberra in honour of Jim Bowler and his contribution to Quaternary Studies in Australia. The event was designed by John Magee and Patrick De Deckker to coincide with Jim's retirement, although this appears to be proceeding in more stages and stadials than an advancing ice age.

At the 'Bowlerfest', AQUA awarded Jim life membership of the association in recognition of the influence he has had on Quaternary studies in Australia generally and on AQUA also. As far as the collective memory of the AQUA executive stretches this is the first life membership to be awarded by the association.

It seems impossible to think of Australia's present landscape and Quaternary history without there being some influence from Jim Bowler. Jim's truly groundbreaking stratigraphic, sedimentological and pedological studies of Lake Mungo and other lunettes, dunes and alluvial landscapes of the Murray Basin changed our (both scientists and layman) appreciation of the stability of the land. Coinciding with a revolution in dating (the availability of radiocarbon), spectacular archaeology and a focus shift from ice to deserts Jim was able to plot the history of aridity in Australia and the history of the arid interior, marked by a concern for both the environment and the indigenous people sustained by it.

As a member of the later generations who first encountered Jim Bowler through his papers, I count Jim's work as some of the most influential in shaping my understanding of and fascination with the Quaternary of Australia. He continues to contribute to our knowledge through actively researching and debating the Mungo record, Lake Gregory and Lake Woods. Jim also played a leading role in building scientific links with China which saw exchanges and collaborations in both directions flower in the period following the cultural revolution. In addition, Jim's terms as Vice-President of INQUA have further enhanced the profile of Australian Quaternary Science on the world stage. At home, Jim was among those who decided to organize the first AQUA conference in 1985 (at Mildura with a fieldtrip to Mungo) and the formation of AQUA itself, more than ten years after a Quaternary newsletter first appeared from an even less formal (amazing but true) grouping of practitioners.

It was my honour to present the award of life membership to Jim in February, on your behalf. He is clearly a deserving recipient.

Yours Quaternarily

Paul Hesse

Australasian Quaternary Association
Financial Statement for 1999

INCOME AND EXPENSE REPORT

(01-01-99 to 31-12-99)

Uncommitted balance brought forward from 1998 $29,620.53

01-01-97 31-12-97		01-01-98 31-12-98	01-01-99 31-12-99
	INCOME		
	Business income - Concession		270.00
	Business income - Full		3,623.48
	Business income - Institute		517.30
	Business income - Student		490.00
3,830.00	**Business Income Total**	**5,080.35**	**4,900.78**
33.99	C'wealth Bank Interest	24.50	11.97
	Bank Melbourne Interest (12 month)	1,045.31	508.18
1,409.77	Bank Melbourne Interest (6 month)		426.11
1,443.76	**Bank Interest Total**	**1,069.81**	**946.26**
	Conference income - Student		15.00
	Donation		140.00
9,055.00	Conference income	7,511.00	
25.00	Miscellaneous income	25.00	
14,353.76	**TOTAL INCOME**	**13,686.16**	**6,002.04**
	EXPENSES		
	1998 cost		80.00
	2001 Conference (accommodation)		100.00
	Commonwealth Bank fee	5.00	10.00
18.57	FID	7.33	3.11
33.30	GDT	25.30	12.23
87.60	Merchant bank fee	424.36	78.80
	Prize – travel (x2)		2,000.00
	Prize - book		25.00
44.70	Postage	56.10	65.25
	QA expense - postage		1,511.65
	QA expense - printing		2,396.85
	QA Expenses		274.56
2,480.74	**QA Expenses Total**	**1,132.08**	**4,183.06**
	Membership expense	157.50	
20.47	Miscellaneous expense		66.27
	1998 cheque presented	25.00	
	Incorporation cost	10.00	
765.00	Insurance	710.00	
12,187.82	Conference costs	8,764.01	
15,638.20	**TOTAL EXPENSES**	**11,316.68**	**6,623.72**
-1,284.44	**INCOME LESS EXPENSES**	**2,369.48**	**-621.68**

Assets (31 December)

5,840.28	Commonwealth Bank account		7,164.34	5,608.61	
10,600.61	Bank of Melbourne Term Deposit (6 month)	11,036.56	11,462.54		
10,809.16	Bank of Melbourne Term Deposit (12 month)	11,419.52	11,927.70		
27,250.05	**TOTAL**		**29,620.53**		**28,998.85**

In 1999 expenses were greater than income by $621.68. This was due to the high costs for Quaternary Australasia in 1999 when payments for a 1998 issue and 1998 QA postage costs were paid. Also, 1999 was the first year AQUA Travel Grants of $1,000.00 were awarded to post-graduate students - two travel grants were awarded. The money for these grants comes from the interest earned on the Term Deposit accounts. In future there will only be one grant awarded in each year. AQUA begins the year 2000 in a good financial position.

Christine Kenyon
(AQUA Honarary Treasurer)

Forthcoming conferences & meetings

Australasian Quaternary Association
Biennial Conference
5th - 9th February 2001
Port Fairy, Victoria

The next AQUA meeting is proposed for 5th-9th Feb, 2001 at Port Fairy, western Victoria. The conference will be held in a small conference centre, Southcombe Lodge, which is adjacent to the beach and Griffiths Island Park in Port Fairy. There is a kitchen, bunk room accommodation for up to 66 people and camping facilities at approximately $13 per night. Hotels are also within walking distance.

The given dates are mainly to avoid a clash with the New Zealand Geomorphology/Geographers conference in January 2001 and hopefully will suit the majority of people. The proceedings will include a special oral paper and poster session in honour of Bernie Joyce to focus on new work in and reviews of geomorphic history from the Highlands to the youthful basaltic province of Central and Western Victoria.

Possible pre- and post- conference field trips

A 2 day Pre-Conference fieldtrip in the western plains of Victoria possibly with Bernie Joyce and Kate Harle taking people through a number of key sites on the way to the conference.

A mid conference 1/2 or 1 day fieldtrip to Tower Hill and Discovery Bay.

A post-conference fieldtrip to the Snowy mountains led by Tim Barrows. This would involve one day of travel to get to the Snowy Mountains, one day walking around the glacial lakes (showing the new dated sites etc) and a second day looking at some newly dated periglacial deposits.

For more information or to make suggestions contact:

Dr Simon Haberle
School of Geography & Environmental Science
Monash University
Clayton, VIC 3168
Australia
Tel: 03 9905 2932 Fax: 0 3 9905 2948
Email: Simon.Haberle@arts.monash.edu.au

Other general events

International Symposium, High Mountain Lakes and Streams: Indicators of a Changing World
(4-8 September 2000)
University of Innsbruck, Tyrol, Austria.
Contact: University of Innsbruck,
Institute of Zoology and Limnology,
Technikerstr. 25, A-6020
Innsbruck, Austria.
E-mail: hmls2000@uibk.ac.at
Website: http://zoology.uibk.ac.at/congress

2000 Victorian Universities Earth Science Conference (for Honours and Postgraduate students)
(29 September 2000)
Monash University, Clayton
Contact: http://www.earth.monash.edu.au/vuesc

Geological Society of America, Annual Meeting
(13-16 November 2000)
Reno, Nevada, U.S.A.
Contact: GSA HQ, Box 9140,
3300 Penrose Place,
Boulder, Colorado 80301, U.S.A.
Ph: (303) 447-2020, X133,
E-mail: meetings@geosociety.org

QRA Discussion Meeting: The use of modern analogues for reconstructing past environments
(3-5 January 2001)
National Museum & Galleries of Wales,
Contact: Dr. Mary Seddon
Mollusca Biodiversity & Systematic Biology
National Museum of Wales
Cathays Park, Cardiff
Ph: 44-2920-573-343
Email: Mary.Seddon@nmgw.ac.uk

Joint Conference of NZ Geographical Society and Institute of Australian Geographers: "2001 – A Spatial Odyssey"
(30 Jan - 2 February 2001)
Univ Otago, Dunedin NZ.
E-mail: geography@otago.ac.nz

Australasian Archaeometry Conference 2001 Australasian Connections and New Directions
(5-9 February 2001)
University of Auckland, Auckland, NZ
Contact: Australasian Archaeometry Conference
Department of Anthropology
University of Auckland
Private Bag 92019
Auckland, NZ
Email: archconf@car.ant.auckland.ac.nz
Web: http://www.car.auckland.ac.nz/archconf/

Archaeology

Computer Applications in Archaeology
(25-29 April 2001)
Visby, Gotland Island, Sweden
Contact: Professor Gvran Burenhult
Cramirgatan 3, 621 57 Visby, Sweden
E-mail: caa@hgo.se
Web site: http://caa.hgo.se/

Geochemistry

The INQUA Carbon Commission and last IGCP-404 meeting (Terrestrial Carbon in the past 125 ka)
(6-17 August 2000)
Rio de Janeiro, Brazil
Contact: Bruno Turcq
Centre IRD d'Ile de France 32
avenue Henri Varagnat 93143
Bondy cedex, France.
Ph: 33 1 48 02 56 63
Fax: 33 1 48 02 55 54
E-mail: bruno.turcq@BONDY.IRD.FR

Geochronology

8th International Conference on Accelerator Mass Spectrometry
(13-17 September, 1999)
VERA Laboratory, Universitaet Wien, Vienna, Austria.
Contact: Gabriele Kratschmann
Ph: +43 1 40480-700
Fax: +43 1 4076200
E-mail: gabikra@pap.univie.ac.at

Geomorphology

Fourth International Meeting on Global Continental Palaeohydrology
(20-28 August 2000)
Hotel of Russian Academy of Sciences "Uzkoe",Moscow
Contact: Dr.Alexander Georgiadi
Laboratory of Hydrology
Institute of Geography,
Russian Academy of Sciences
Staromonetny per., 29 109017
Moscow, Russia
E-mail: geography@glasnet.ru, georg@ipcom.ru
Website:
http://www.ccma.csic.es/dpts/suelos/hidro/glocoph/

INQUA Commission on Glaciation Working Group on Geospatial Analysis of Glaciated Environments (GAGE): 2000 field conference
(late September 2000)
Tatra Mountains of Slovakia and Poland
Participants are encouraged to present results of projects dealing with GIS and remote-sensing applications to glaciation and glaciated environments. Topics on any methods of study and locations are invited.
For more information see:
http://www.emporia.edu/earthsci/gage/

Global Ice Sheets and Sea Level during the Last Glacial Maximum
(October 2000)
Mt. Hood, Oregon, USA,
Contact: INQUA Commission on Glaciation
E. Bard (bard@eps.harvard.edu)
P.U. Clark (clarkp@ucs.orst.edu)
A.D. Mix (mix@oce.orst.edu)
Website: http://www.inqua.au.dk/cog/

The Ninth Australia New Zealand Geomorphology Group (more or less Biennial) Conference
(11-15 December 2000)
Otago, New Zealand
Contact: Kirsten Hennrich
School of Earth Sciences
Victoria University
PO Box 600
Wellington, New Zealand
Email: Kirsten.Hennrich@vuw.ac.nz
Website: http://www.geo.vuw.ac.nz/conferences

5th International Conference on Geomorphology
(23 - 28 August 2001)
International Association of Geomorphologists
Chuo University, Tokyo, Japan.
E-mail: 5icg@aptech.co.jp
website: http://wwwsoc.nacsis.ac.jp/jgu/

ESF conference, "meso- and microscale sea-surface changes"
INQUA Commission on Sea-level Changes and Coastal Evolution (RT) 17 Paleo-tsunamis and storm records
(31 March - 5 April 2001)
St. Andrews, Scotland
Contact: INQUA Commission on Sea-level Changes and Coastal Evolution
Cesar Andrade,
E-mail: candrade@fc.ul.pt
Website: http://www.pog.su.se/sea/

Glacier-influenced sedimentation on high-latitude continental margins: modern and ancient
(29-30 March 2001)
School of Geographical Sciences
University of Bristol
Bristol, England
Contact: Dr. Colm Ó Cofaigh
Bristol Glaciology Centre
School of Geographical Sciences
University of Bristol
Bristol BS8 2SS, U.K.
Ph: +44 (0) 117 9289830
Fax: +44 (0) 117 9287878
E-mail: Colm.OCofaigh@bristol.ac.uk

VI International Symposium and Field Workshop on Paleopedology (ISFWP)
(October 2001)
Mexico City, Mexico
Contact: INQUA Commission on Global Continental Palaeopedology
Dr. Elizabeth Solleiro-Rebolledo,
nstituto de Geologia, UNAM
Ph: +52-56-22-42-86 ext. 142
E-mail: solleiro@geologia.unam.mx,
Website: http://inqua.nlh.no/commpl/pedmeet2.htm

Micro and Macro Fossils

5th International Ancient DNA Conference
(12 - 14 July 2000)
University of Manchester, Manchester, England
Contact: Terry Brown
Department of Biomolecular Sciences
UMIST, Manchester M60 1QD, UK
Ph: +44 161 200 4173
E-mail: terry.brown@umist.ac.uk

Sixth Quadrennial Conference of the International Organisation of Paleobotany (IOPC IV - 2000)
(30 July - 3 August 2000)
Qinhuangdao, Hebei, China.
Contact: Prof. Lujun Liu,
Secretary-General of IOPC-VI Organising Committee, Nanjing Institute of Geology and Palaeontology, Academia Sinica, 39 East Beijing Road, Nanjing 210008, PR China,
Ph: +86-25-6637 208
Fax: +86-25-3357 026
E-mail: paleobot@public1.ptt.js.cn

8th International Symposium on Palaeolimnology
(20-24 August 2000)
Queen's University, Kingston, Ontario, Canada
Contact: John P. Smol
Palaeoecological Environmental Assessment and Research Lab (PEARL), Department of Biology, Queen's University,
Kingston, Ontario, K7L 3N6, Canada
website: http://darwin.biology.queensu.ca/~pearl/

Announcement of Special Session on "Long term environmental change in mountain lakes at the 8th International Paleolimnology Symposium, Queen's University, Kingston Ontario

16th International Diatom Symposium
(25-27 August 2000)
Hellas, Greece; Athens 25-27 August,
Aegean Islands, 28 August - 1 September.
Contact: Dr. Richard M. Crawford
Curator: Friedrich Hustedt Diatom Collection,
Alfred Wegener Institute for Polar and Marine Research,
AM Handelshafen 12, 27570 Bremerhaven, Germany.
Ph: 49 471 4831 530;
E-mail: rcrawford@awi-bremerhaven.de
Website: http://www.uoa.gr/IDS2000

Application of Micro-organisms to Environmental Problems, 2nd International Conference
(27-31 August 2000)
Winnipeg, Manitoba, Canada.
Contact: Dr. Irena Motnenko,
Avalon Institute of Applied Science,
Box 60013 - RPO, Tuxedo Park, 110-2025 Corydon, Winnipeg, Manitoba, R3P 2G9
Canada
Ph: (204) 489-4569,
E-mail: valyan@ilos.net

3rd International Symposium on Extant and Fossil Charophytes
(16 - 20 October 2000)
Nanjing, China
Contact: Qi-fei Wang
E-mail : qfwang@jlonline.com
or Ingeborg SOULIE-MARSCHE
Laboratoire de Paleobotanique
UMR 5554 du C.N.R.S.
Email: marsche@isem.univ-montp2.fr
Website:
http://members.tripod.com/bruno.granier/3rd-charo.htm

From Palaeoecology to Conservation: an Interdisciplinary Vision
An international symposium to celebrate the 70th Birthday of Prof. W.A. Watts
(25 - 26 October 2000)
Dublin, Ireland
Contact: Fraser Mitchell
Botany Department
Trinity College
Dublin 2, Ireland
Ph: +353 1 6081811
E-mail: fmitchll@TCD.IE
Website: http://www.tcd.ie/Botany/

The 2nd International Paleoflood Conference, Prescott, Arizona

by John Jansen

Dept. Physical Geography
Macquarie University
Sydney, NSW, Australia

About sixty paleoflood devotees indulged in the thrills of big floods at Prescott, Arizona, September 26-29, 1999. This Old West town-infamous haunt of Doc Holiday and other reckless types-was much enjoyed from the salubrious setting of the Hassayampa Inn (reputedly linked to Frank Lloyd Wright in some way, though I forget exactly how).

The small-scale of the meeting contributed to the informal atmosphere. Naturally, delegates stemmed predominantly from American academic and government institutions, but travellers from Spain, Portugal, Britain, Israel and Poland were also present. I presented some speculations on the links between riffle-pool sequences and processes of knickpoint incision in bedrock channels. Representatives from the antipodes were pretty thin on the ground (me only), though Mary Bourke was there with the latest from her Todd River story. During the conference, a media frenzy converged upon Mary seeking her expert opinion on the floods that were devastating the Carolina coast at the time. Many cheers in her honour followed as we viewed the results on NBC news that night from the Hassayampa bar.

This was one of the best-organised conferences I've attended-apart from the food, which is not a high point in US culture. It was a great personal pleasure to meet and see in action key fluvial figures such as Vic Baker, Paul Carling and Ellen Wohl. In his keynote address, Vic Baker delivered a blistering attack on the flood frequency paradigm and the failure of US flood policy to incorporate now well-established paleoflood hydrology techniques in flood risk assessment. Curiously, Australia was cited, among other nations, as having a current program of widespread paleoflood hydrology application (appropriated, of course, from US research developments). If only that were true, there might be a job for the c. three researchers currently involved in paleoflood hydrology in Australia.

The convenor P. Kyle House put on a first class show both during the meeting and on the subsequent field trip; the excellent accompanying field guide is a substantial document in itself. The three day field trip toured important paleoflood sites of central and western Arizona, taking in a couple of sites on the Verde River and the remote Bill Williams River in the Sonoran Desert portion of the Basin-Range province: cholla and saguaro cactus country. The sites featured awesome slackwater deposits (some exceeding 4 m thickness) in which trenches were miraculously labelled with little stickers denoting radiocarbon ages of various sedimentary units (America has everything). For me these deposits underlined the outstanding difference between dryland fluvial landscapes of the American Southwest and the Australian interior-the great abundance of sediment supply. Indeed, this is a source of some discrepancies when 'northern hemisphere notions' are applied to our predominantly supply-limited systems.

The evidently generous sponsorship of this conference by institutions such as the Nevada Bureau of Mines and Geology, the United States Bureau of Reclamation and the Arizona Geological Society, left me to wonder: where are the equivalent government agencies back home? Of course, this is 'the American way' familiar to many, but it certainly left a big impression, having come from a nation where science and the Tertiary sector is subjected to an endless barrage of funding cuts and myopic anti-intellectual sentiments. Thank you John Howard and your league of troglodytes.

I thank the Australasian Quaternary Association for kindly assisting me with travel expenses to the United States. My late submission of this report is certainly not at all linked to the fact that my PhD is also several years overdue; I returned to Australia via an extended stopover in Crete (land of a hundred gorges) and missed the deadline for the preceding edition of QA.

(No problems John! Very happy to have your report, no matter when it arrived and how far it travelled to get here! - Ed.)

Workshop Report: BIOME 300

March 5 - 7, 2000 at the University of Bern, Bern, Switzerland

by Scott Mooney

School of Geography
University of NSW
UNSW, Sydney, NSW 2052
s.mooney@undw.edu.au

Biome300 is a new PAGES initiative, which aims to "make the best possible contribution to the reconstruction of changes in land cover over the last 300 years on as nearly global a scale as possible" (Frank Oldfield, *pers. comm.* 1999).

The contribution of land cover change to atmospheric carbon increases has been poorly quantified to date, and this project has the primary aim of providing empirical evidence for assessment of these changes to atmospheric carbon concentrations. It also allows the 'palaeo'-community some input into a field (ie modelling) that has largely neglected us to date. The 300-year time slice, although short for most 'palaeo' studies and presenting problems with chronological control, is of interest as it contains the major increase in world population and the increase in atmospheric carbon.

The project was initiated by Frank Oldfield, is lead by Marie-Jose Gaillard (Vaxsjo, Sweden, formerly Lund) and Andy Lotter (Uni of Bern) is acting as the local co-ordinator for the PAGES Bern office. It has arisen at the point of contact with other IGBP groups, notably LUCC and the modelling and integration group, GAIM. It is the first planned activity of the IGBP/PAGES Focus 3 (Human Interactions in Past Global Changes) Activity 2 (Human Impact on Terrestrial Ecosystems or HITE). The project is expected to run for 3 years, but with a fast track program feeding into the next IPCC report by late this year (through interaction with the HYDE past land cover maps).

The project is based in the palaeo-community (especially palynologists) but notably it aims to involve anyone with experience in documentary, cartographic, statistical and model-based reconstructions of past land cover/use. This was reflected in the first workshop, which included *ca.* 50 people, drawn from the PAGES community as well as modellers, historians, geographers, remote sensors and archaeologists! The meeting was dominated by Europeans, but included Americans, a couple of people from Japan, India and the former USSR and me, the sole representative from the SEAPAC region.

The meeting consisted of introductory plenary sessions, but was designed around working sessions and discussion. For those with an interest in palynology the highlights included presentations by Marie-José Gaillard ('The calibration of pollen-analytical data in terms of land cover in Sweden'), Bent Odgaard ('Historical analogues in pollen calibration') and Shinya Sugita ('Methodology and spatial scale appropriate for reconstructing land use changes from fossil pollen'). A presentation by Rik Leemans ('Land-use/land-cover change and the global carbon cycle') was also a personal highlight.

As the BIOME 300 group consists of people from many disciplines it is clear that a major challenge will be in the integration of data sources. It also became evident that (surprisingly) it is the Europeans that are behind the rest of the world in producing land cover maps for *ca.* 300 years ago: this reflects a longer history of agricultural impacts and the lack of communication between European countries.

With regard to Australia, land cover at *ca.* AD 1700 is approximated in the 1:5,000,000 AUSTLIG Natural Vegetation map. In my presentation I suggested that our pollen database is unlikely to provide continent-wide information on a scale at anything approaching the AUSTLIG map. Nonetheless, in some regions some attempt at comparing palynology and other vegetation reconstructions may be useful. In this regard the pollen people were pretty impressed with Eric Colhoun and Peter Shimeld's attempt at this in Tasmania.

There was quite a bit of debate about methodological issues for pollen, with a modified biomisation process likely to be adopted. Shinya Sugita, Marie-José Gaillard, Bent Odgaard and Eric Grimm are all likely players in this regard (with Shinya acting as co-ordinator). Whatever happens, the group will try to use the DISCOVERY map categories (see edcdaac.usgs.gov/glcc/globdoc1_2.html) so that there will be some sort of data harmonisation. For Australia this potentially offers some interesting and novel applications for palynology and it will hopefully stimulate more work on pollen-vegetation relationships. The potential to examine land use change (perhaps at 50 year increments) is especially good in south-eastern Australia, including Tasmania,

but will require more sites with good chronological control.

Overall the meeting was excellent, but a little frustrating that some of the nuts and bolts of the project were not formalised. I think one of the major contributions of BIOME 300 will be the multi-disciplinary network that it creates, and as happened with BIOME 6000 it should get palynologists thinking in a slightly different way.

If you would like any further information about the project or would like to contribute to the project drop me a line (s.mooney@undw.edu.au).

Report on the Inaugural Meeting of the IGCP Project 437

The Non-Steady State of the Inner Shelf and Shoreline: Coastal Change on the Time Scale of Decades to Millennia, Hawaii, 7-12 November 1999

by Catherine Chagué-Goff

National Institute of Water & Atmospheric Research Ltd
PO Box 8602
Christchurch
New Zealand

This meeting was the inaugural meeting of the IGCP Project 437, which runs from 1999 to the end of 2004. The project leader is A/Prof. Colin Murray-Wallace from the University of Wollongong, Australia, who opened the meeting by welcoming all participants and by presenting the aim of Project 437. Project 437 extends back in time (from the previous project 367) and seeks to examine the nature of processes responsible for coastal changes during sea level highstands, with the ultimate view of applying the results in the management of present and future coastal changes. It also includes a comparison of the evolution of coasts during the last few thousands years with earlier highstands, in particular the last interglacial maximum 121-128,000 years ago.

The meeting was hosted at the University of Hawaii, in Honolulu, USA, by Prof. Charles (Chip) Fletcher from the Department of Geology and Geophysics, University of Hawaii. It was a well attended meeting, with 82 participants from 16 countries, of which half (41) came from the USA. The Pacific was also well represented, with attendees from Japan (3), New Zealand (5), Australia (9) and Fiji (1).

The conference started with a one-day fieldtrip to the island of Molokai, 20 minutes flight from Honolulu. The highlight of the fieldtrip was the stop at a deposit, at more than 60 m above present sea-level and nearly 2 km inland from the present shoreline, which is believed to be the result of a mega-tsunami about 200,000 years ago. The bad weather unfortunately prevented us from admiring the full extent of the world highest sea cliffs, formed when a large part of the volcanic caldera fell into the sea. The fieldtrip also took us on a three kilometres hike along a beach (in between showers, we didn't get sunburned that day!) to carbonate deposits indicating previous early Holocene sea level highstands. A second half-day fieldtrip took us to Hanauma Beach, about 20 km east from the university, which represents a remnant of the inner crater of Koko Head volcano. The contemporary coral reef was quite disappointing when compared with similar reefs in the Pacific. However, on Oahu, the unique tectonic environment means that this is one of the few places where there is sufficient room under the sea surface (accommodation space) for contemporary reef growth. This accounted for the excessive numbers of tourists and the rapid degradation of the environment that is taking place. Fortunately, it was a most pleasant day with bright sunshine, which was a great change to the cold air-conditioned conference room at the university.

The technical sessions of the meeting consisted of six keynote talks (45 minutes long) and 68 posters, each of which was introduced by a 10 minute presentation (although some presenters took advantage of being at the end of a session and talked for up to 20 minutes, while we were all dying for a coffee!). Due to the conference location, many posters dealt with beach processes and reported on reef studies, mostly from extremely pleasant locations around the Pacific. However, on the whole, all aspects of coastal changes were covered, from tectonics, modeling, sediment budget, sea-level change, human impact, catastrophic events (storm surges, cyclones, hurricanes, tsunami) to climate change. El Niño and La Niña were mentioned more than once.

Keynote addresses were also representative of the range of studies in coastal research. I would say that the best was the one given by Prof. Richard Fairbanks, of Columbia University, New York, who discussed the Quaternary sea

level records based on coral reef studies, and the problems with Th/U dating. Other keynote addresses included discussion of the global glacial isostasy and coastal evolution, morphodynamic response of shoreline to interglacials, the role of tectonics in shaping New Zealand Late Quaternary shorelines, the nature of environmental changes during warm interglaciations, and sea-level and deep ocean temperature history.

Prof. Nils Mörner (University of Stokholm) was, as usual for the IGCP coastal meetings, the entertainer of the conference. He not only gave very short and abrupt presentations for his posters, but his controversial comments about other presentations were often far more extensive than his own presentations and were mostly received with smiles and laughs, although his comments were normally very appropriate.

There were a few talks about catastrophic events, ranging from cyclones, hurricanes, storm surges and tsunami. Several talks presented by participants from Hawaii attempted to address catastrophic coastal features, but when compared with the work from New Zealand and elsewhere, seemed to fall well short of the mark.
At the business meeting, Dr. Enrique Schnack (University of La Plata, Argentina) suggested that the next meeting be held in Patagonia, in late October-early November 2000 and it was unanimously accepted. Prof. Ian Shennan (University of Durham, UK) suggested Scotland for the 2001 meeting, while Portugal was proposed for 2002 by Dr. Thomas Boski (University of Algarve, Portugal), and Nova Scotia (Canada) was proposed by Prof. Dave Scott (University of Dalhousie, Canada) for the final meeting in 2004.

Working groups were proposed by A/Prof. Colin Murray-Wallace, but after some discussion, which involved renaming groups, addition of new groups, deletion of some groups, it was decided that it was better to have only a few well-defined working groups. The final decision was referred to the Executive Committee of the IGCP Project 437, although there was general agreement on a working group looking at extreme events.

It was proposed to publish a special issue of Sedimentary Geology, entitled "Decadal to millennial variability of interglacial sea levels and shorelines", with original research contributions from this inaugural meeting. Deadlines for submission of paper proposal, and for submission of papers are 15 December 1999 and 1 June 2000, respectively.

Abstracts can be viewed and downloaded from the Conference web site at
http://imina.soest.hawaii.edu/Coastal_Conf

Pollen image management: the Newcastle digital collection initiative

by Peter Shimeld, Feli Hopf and Stuart Pearson[1]

Geomorphology and Quaternary Science Research Group
School of Geosciences
The University of Newcastle
Callaghan NSW 2308 Australia
[1] corresponding author: ggsgp@cc.newcastle.edu.au

Introduction

A reference collection is a necessary outgrowth of many research projects. The need for modern morphological information at appropriate taxonomic levels seems to drive the early stages of many bioindicator projects. In palynology, the development of these collections is often a fundamental part of researcher training. It is a time consuming and materials-expensive task that includes; the gathering and identification of herbarium specimens, the destructive processing of the specimen, the storage of reference vials of material and the recording of the images for later cross-referencing. The microscope slides and processed materials have a limited (undefined) shelf-life. Retrieving reference material for routine comparison with unknown materials can be frustratingly slow using reference slides. Consequently, students have traditionally used a combination of annotated sketches and photographic print film to compile a reference collection. Most pollen laboratories are festooned with hardcopies of pollen images for the enjoyment of those in the laboratory and the collections tend to 'go with' the collector. This does not always result in accumulation of taxonomic information. Although this project report relates to a pollen collection, the principles and techniques used have universal application to people working with image management.

Greater efficacy in image management

To achieve greater effectiveness we have developed a simple system that students can use to build high quality databases of reference and unknown materials with little training or specialised equipment. The system replaces the older retrieval problem with near instantaneous access to a notionally unlimited number of reference grains. The digital images are more readily shared with others and replace the hardcopies of pollen images. The system uses digital images that replace the delays between; taking a photograph and having it added to the reference collection, the delay of duplication for sharing images with others, the costs and delays of photographic procedures. Digital images also allow easy duplication without any loss of resolution. Training of undergraduate and research students is more efficient because images and unknown grains can be routinely compared on the screen. With a few minutes training, the same equipment can be used for 'capturing' images of unknown grains for later identification or comparison. Preliminary results with honours students suggests it reduces the microscope work time by ca. 50% and concentrates the time needed for experts to identify unknown grains.

Why a digital collection from the Geomorphology and Quaternary Science Research Unit?

The Unit has a diversity of research sites and the combined pollen reference collections cover a range of biomes. These collections include material from Tasmania, Hunter Valley (and other lower north coast sites), arid sites in the Northern Territory, Queensland, New South Wales and Western Australia. These collections traditionally consisted of separate site collections, managed by separate researchers with pollen samples on microscope slides and photographs stored in albums or glued to filing cards (Plate 1). Accessing these collections was unwieldy and time consuming. New researchers have often worked with limited or incomplete reference sets and this has slowed progress on analysis of the fossil materials.

In response to multi-user demands for reference materials, and falling costs per unit of computer processing and storage, we investigated top-of-the range image grabbing and processing configurations. The set-up costs of these systems on existing scopes was >$ 20 000 and required specialised operators and software. During our recoil from this discovery we identified a 'diminishing return' in performance improvements beyond a few thousand dollars. In other words, to get small increases in performance we were expected to spend large amounts of money on a single unit.

With the impatient enthusiasm of postgraduate researchers driving the project, the occasional injection of small amounts of money and even an

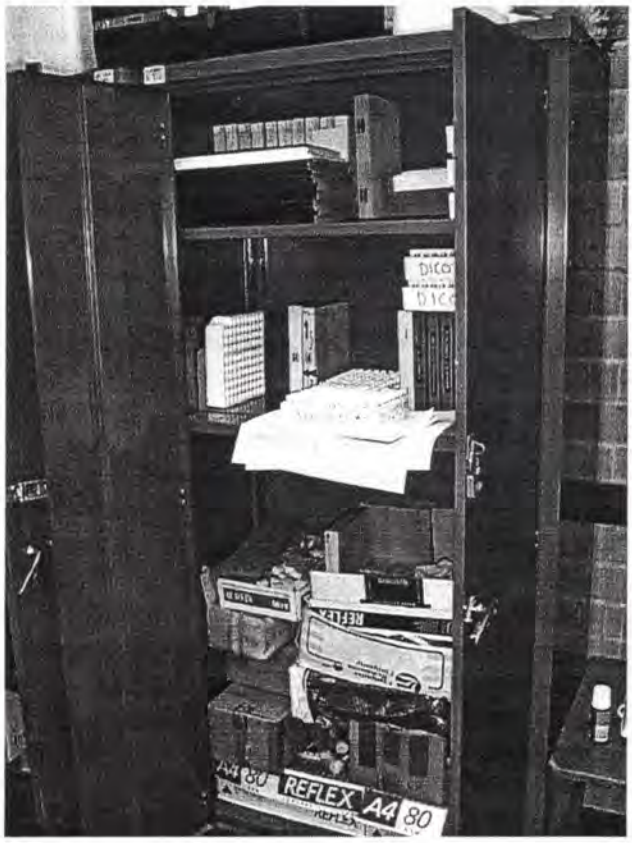


Plate 1. A traditional format reference collection.

'experiment' on a stolen Unix machine, the image grabbing capability was built onto 2 existing microscopes linked to a computer.

Our initial interest grew into a commitment to rapidly share images at no profit using both Web (www.newcastle.edu.au/department/gg/pol/0intro.html) and CD media. In 1998 we ran a workshop on image grabbing for pollen analysis and established there was some interest in this kind of tool. In 2000 we presented a paper on the pollen reference collection and the image grabbing system at the Southern Connections Congress at Lincoln University, New Zealand, 17-22 Jan 2000 and a poster and display at the Quaternary Studies Meeting at Australian National University, Canberra 7-9 Feb 2000. There have been requests for copies of the CD, offers of additional collections and information on how to set up similar hardware and software systems. The step-by-step protocol for developing images for the collection are available from the authors who are also happy to discuss set-ups for new applications.

The collection system

The collection is designed for use on standard PCs running software such as *Netscape Navigator* or *Internet Explorer*. The JPEG image file format was selected for small file size and compatibility across software. At the moment the collection contains about 450 taxa, with another 900 taxa in progress. The CD can hold images representing 2000 taxa.

The software is structured to use the brain's remarkable ability to recognise spatial pattern and make visual comparisons. Unlike conventional databases searches are image-driven rather than text driven, using selectable sketches and thumbnails to move through the collection and select best matches. The hierarchical complexity is minimised – researchers are never more than two mouse clicks from an image. The system is computer mouse-controlled and does not clutter the microscope workspace with a keyboard or the researcher's mind with esoteric morphological terminology. There is a minimum of text and specialised jargon. This increases accessibility and reduces query-to-solution times. The new collection can be used in conjunction with the ANU collection (http://pollen.anu.edu.au/pollensearch.phtml) that is more text-based with images only available at the final stages of identification.

The opening page provides 2 routes; a graphics interface page of 52 thumbnail-sized drawings and a taxonomic treatment based on Family names. We have found the line drawings are the preferred route in most situations. Selecting one of the thumbnails opens a number of thumbnail images (ca 4 KB each) of pollen grains. Selecting one of those images opens a large format image (ca. 350 KB) showing the name of the grain with a scale bar. Selecting 'Back' allows for quick comparisons with other morphologically similar grains. The large format images for each taxon are composites of a few images taken using the Hi-Lo method to show surface textures and cross-sections and usually include polar and equatorial views. Morphological variations within a species can be reflected by re-listing the images under a couple of thumbnails. For example, grains that are usually present as crushed grains can be represented by two line drawings, one showing the undamaged form and the other a crushed form. Saved with the image are a scale bar and the name of the taxon so the grain, scale and source are stored together. Some of the images have been scanned from 35mm print film photographs, but most are digitised directly from microscope video cameras. Digital "enhancements" that modify the appearance of the grains are not used to ensure images match what might appear during routine counting. The images can be enhanced from the originals if desired.

We have found it useful to develop a standard protocol for naming files to help in knowing exactly what an image is and how it was gathered. For example the file name "Solanum plicatile EV1L500.JPG" gives the following information: the specific epithet, the equatorial orientation or type of view (EV), the image number (1), the depth of focal plane (low), and that the image was taken on the Leitz scope at 500x magnification. When a number of images were compiled together we added the scale, family and specific epithet into the background (Plate 2).

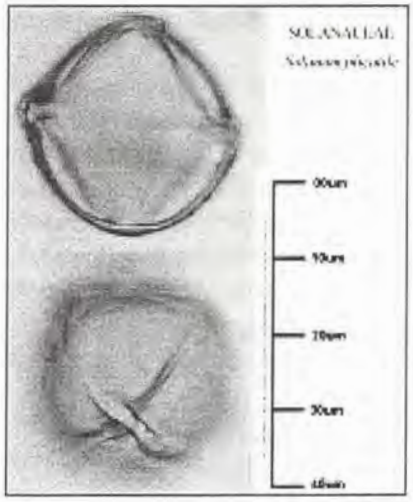


Plate 2. Example of a reference pollen grain.

From the earlier example, the image was now simply "Solanum plicatile.jpg" these files are ca 350 K. From these images we copied and resampled images to save them as thumbnails that are 125 pixels high. These thumbnail images were matched to the line drawings and from them allocated a group number. The thumbnail file name became "36Solanum plicatile.jpg". This protocol saved considerable time in building the web pages

Setting up the system yourself

The hardware configuration we have used is probably already antiquated, for example video cards are now frequently standard in contemporary computers. Nevertheless, the decisions we made in setting-up the system should encourage researchers without large budgets. We used a colour CCD video camera purchased from *ISSCO* for $500. C-mount adaptors threatened to be an expensive part of the set-up. So C-mounts were made using 50mm PVC drain fittings and the correct tube lengths were set by having a sliding section. This fitting was done easily on a *Leica* scope but we needed a precision steel engineering company to produce a mount for the *Zeiss* Axioplot microscope.

The television we use for checking image quality prior to grabbing is 46 cm however we have also used a portable 32 cm. The television is useful for expert identification and checking image quality. Although one postgraduate dreamed of counting pollen from video, we believe it is not suitable for counting. As an aside, the television set-up has been useful for teaching classes using both the light and dissecting microscopes.

A plug-in to the serial port called *Snappy* converts the video signal to digital images. The short-lived 9 volt battery was replaced by a plugpack regulator and transformer from *Dick Smith*. The computer is a Pentium II loaded with the software *Photodelux* that is sufficient for capturing the image, editing and saving. For bulk editing, scanning prints and compiling composite images we have used *PhotoImpact* or *Corel Photo-Paint* Version 8. The baseline options to set-up a system is ca. $1000 and this cost is probably falling.

Conclusion

We are planning to group images under the thumbnail leader by size and surface texture so researchers can use size or surface to speed their search. The development of Genus and Species search capabilities and provision of provenance and processing information for each image is a priority. We are also developing an instructional CD for demonstrating and teaching some aspects of Quaternary palynology.

The image grabbing and sharing project that started humbly has developed into a reasonable model for others who have large numbers of images that require some management. We have used cheap and readily available materials to achieve our goals. The equipment has, we feel, repaid the costs and trouble of set-up and we are keen to convert others to the digital image path.

Acknowledgments

This is contribution number 44 of the University of Newcastle Geomorphology and Quaternary Science Research Unit. We acknowledge with thanks the contributions of Eric Colhoun, Mike Macphail, Mike Cvetanovski David O'Brien, Richard Dear and Lucy Gayler. Thanks also for suggestions from John Dodson, Scott Mooney and Scott Anderson. The work would not be possible without the support of the Discipline of Geography and Environmental Science.

Plate 3. Detail of the image grabbing setup.

Quaternary studies at the University of Melbourne.

by Matt Cupper

School of Earth Sciences
The University of Melbourne
Victoria 3010
m.cupper@pgrad.unimelb.edu.au

Study of the relationship between people and their environment is an important aspect of Quaternary research. Homo sapiens sapiens is such a self-absorbed species it is little wonder that most Quaternarists working within the School of Earth Sciences and the Department of Geography and Environmental Studies at the University of Melbourne are focusing on human-landscape interactions. Research interests at Melbourne span the continents of Australia, Africa and Asia, and range from the Plio-Pleistocene boundary to the present.

Melanie Ashton (BSc [Honours] scholar) is using optically stimulated luminescence (OSL) to date quartz in mud-wasp nests from Aboriginal rock art sites in Arnhem Land. She is being supervised by Bert Roberts of Latrobe University. Her aim is to determine the minimum and maximum ages of rock paintings of the megafaunal marsupial Palorchestes in northern Australia.

Jim Bowler (Professorial Fellow) is digitizing over three decades of research in the Willandra Lakes region into a CD-ROM accessible to educators and students. His life-long interest in the environments of the last glacial maximum is ongoing, and he remains particularly challenged by the apparent paradox of synchronous wet and dry environments in southeastern Australia. Jim is also involved in a collaborative project with Karl-Heinz Wyrwoll (University of Western Australia) investigating the stratigraphy and TL chronology of Lake Gregory.

Matt Cupper (PhD scholar) is researching the geomorphic history and palynology of salt lakes and their associated lunette dunes in southwestern New South Wales. He is being supervised by Bert Roberts, Ian Thomas and Ian McNiven (School of Fine Arts, Classics and Archaeology). He aims to reconstruct a record of Late Glacial and Holocene palaeoenvironmental change for this semi-arid region.

Michael Fletcher (Postgraduate Diploma scholar) is investigating the long-term effects of fire on buttongrass moorland near Lake Pedder in southwest Tasmania under the supervision of Ian Thomas. He is analysing pollen and carbonised particles from a core to identify possible correlations between vegetation patterns and wildfire in the landscape.

Pandora Hope (PhD scholar) is modelling the weather and climate of Australia over the last glacial cycle with a global General Circulation Model under the supervision of Ian Simmonds. She is assessing the sensitivity of simulated weather and climate to changes in sea-surface temperature, solar input and atmospheric carbon dioxide. Palaeo-studies will provide proxy data for climates of the last glacial cycle.

Bernie Joyce (Fellow) is researching the surficial geology of western Victoria with Honours students and the Geological Survey of Victoria. Their focus is the regolith and landscape history of the basalt plains. He is also working on a revision of earlier mapping to produce a geomorphic map of Victoria.

Christine Kenyon (PhD scholar) is using fine-resolution stratigraphic, carbonised particle and pollen analyses of floodplain deposits to determine landscape dynamics within the Barmah Forest and wider Murray Basin during the European settlement period. Christine aims to correlate changes in the sediment, fire and vegetation records with climatic events, environmental disturbance and human activities. Ian Thomas is supervising this project.

Jenny Newton (PhD scholar) is developing a site catchment model comparing environmental and economic changes at Sos Hüyük, an archaeological site in eastern Turkey. Jenny is supervised by Ian Thomas and Tony Sagona (School of Fine Arts, Classics and Archaeology).

Johanna Slykerman (BA [Honours] scholar) is using pollen and sediment analyses to examine the effects of cattle

grazing in the Victorian Alps. She supervised by Ian Thomas.

Wayne Stephenson (Lecturer) has interests in coastal geomorphology, coastal management and Quaternary coastal developments. Wayne is researching the dynamics of coastal platform formation in modern settings. Modelling of these processes will enhance understanding of ancient coastlines and sea-level changes.

Tim Stone (PhD scholar) is researching the rivers and lakes of the Cadell Tilt Block and Tyrrell Basin, northern Victoria with Bert Roberts and Jim Bowler as supervisors. He aims to construct a record of regional hydrologic change spanning the last glacial cycle using OSL dating methods.

Ian Thomas (Senior lecturer) is primarily interested in human impacts on landscapes and the response of plant communities to climate change. His research interests include a collaborative study of the recent evolutionary history of mediterranean type plant communities in Australia and South Africa with John Dodson (University of Western Australia) and Brett Smith (University of Cape Town). Ian is also investigating the long term effects of people on the forests and soils of eastern Turkey with Tony Sagona and the Holocene history of lowland buttongrass moorlands in the southwestern Tasmanian World Heritage Area with Phil Cullen (Tasmanian Department of Parks and Wildlife).

Life membership awarded

AQUA has awarded a life membership to Jim Bowler in recognition of his influence on the organisation as well as Australian Quaternary studies in general. This is the first time, in collective memory, that AQUA has awarded a life membership. The award (reproduced below) was presented to Jim at a special meeting/conference held at ANU in February to honour Jim. The meeting was organised by John Magee and Patrick DeDeckker and was designed to coincide with Jim's "retirement", although there are some doubts as to whether he will ever truly retire!

AQUA Student Travel Prize

It was another tough competition this year, with four excellent entries. In the end the judges could not decide between two of the entrants and decided to split the Yr2000 AQUA Student Travel Prize between Nick Porch (Monash) and Lynley Wallis (ANU). Nick presented a poster entitled "Quaternary beetles in southern Australia: a method for reconstructing palaeoclimates" at the American Quaternary Association 16th Biennial Meeting in May this year. Lynley will be presenting two papers at the Third International Meeting on Phytolith Research in August this year.

the

Australasian Quaternary Association

awards

Jim Bowler

life membership of the Association

in recognition of

his distinguished contribution to

Quaternary Geology, Geomorphology & Prehistory

in Australia and China

Paul Hesse, President
Christine Kenyon, Treasurer
Kate Hadle, Honorary Editor
Tim Barrows

Geoff Hope, Secretary
Simon Haberle, Conference Secretary
John Dodson
James Shulmeister

8th February 2000

Congratulations

Congratulations to Geoff Hope, who was awarded a DSc from the University of Melbourne in March. The title of his DSc thesis is "Environmental and Anthropogenic Change in the Late Quaternary of the Southwest Pacific Region". The abstract from this thesis is in the Thesis Abstracts section.

Congratulations also to Catherine Chagué-Goff who recently obtained a position with the New Zealand National Institute of Water and Atmospheric Research.

Nicola Franklin has won two scholarships to assist with her studies of palaeoenvironmental change in coastal eastern New South Wales - the Tempe Mann Award from the Australian Federation of University Women and the Queens Trust Achiever Award for young Australians. She is using these scholarships to attend palaeoecology courses at University College in London.

Baby Boom at ANU

[Geoff Hope reports]
Baby booms usually follow disasters and wars – the slow recovery of Archaeology and Natural History at ANU following its near-closure in 1997 (and subsequent loss of our dating labs and geomorphologists) has sparked the following arrivals: Ms Violet Denham-Blau, born March 2000 to Tim Denham and Soren Blau (this kid hung on for 2 weeks to be in the correct millennium), Mr Tim Barham, born February 2000 to Tony Barham and Sue O'Connor and Ms Michaela Moylen, born in March 2000 to Dominique O'Dea and Brendan Moylen. We have just sold one of the Department's Landcruisers to provide room for the pram park!

PhD studentships

Victoria University Wellington, New Zealand
A Phd scholarship is available in the School of earth Sciences, VUW.

Project title: Modelling past climates: Understanding New Zealand climate during the Last Glacial Maximum (LGM)

Primary Supervisors:
Dr James McGregor, School of Earth Sciences, VUW
Dr James Renwick, National Institute of Water and Atmosphere (NIWA), Wellington

For more information contact:
Jamie Shulmeister
James.Shulmeister@vuw.ac.nz

Department of Environmental and Geographical Sciences, Manchester Metropolitan University, UK.
A PhD position is available in Physical Geography at Manchester Metropolitan University.

Project title: Environmental Changes Recorded in Scottish Lake-Catchment Sediments: a Multi-Proxy Approach.

Project enquiries to:
Dr Jane Boygle
Department of Environmental and Geographical Sciences
Manchester Metropolitan University
Manchester M1 5GD, UK
Tel.: +44 (0)161-247-6231
Email: j.boygle@mmu.ac.uk
http://www.egs.mmu.ac.uk/research/phd_studs.html

Department of Geography, University of Liverpool, UK.
Applications are sought from candidates with (or who expect to receive in 2000) upper second or first class honours degrees in Geography, Environmental Science, Earth Sciences, Physics and Mathematical Sciences for the following ten MPhil/PhD studentship topics:

1) Detecting nonlinear environmental change in lake sediment records.
Contact: Prof John Dearing
(email: j.dearing@liv.ac.uk)

2) Excess 226-Ra chronology of lake and deep-sea sediments.
Contact: Dr Andy Plater
(email: gg07@liv.ac.uk)

3) Estuarine pollution: the role of bacteria and diagenesis
Contact: Dr Andy Plater
(email: gg07@liv.ac.uk)
4) Late Holocene Monsoon records from East Asian Aeolian and Lake Sediment Deposits.
Contact: Dr Jan Bloemendal
(email: jan@liv.ac.uk)

5) The Faro-Quarteira Formation of southern Portugal: origin stratigraphy and diagenesis
Contact: Dr David Chester
(email: jg54@liv.ac.uk)

6) Weathering and soil formation on lava flows: Mount Etna, Sicily.
Contact: Mr Peter James
(email: p.a.james@liv.ac.uk)

7) Interaction of climate and human activities and geomorphological change over the past 500 years: lake and floodplain sediment records.
Contact: Prof John Dearing
(email: j.dearing@liv.ac.uk)

8) Alluvial fans and sea-level change.
Contact: Prof. Adrian Harvey
(email: amharvey@liv.ac.uk)

9) Incidence and causes of hillslope debris flows.
Contact: Prof. A.M. Harvey
(email: amharvey@liv.ac.uk)

10) Bromine concentration profiles in peat cores: evaluation of the palaeoenvironmental significance.
Contact: Dr John Boyle
(e-mail: jfb@liv.ac.uk)

Lectureships

Temporary lectureship in Biogeography/landscape ecology with the School of Geography, University of New South Wales
There is a six-month full-time contract lectureship in biogeography/ landscape ecology currently available in the School of Geography, UNSW. The successful candidate will contribute to the teaching of Biogeography and Australian Climate and Vegetation during Session 2, 2000. Honours thesis supervision may also be involved. For more information contact:
Dr Scott Mooney
School of Geography, UNSW,

Grants & Awards

IAG Honours Award
Each year the Institute of Australian Geographers offers a cash Award and a year's free membership of the Institute for a paper based on work undertaken in the 4th year Geography Honours degree, or equivalent program, at an Australian university.
Closing date: 1 October 2000

IAG Postgraduate Paper Award
Applicants for the Postgraduate Paper Award are asked to submit a paper based on work undertaken during their own research for a higher degree. The paper could be submitted during the period of enrolment but should not be submitted later than one year after the award of the degree. The paper must be single authored.

The Award will consist of one year IAG membership fees and a cash sum of $200.00.
Contact: the Editor,
Australian Geographical Studies,
Department of Geography and Environmental Science
The University of Newcastle,
Callaghan NSW 2308, Australia.

INQUA news

INQUA Commission on Glaciation
The Geospatial Analysis of Glaciated Environments (GAGE) webpage has been updated with projects for the current inter-congress period. Please contact project leaders, if you wish to participate or contribute to these undertakings.

Following the conference Modern and Ancient Ice-marginal Landsystems, an invitation has been extended to "all people interested in end Moraines" to join a project titled: 'Sedimentary environments of terrestial end moraines'. This will form part of the INQUA Commission of Glaciation Workgroup: Sedimentology of Glacial Deposits. The organisers are seeking an international group, though whether that extends to the Southern Hemisphere remains to be seen! If you are interested contact Darek Krzyszkowski, (email: Darek.Krzyszkowski@UNI-KOELN.DE)

Australian Vertebrate Fossil Field School July 2001

The Queensland Museum Palaeontology Department is planning a Vertebrate Palaeontology field school/ expedition during July 2001. This two week field school will teach the principles of vertebrate fossil excavation and field techniques, as well as involve the serious excavation of Pleistocene-Holocene cave and surface fossil sites in north Queensland and the survey of a major limestone karst region for similar fossil sites.
Expected costs are around $2100 (ex Townsville Airport). Places are limited.
For more information
contact: Dr Alex Cook
Curator, Geology and Palaeontology,
Queensland Museum
alexC@qm.qld.gov.au

The Bowler Fest

From the 7th to the 9th of February, Quaternarists from around the country and even from over seas, gathered in Canberra to celebrate Jim Bowler's contribution to Quaternary science. Timed to coincide with Jim's retirement (more or less), this extravaganza consisted of a three day scientific meeting focused on regional aspects of Australian Quaternary records, in particular those dealing with the last Glacial Maximum, the Last Interglacial and the late Holocene. Included in the "Bowler Fest" was a healthy social itinerary, including a cricket match and a "Bowler Feast" held in the Great Hall. Stuart Pearson was there to capture the action with his trusty camera!

The "Bowler Feast"

Professor Liu, who travelled from China especially for this event!

Three likely characters: Peter Kershaw, Allan Chivas and John Magee

The cricket combatants!

New books

Second Nature

The History and Implications of Australia as Aboriginal Landscape

(Syracuse University Press - http://sumweb.syr.edu/su_press/)

Lesley Head

In Second Nature, Lesley Head examines modern Australia's efforts to come to terms with its Aboriginal past. Like other postcolonial countries, Australia has been confronted by research challenging the myth of a prehistoric (pre-1788) pristine wilderness.

Drawing on anthropology, archaeology and history, Head shows that through their use of fire and their methods of hunting and gathering, Aboriginal ancestors transformed the country's biophysical landscape in a variety of still debated ways. These findings present a dramatic shift away from the nineteenth-century evolutionary models, which viewed Aborigines as an unchanging people in an unchanging land.

Given the strength of this challenge to earlier models and the increasing political voice of indigenous people, Head asks why the disruptions to colonial thinking have been so partial. She revisits historical debates to show that Australia's colonial heritage is more deeply embedded in contemporary environmental attitudes than is generally acknowledged. In 1992 the Australian legal system rejected the myth of *terra nullius* - land belonging to no one - and recognised the persistence of Aboriginal ownership.

Price: $39.95

Reviews

A review of Paleoclimatology: Reconstructing Climates of the Quaternary

(Volume 68 of the International Geophysics Series, Academic Press, ISBN 012124010X)
Raymond S. Bradley

by Colin Pain
CRC LEME
Australian Geological Organisation

Australia

The author claims in his Preface to provide a contemporary overview of the field of Quaternary paleoclimatology, while noting that some topics are not adequately reviewed. However, this is a remarkably detailed book that, in 511 pages, covers pretty much the whole gamut of evidence for, and climate changes in, the Quaternary. It details the phenomena that provide proxy data for past climates, which in turn provide the basis for testing hypotheses about the causes of climatic change. As the author points out, once this is understood, we will be able to forecast future climate variations, and point to possible results of human interference in the Earth's climatic systems.

Chapter 1, Paleoclimatic Reconstruction, is an excellent overview of proxy data sources for Quaternary climates. The author identifies 26 sources of proxy data, ranging from ice cores and marine and terrestrial sediments to biological and historical sources. The importance of dating is stressed, and there is discussion of the resolution of various data sources – some give a broad view of tendencies, while others give detailed, even daily, records of change.
Chapter 2 is about Climate and Climatic Variation. It covers the concept of climate as the statistical expression of daily weather, the present climatic system, and the nature and timing of climatic variation.

There are then two chapters on dating, a central part of reconstructing climatic change. In his discussions the author

covers the methods, their uses, and problems associated with their interpretation. Chapter 3 deals with radioisotopic methods, spending more space on radiocarbon dating that any of the others. This is reasonable in view of the central place that radiocarbon dating tends to have in studies of the late Quaternary. Potassium/Argon, Uranium series, and thermoluminescence are also covered. Chapter 4 is about paleomagnetism, as well as chemical and biological methods.

There is then a series of 7 chapters on various kinds of proxy data. Chapter 5, on Ice Cores, cavers stable isotope analysis, ice core dating, and paleoclimatic reconstructions from ice core data. These cores provide a great deal of high resolution data, especially the δO^{18} analyses. Chapter 6 (Marine Sediments and Corals) not only looks at the evidence for past climates contained in marine cores and corals, but also considers past ocean conditions in the context of the present oceans. The author points out that between 6 and 11 billion tonnes of sediment are added to the oceans each year, and that these sediments are an archive of data about the oceans themselves as well as adjacent land masses.

Chapter 7 deals with Non-marine Geological Evidence, considering loess and paleosols, periglacial features, snowlines and glacial features, and lakes, among others. Chapters 9 and 10 then discuss Pollen Analysis and Dendrochronology respectively. Chapter 9 is especially detailed on the sources, preparation and analysis of pollens. In Chapter 10 the impressive resolution of tree-ring data is highlighted.

Chapter 11 is about Documentary data, derived from historical records of various kinds. The use of old weather records is not surprising. More surprising is the report on a study of 12,000 paintings done between 1400 and 1967 that depict information about the weather, including cloudiness, visibility and the abundance of low and convective clouds. From this record, the period 1400-1549 is seen to be less cloudy and to have greater visibility than later periods. Another interesting source is the record of cherry blossom blooming dates in Japan.

Chapter 12 is about Paleoclimate Models. Perhaps the most important sentence in this chapter is "Models are simplifications of reality." However, for those who like models, this chapter presents a good overview of the ones that have been tried.

There is an Appendix that contains yet more information about radiocarbon dating, and a list of useful World Wide Web sites. The latter will undoubtedly become a more common feature in books.

The book concludes with 81 pages containing more than 1700 references! I didn't expect to find anything I have written in the list, but I did expect to find a lot of Australian work. I was disappointed. Very little of the extensive work on the Quaternary of Australia – or indeed of anywhere much in the Southern Hemisphere – is used in this book. This is its only real failing. However, on the bright side, this makes it an ideal book for workers in the Southern Hemisphere, in that it deals with much that we are not familiar with, while not presenting us with material we already know.

In reading this book I learnt a great deal about climate and its controls, and about the evidence for changing climates in the Quaternary, especially in the Northern Hemisphere. I strongly recommend it to anyone with more than a passing interest in the field of Quaternary studies.

Thesis abstracts

Environmental and Anthropogenic Change in the Late Quaternary of the Southwest Pacific Region.

Geoff Hope (DSC)
University of Melbourne

DSc theses are collections of published and unpublished papers which in this thesis are presented in three areas of study; Palaeoecology and Environmental Change, Ecology and Historical Biogeography and Prehistoric impacts and fire. The first section covers the introduction of Quaternary vegetation historical studies in southeastern Australia, montane New Guinea and the lowland tropics from eastern Indonesia to Fiji. Pollen analysis had been tested in these areas but required consistent stratigraphic and chronologic controls together with major studies of modern pollen sources, pollen morphology and pollen dispersal over the last thirty years. This work has formed part of the framework for a new understanding of Late Quaternary change which has arisen since early work by Edmund Gill and Jim Bowler and the development of absolute dating techniques started to establish the pattern of change in southern Australia. A theme in these papers is the complexity of environmental change as reflected by changes in the biota. These have responded to a complex of change including autogenic change, plant invasion and extinction, climatic change and extreme events, fire and anthropogenic change, confounding early attempts to fit everything to a climate scheme.

Geoff produced the first pollen diagrams in Victoria and Tasmania in 1970 and was the first to point out the widespread nature of the Pleistocene grass-composite steppe at 22-14,000 yr BP and to record how extensive the now possibly extinct Tubulifloridites pleistocenicus was on the Bassian plain. Other papers reflect extensive fieldwork in South Sulawesi, Maluku and Irian Jaya provinces, Indonesia, in Papua New Guinea and southern Vanuatu, Fiji and New Caledonia and the Kakadu area of the Northern Territory, Australia. The very low treelines discovered in the Central Highlands of PNG by Donald Walker and John Flenley have been shown by this work to be a wider phenomenon which cannot be interpreted in terms of mean annual temperatures. The modern treeline has different floristics and structure to that of glacial times. This implied an equivalent rise in vegetation boundaries of about 1000m, which is comparable with the snowline rise of 1200m established from moraines. The thermal change of at least 6°C remains an anomaly given change estimated at less than 2°C by marine core analyses in the New Guinea warm pool to the north. His diagram of community boundary change has been abstracted or extended by several authors (e.g. Flenley 1985, Haberle 1994, Johns 2000), usually without attribution.

Tropical weathering produces closed basins and other karst phenomena in ultramafic rocks and these are filled by swamps that provide very long records due to the poverty of the soils which also cause small disturbances to be ecologically "amplified" in that they may affect vegetation for centuries. Sites in northern Irian Jaya and Sulawesi covering more than 60,000 years show a distinct response to glacial conditions, implying temperature changes of at least 4°C, judged by depression in the lower montane boundary. There is also a pattern of change seen in two Irian Jaya sites where a short term reversion to higher altitude vegetation after the start of the Holocene occurs. In New Caledonia the height of the glacial is marked by increased fire, possibly as a response to periods of drought, and this led to erosion. Curiously Holocene deposits have been hard to locate, raising the hypothesis that greatly increased cyclone activity may be cleaning out the basins.

Several reviews are included that provide explanations for the modern biogeographic patterns found in the Indo-Pacific area based on the vegetational responses to climate change and anthropogenic impact within the Quaternary. The environmental response in the tropics and southeastern Australia has been more extreme than was generally believed. There is a contrast between the over-stressed biogeographic area of Bassiana (where extinction results) with less -stressed areas in which climatic fluctuation has been a force for speciation. In finer scale, the homogeneity of alpine communities by contrast to the individualistic upper montane communities may be a similar differential response. In the case of subalpine vegetation in New Guinea, It is likely that the more individualistic communities were those which have formed (or reformed) in the

Holocene, as they seem to have had no floristic-structural analogues in the late Pleistocene.

Palaeoecology must consider possible direct and indirect impacts of people as a cause of vegetation change, in addition to other autogenic and allogenic causes. Palaeoenvironmental studies can also establish the conditions and probable resources available to prehistoric communities. In Australia cave and shelter sites show that many sites cease to be utilised as climates become warmer and wetter in the Holocene. The study of swamp or lake sequences near archaeological sites provides an independent but parallel record that in some cases provides evidence of human arrival earlier than that shown from the sequence. For example at Kosipe, Papua New Guinea, archaeology has established settlement at 26,000 yr BP while fire and grassland expansion commence about 30,000 years ago. The environment at this time was near treeline, but suitable for nut trees that may have been a motive for settlement.

The timing and rate of conversion of natural environments into human landscapes is a facet of archaeology. In the humid tropics, many swamps are initiated on formerly forested terrain by the change in water relations. In these cases the base of the deposits provides a minimum date for the clearance, and these sites usually have considerable depths of slope derived sediments, representing major deposition following initial clearance. The study of long sequences that extend back beyond any human disturbances shows that some environments are naturally unstable, for example the maquis areas of southern New Caledonia. Here major erosional events occur around 20,000 years ago, probably caused by drought and natural fires. These events are of similar magnitude to pre-European anthropogenic forest clearance and erosion that starts about 3000 years ago.

A major interest has been the question of natural versus anthropogenic fire in influencing vegetational structure. This question is central to deciding whether the present interglacial and its immediately preceding glaciation are different to previous cycles due to the specific palaeo-climates or were the anthropogenic influences critical. There is a spectrum of opinion on this question amongst ecologists, and the jury is still out. However pollen and microscopic charcoal records generally show that, as expected, fire has been important in pre-human ecosystems and that some "modern" vegetation does seem to have analogues in the past. However in some environments human use of fire does modify vegetation, and certainly the relative areas occupied by various types. Discontinuously occupied islands are important as they can be contrasted to mainland sites. In southern Australia in areas prone to drought, the natural fire regime appears to be much more episodic but more damaging than the continuous fire seen under Aboriginal occupation. The periods between fire encourage increased woody vegetation by comparison with the more continuous fire.

Late Quaternary Environments of the Humid Tropics of Northeastern Australia

by Patrick Moss (PhD)
Department of Geography and Environmental Science
Monash University

A high resolution environmental record, covering the last 250,000 years, has been constructed for the humid tropics of northeastern Australia from pollen and charcoal analysis of ODP site 820 situated on the continental slope, about 40 km off the northeastern Queensland coast. This record is compared with a terrestrial record from Lynch's Crater, an adjacent site in the Atherton Tableland. In addition, processes of pollen transport and deposition to ODP site 820 have been investigated from surface samples collected from the Russell/Mulgrave and Barron Rivers and two mid-shelf marine cores, KG 951 V.C. 1 and V.C. 2, to assist in the interpretation of the long marine record.

Both the ODP 820 and Lynch's Crater records reveal clear cyclical vegetation patterns for the region over the last 215,000 to 250,000 years. Complex rainforest communities have expanded during interglacial and interstadial periods (oxygen isotope stages 7, 5, 3 and 1) and contracted during glacial and stadial periods (oxygen isotope stages 8, 6, 4 and 2). In addition, there have been expansions in araucarian-rich drier rainforest and/or sclerophyll communities during the glacial periods. Spectral analysis conducted on both records suggests that orbital forcing, particularly eccentricity and obliquity, play a major role in controlling the abundances of these various community types at both locations.

Superimposed on these cyclical alterations in vegetation are a number of abrupt changes in vegetation and burning observed in both the ODP 820 and Lynch's

Crater records. The ODP 820 record displays three abrupt alterations in vegetation around 170,000 years BP (increase in Poaceae, decline in palms and ferns), 137,000 to 130,000 years BP (decline in Araucariaceae and increase in Myrtaceae) and 37,000 years BP (a further decline in Araucariaceae and increase in sclerophyll taxa), with only the 173,000 years BP alteration not having an associated charcoal peak. In contrast, the Lynch's Crater record reveals one abrupt alteration in vegetation (decline in Araucariaceae, increase in Myrtaceae), and an increase in burning at 38,000 years BP.

It is suggested that the earlier alterations in the ODP 820 record, at 173,000 and 137,000 to 130,000 years BP, may be related to the onset of El Nino/Southern Oscillation (ENSO) variability linked with a 30,000 year secondary Milankovitch cycle. The later alterations in the ODP 820 core (37,000 years BP) and the Lynch's Crater core (38,000 years BP) are thought to predominantly reflect, the impacts of people on the humid tropics region of northeastern Australia. Furthermore, it is suggested that both people and climate (through ENSO variability) have continued to exert an influence on the region's environment through to the present day.

In addition, a detailed record of coastal environmental change has been obtained for the region based on the ODP 820 mangrove pollen record. It is suggested that optimum mangrove growth in the region has occurred during transgressive periods, with mangrove communities being virtually absent during regressive events. This pattern would appear to reflect alterations in sea level, sedimentation rates and precipitation, with optimum mangrove growth coinciding with increases in sea level, high sedimentation rates and relatively wet climates. In contrast, the decreases in sea level, low sedimentation rates and dry climates that mark regressive events do not appear to promote mangrove growth.
A picture of pollen representation, transport and deposition for the humid tropics of northeastern Australia has emerged. It is suggested that there is no separation of pollen taxa into distinct sand or silt-sized floras as a result of fluvial transport activities. However, it is thought that carbonate sediments over-represent grass and Cyperaceae values (as observed in the two mid-shelf cores), while mixed terrigenous/carbonate sediments (as seen the ODP 820 record) are reasonably representative of the nearby terrestrial vegetation communities.

Quaternary Stratigraphy and Evolution of Aeolianite on Lord Howe Island

by Brendan Brook (PhD)
School of Geosciences
Wollongong University

Lord Howe Island is a remote subtropical island in the Tasman Sea, situated 700 km east-northeast of Sydney. It is composed of Miocene basalt and outcrops of aeolianite, a bioclastic limestone deposited as dune units with subordinate beach, palaeosols and reefal units. This thesis investigates the chronostratigraphy of the aeolianite, identifying a far longer Quaternary record of dune emplacement on the island than has been reported in previous studies. This study also reveals that the major periods of dune emplacement on the island are linked to glacio-eustatically controlled sea-level highstands. Past studies of the island have concluded that the dunes which comprise the aeolianite formed during periods of low sea level around the time of the Last Glacial Maximum, when the broad shelf surrounding the island was exposed.

The aeolianite comprises two lithostratigraphic formations, the Searles Point Formation and the Neds Beach Formation. This classification revises the previous proposed lithostratigraphy of the aeolianite which recognised only a single formation. The diagenetically-mature lower unite, the Searles Point formation, consists of well-cemented dune units comprising red algal, molluscan, micritic and recrystallised grains with minor proportions of foraminiferal and volcanic grains. Major units within the formation are capped by well-developed, clay -rich palaeosols. The upper formation, the Neds beach Formation, comprises mostly very pale-brown, lightly- to moderately-cemented dune and beach units which exhibit only minor diagenetic alteration. Most units of this formation exhibit a mix of skeletal grains similar to that observed in the Searles Point Formation. The Neds Beach Formation includes several outcrops of beach deposits that record open coastal environments. The beach units are considerably more extensive than has previously been recognised. This study shows that the major aeolianite ridge on the island is predominantly composed of dun units of the Neds Beach Formation. Both the bedding structures within and the shore aligned orientation of the ride suggests much of the deposit was emplaced as a source-bordering transverse dune.

The Neds Beach Formation includes two members, the Middle Beach and Cobbys Corner Members. The Middle Beach Member is characterised by white dune units with a major proportion of miliolid foraminiferal grains and rare volcanic grains. This is distinct from the Cobbys corner Member which comprises dune units with major proportion of volcanic grains and brown micritic cement. The two members represent distinctly different shoreline environments on the east and west coasts that appear to have exited during the Last Interglacial.

Geochronological determinations using the uranium-series (U/Th), radiocarbon (AMS 14C), thermoluminescence (TL) and amino acid racemisation (AAR, mollusc and "whole-rock") techniques provide reliable chronologies for the lithostratigraphic units and help correlate disjunct outcrops. Speleothems from the Searles Point formation range in age from approximately >35 ka to 95 ka and dune and palaeosol units range from approximately 274 ka to 201 ka. Speleothems, corals, aeolianite and fossil land snails from the Neds beach Formation range in age from ~ 125 ka to >40 ka.

Allostratigraphic mapping of the aeolianite indicates up to nine major phases of dune building in contrast to previous studies which recognised two phases. During each phase the emplacement of dunes was followed by a relatively long period of pedogenesis. These cycles of sedimentation have occurred since the Middle Pleistocene or possibly earlier. The Middle Beach Alloformation outcrops at all the main sites except North Bay and represents the final phase of Pleistocene dune sedimentation on the island, probably occurring at the end of oxygen isotope stage 5.

As on the islands of Bermuda and the Bahamas, most dune units on Lord Howe Island appear to have been emplaced during periods of high sea level in the Middle and Late Pleistocene. Dune emplacement occurs predominantly after the sea has flooded the platforms surrounding the islands during interglacials. Thus, carbonate sedimentation is linked to global eustatic changes in sea-level. In contrast to Bermuda and the Bahamas, during the last Glacial cycle on Lord Howe Island, aeolianite appears to have been more a product of sea-level highstands during oxygen isotope susbstages 5c and 5a rather than substage 5e, when sea level was approximately 20 m below present. During these periods, the island was surrounded by a shallow sea, 10-30 m deep, that formed a highly productive Heterozoan subtropical to temperate carbonate province.

The stratigraphic and geochronological findings presented in this thesis show Lord Howe Island possesses a long record of Quaternary coastal environments. This mid-ocean record provides important new palaeoenvironmental information of the southwest Pacific.

Other Recent Publications

Higham, T.F.G.; Anderson, A.J.; Jacomb, C. 1999. Dating the first New Zealanders: the chronology of Wairau Bar. *Antiquity* 73, 420-427.

Lowe, D.J.; de Lange, W.P. 2000. Volcano-meteorological tsunamis, the *c.* AD 200 Taupo eruption (New Zealand) and the possibility of a global tsunami. *The Holocene* 10, 401-407.

Petchey, F.J. 1999. New Zealand bone dating revisited: a radiocarbon discard protocol for bone. *New Zealand Journal of Archaeology* 19, 81-124.

Petchey, F.J.; Higham, T.F.G. 2000. Bone diagenesis and radiocarbon dating of fish bones at the Shag River Mouth site, New Zealand. *Journal of Archaeological Science* 27, 135-150.

Shane, P.A.R. 2000. Tephrochronology: a New Zealand case study. *Earth-Science Reviews* 49, 223-259.

Two new AMS radiocarbon dates from Lake Frome, arid South Australia

by John Luly[1] and Geraldine Jacobson[2]

[1]School of Tropical Environment Studies and Geography
James Cook University
Townsville, QLD 4811, Australia
email: Jonathan.Luly@jcu.edu.au
Fax: 07 47814020

[2]Physics Division
Australian Nuclear Science and Technology Organisation
PMB 1 Menai
NSW 2234, Australia

Abstract

Two AMS radiocarbon dates from Lake Frome provide a test of the previously published conventional chronology of deposition at the site. Both AMS dates conform closely to the conventional ^{14}C age depth curve published by Bowler *et al.* , (1991) and support their reconstructions of the timing and rates of environmental change at Lake Frome. *Callitris* woodlands dominate latest Pleistocene vegetation, with probable tree densities comparable to those found in the southern Flinders Ranges today. *Callitris* declines after 13,000 BP, possibly in response to a more active fire regime.

Introduction

Jim Bowler's account of the life and times of the SLEADS project at the Long Quaternary Records workshop, held in Canberra this year, was something of a *tour de force*, reflecting with humour and perspicacity on an impressively ambitious undertaking. As a marginal SLEADian, I had the privilege of watching central figures in the SLEADS community become wizened before their time in the attempt to wrest an appreciation of the palaeoenvironmental history of arid Australia from dust, mud, flies and copious quantities of dubiously vintaged red wine.

Dating of salt lake sediments was a particular concern in an era where chronological exotica such as TL, OSL and the rest of the alphabet soup had yet to make an appearance. The low rates of sediment accumulation and minuscule carbon content of salt lake sediments provided limitless scope for chronological embarrassment due to sample contamination, mammoth error terms attached to radiocarbon ages and the exaggerated effects of small (or even large) scale vertical mobility of potentially datable carbon fractions through the sediment column (Longmore *et al.*, 1986).

Early attempts to date salt lake materials employed enormous volumes of saline mud, which were reduced to a manageable size by immersion in industrial quantities of hydrofluoric acid, before dating whatever was left by conventional means (c.f. Draper and Jensen, 1976; Bowler *et al.*, 1991; Luly *et al.*, 1986). Understandably, this type of pre-treatment has limited appeal, quite apart from the dubious reliability of conventional dates produced using fractional gram-sized samples of datable material. The advent of AMS dating, which offers the opportunity to date selected targets such as pollen grains and dispersed carbonised particles, was greeted with enthusiasm and provides a key element in the chronological framework for sedimentation within the main basin of Lake Eyre (Gillespie *et al.*, 1991).

This paper reports results of two AMS radiocarbon dates obtained from Lake Frome as a test of the conventional radiocarbon dates used in reconstructions of vegetation (Singh, 1981; Singh and Luly, 1991) and palaeohydrological histories (Bowler *et al.*, 1991; Ullman and McLeod, 1986; Ullman and Collerson, 1994) from the lake. We consider some possible implications for the nature of Late Pleistocene vegetation in the Lake Frome district and make a delicately phrased defence of the utility of salt lakes as sources of palynological information.

AMS sample collection and preparation

Samples to be dated were cut from one of three duplicate cores (LF 82 / 1 - 3) collected from the focal site of work reported by Bowler *et al.* (1991) and Singh and Luly (1991), which are held in the SLEADS core library at the Australian National University. The core site lies mid way up the western flank of the lake, approximately 6 km from the shoreline (fig. 1).

Sample OZD - 055 comprises grey gypseous clay from a depth of 35-38 cm in core LF 82/2. This material is interpreted by Bowler *et al.*, (1991) as being indicative of a brief late to mid Holocene phase of ephemeral saline lake deposition and is sandwiched between reddish sandy clays representing

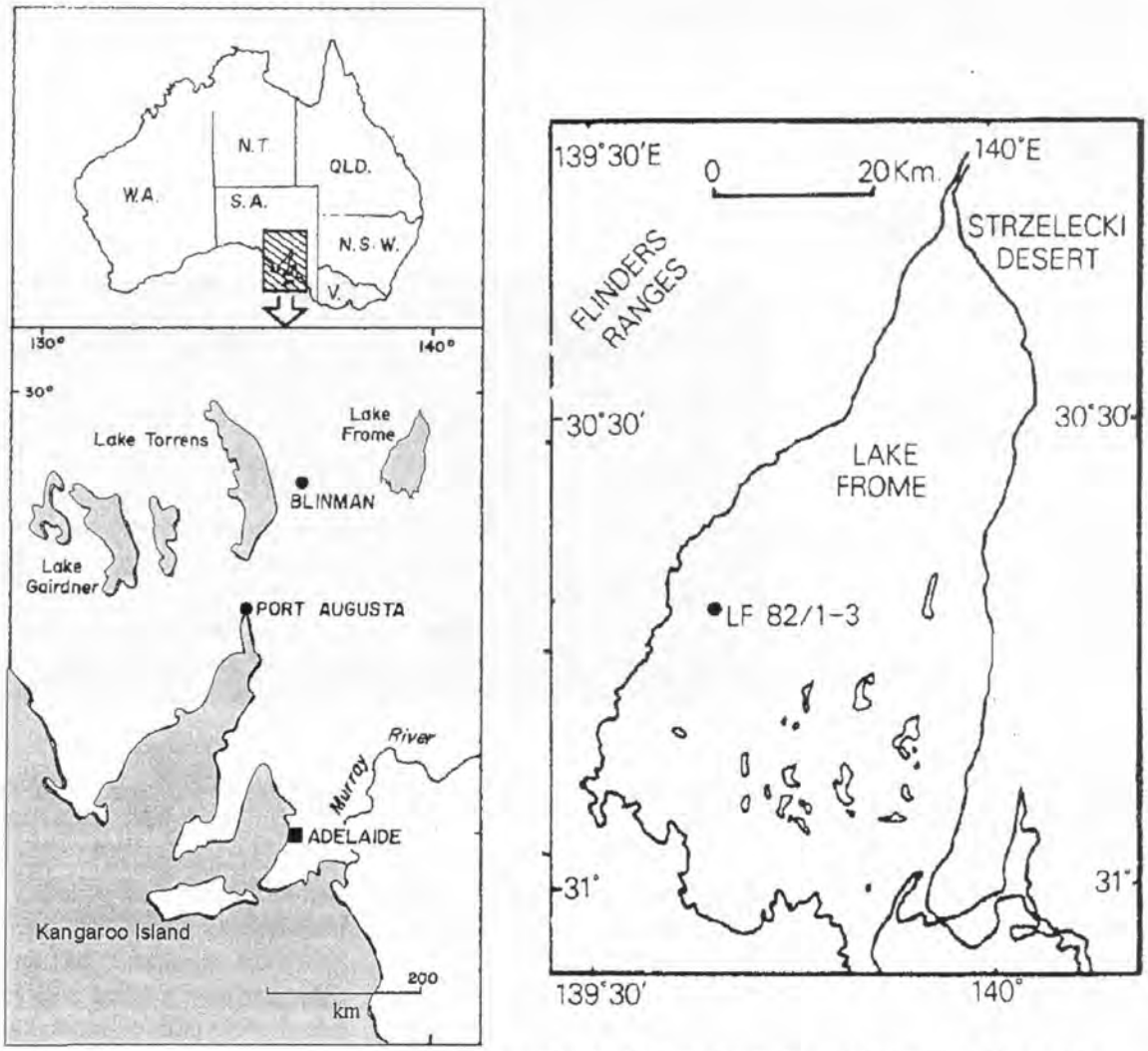


Figure 1: Map showing position of Lake From in mid-north of arid South Australia. Note location of core site LF82/1-3 mid way up the western flank of the lake.

deposition under playa conditions (fig. 2).

Sample OZD - 056 is from 272-275 cm in the same core. It was selected to constrain the age of an increase in the prominence of *Callitris* in pollen spectra at Lake Frome. Bowler *et al.*, (1991) consider sediments at this level in LF 82/2 to be material re-worked from aeolian islands and lunettes by shallow saline waters returning to the lake basin after dry times at and about the Last Glacial Maximum. Sediments in this interval are considered by Bowler *et al.*, (1991) to have been deposited very rapidly in comparison to those laid down under playa conditions at higher levels in the core.

AMS dating was carried out on pollen and dispersed carbonised particles extracted from the samples at ANSTO following their standard protocols for this task. A solution of Na4P2O7 / NaOH was used to disaggregate samples and to remove whatever humic fraction was present. The residue was then sieved, retaining the fraction between 5 μm and 150 μm, which was then washed twice in HCl. Silicates were removed with fifty percent HF and further oxidation carried out in two percent NaOCl. Residues were then washed, dried, burned at 900° C over CuO and Ag wire, converted to graphite using an iron catalyst in the presence of zinc, and sent off to the accelerator for a date with destiny.

Results and discussion

AMS dates from core LE 82/2 are remarkably consistent with the ages presented in Bowler *et al.*, (1991). At 4410 ± 60 BP, OZD - 055 falls almost exactly on Bowler's notional line linking conventional dates based on dispersed organic matter from the site. OZD - 056 (14,850 ± 100 BP) lies close to the curve, and as noted by Bowler *et al.*, (1991), is comparable to the conventional dates reported by Draper and Jensen (1976) for similar materials in other parts of the lake. On the basis of this similarity, it seems clear that our AMS dates support the original interpretation of the chronology of sedimentation at Lake Frome. In particular, the observation that a shallow water body and high sedimentation

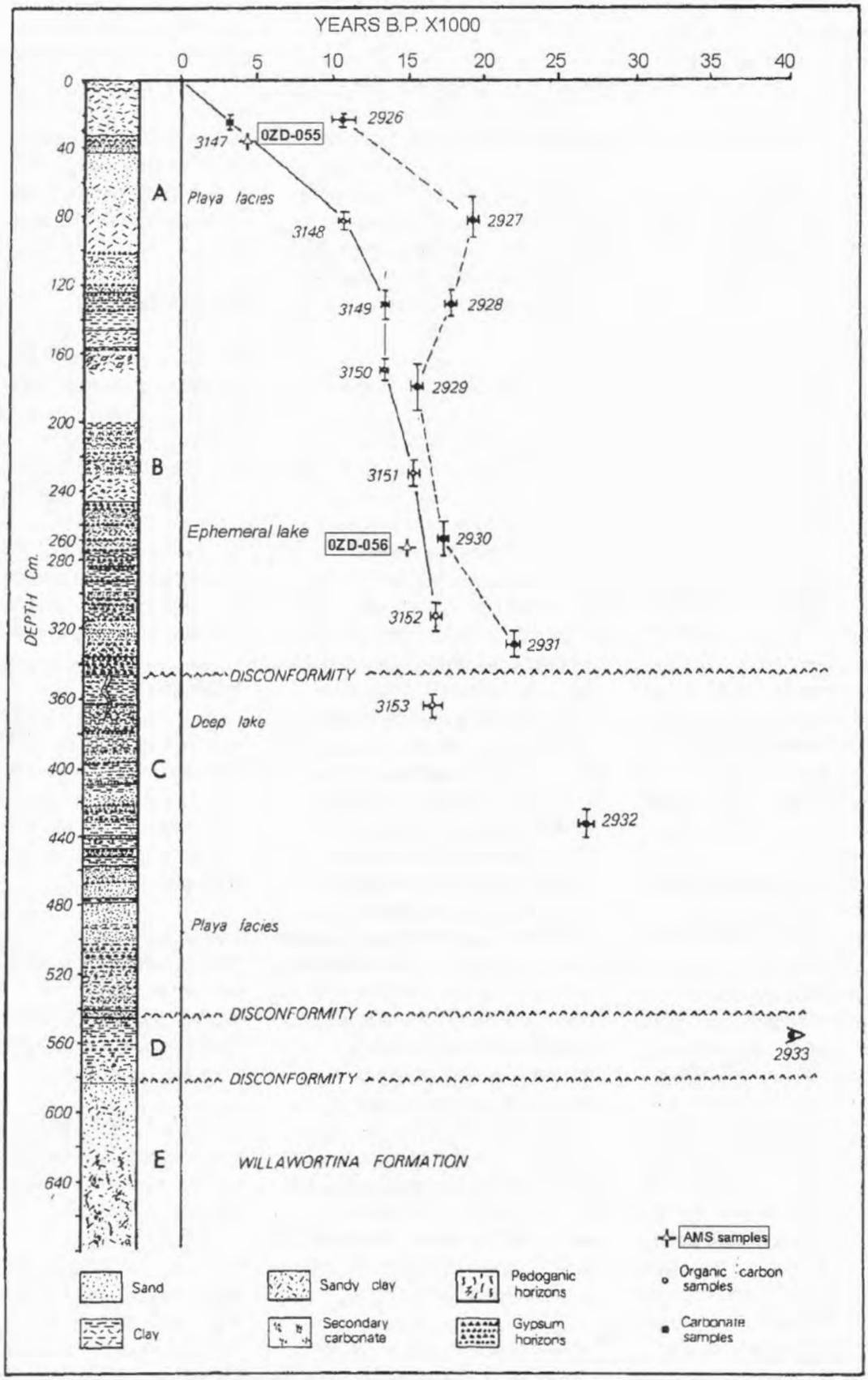


Figure 2: Age-depth curve from core LE82/2 showing original dates reported by Bowler et al. (1991) and AMS dates OZD-055 and OZD-056. Modified from Bowler et al. (1991).

rates characterise the interval immediately following Last Glacial Maximum aridity and deflation, seems apposite.

Based on the combined AMS and conventional chronologies, the rise in *Callitris* pollen percentages noted by Singh and Luly (1991) at 340 cm depth in LF 82/2 dates to approximately 16,000 BP. Comparisons between percentage values in the core and those of modern plant communities featuring a significant *Callitris* component (Dodson, 1982; Luly, 1991; Newsome, 1999) suggest presence of a moderately dense woodland at this time – perhaps comparable to that of the southern Flinders Ranges or Wilpena Pound, though without the subsidiary eucalypts and other assorted woody elements. Unfortunately Singh (1981) did not recognise *Callitris* pollen in his study of modern pollen rain from the region but the minimal representation of *Callitris* in sediments from the top of LF 82/2 (fig. 3) indicates that the few *Callitris* trees still surviving on islands towards the southern end of the lake make a negligible contribution to modern pollen spectra.

The prominence of *Callitris* trees in the latest Pleistocene landscape at Lake Frome is emphasised by concentrations of *Callitris* pollen, which rise to remarkable levels (fig. 3), despite the high sedimentation rates characteristic of this interval in the core. Given the notable drought tolerance of *Callitris* in the modern environment (Bowman and Harris, 1995) and the relative lack of charcoal in pollen samples (fig. 4), this is readily understood as the first phase of trees returning to a previously treeless Last Glacial Maximum landscape under a benign fire regime. While it is tempting to attribute expansion of *Callitris* soon after the Last Glacial Maximum to rising levels of moisture availability, the recognition that L.G.M. temperatures were also deeply depressed (Miller *et al.*, 1997) adds a level of complexity to interpretations of arid zone palaeoecology which have yet to be considered fully.

The decline of *Callitris* after about 13,000 BP coincides with an overall increase in occurrence of carbonised particles in pollen samples (fig. 4) and, in the absence of sedimentary or other indications of a climatic explanation, is probably best attributed to an inability of *Callitris* trees to cope with a more active fire regime around the lake (Luly, in press).

Whilst Gell and Bickford (1996) and McCarthy *et al.* (1996) point to differences between records of vegetational change obtained from stick-nest rat (*Leporillus* spp.) middens, and those presented from Lake Frome, it is important to recognise essential differences between the sites and the records they contain. Large playa lakes integrate the airborne pollen flux generated at regional to long distance scales. They reflect vegetation at the broadest of scales and only the most ambitious consumers of palynological information would expect nuances of local detail to be accurately recorded in their sediments. Stick-nest rat middens, on the other hand, provide a splendid record of local vegetation change through macrofloral and faunal constituents. They may also offer a more expansive record from contained pollen but there is a distinct possibility that pollen assemblages from stick-nest rat middens reflect rat activity and preferences as much as they do airborne pollen flux. The scarcity of *Callitris* in pollen spectra from recent stick-nest rat middens at sites where *Callitris* is part of the modern flora (McCarthy *et al.*, 1996) is a case in point and emphasises the need to treat the midden records with the same caution as is necessary with the tale presented here.

Pollen records from Lake Frome point to a degree of volatility unusual in latest Pleistocene vegetation and it would not have been surprising to find that AMS dates pushed the waxing and waning of *Callitris* woodlands considerably further back in time than turns out to be the case. The recent dynamism of arid vegetation hinted at by pollen from Lake Frome may turn out to be a chimera once there is a decent body data available from arid Australia. Sadly, unless the worst ravages of myopic economic rationalism and managerialism can be resisted, we are unlikely to find out.

Acknowledgements

I (J. L.) am pleased to be able, at this late date, to acknowledge the support and guidance offered by Jim Bowler during my early frolics in salt lake palynology. As a guilty party in Bowler's lament about delayed publication of SLEADS results, I can only offer the nostrum of "better late than never". AMS dating was funded through AINSE, while learned comment and criticism of the manuscript was provided by John Magee, Scott Smithers and Patrick De Deckker.

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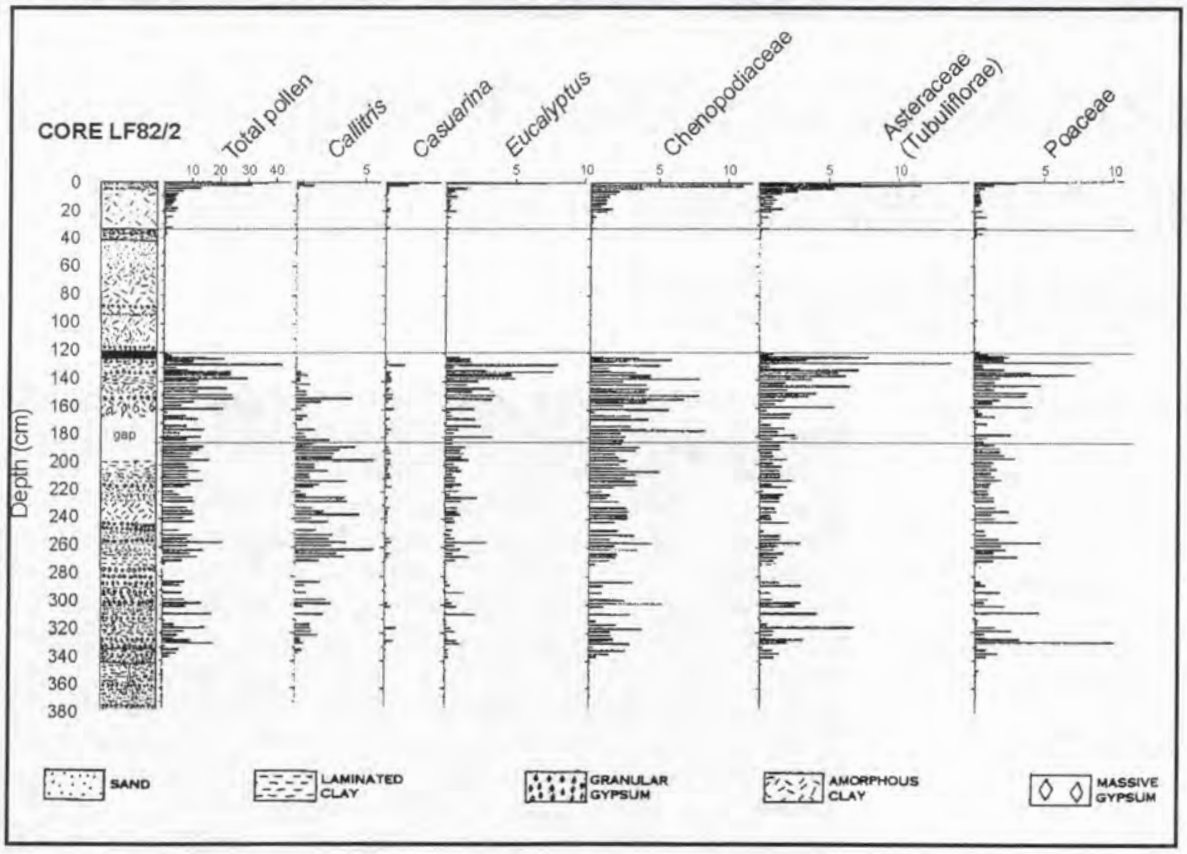

Figure 3: Pollen concentrations (thousands/cm³ from core LF 82/2)

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Palaeoecological transition in southwestern New South Wales: ecosystem changes in pollen assemblages revealed by fuzzy analysis

by Matt Cupper[1] and Bill Ward[2].

[1]School of Earth Sciences,
The University of Melbourne
Victoria 3010
m.cupper@pgrad.unimelb.edu.au

[2]Faculty of Environmental Sciences,
Griffith University, Nathan
Queensland 4111
billward@webtime.com.au

Abstract

Fuzzy analysis, a numerical analytical technique, was used to elucidate vegetation changes expressed in pollen proxy data from Warrananga salt lake, southwestern New South Wales. Significant modifications of the structure and composition of plant communities occurred in this region during the Holocene. These included the development of casuarinaceous woodlands in the mid-Holocene and subsequent woodland-decline with the expansion of chenopod shrublands during the late Holocene. Eucalypts became more prominent and Casuarinaceae recovered prior to the European settlement phase. Significantly, fuzzy analysis also revealed phases of grassy open-woodlands between the woodland-shrubland transitions, suggesting a complex sequence of ecological succession. This study highlights the considerable potential of fuzzy analysis in interpreting fossil assemblages.

Introduction

Counts of fossil pollen in sediment sequences usually generate large multivariate data sets and are often difficult to interpret objectively. Numerical analysis is often enlisted. Many palynologists, for instance, use techniques such as CONstrained Incremental Sum-of-Squares [CONISS] (Grimm, 1987, 1988), Non-metric Multi-Dimensional Scaling [NMDS] (Kruskal, 1964), and Detrended Correspondence Analysis [DCA] (Hill, 1979). Principal Component Analysis [PCA] (Pearson, 1901) is also common. Analyses usually represent the relationships of the pollen assemblages at each sampled depth as cluster dendrograms, or as spatial ordination diagrams. These techniques are merely tools to simplify large data sets. They facilitate interpretation of the data, but do not offer solutions.

The different numerical procedures elucidate particular aspects of a multivariate data set. CONISS, for example, constrains the sample depths stratigraphically, to facilitate the selection of phases of change through a sequence (e.g. Horrocks and Ogden, 2000). Spatial arrangements of samples, generated by NMDS, PCA or DCA ordinations, can be useful for comparing samples within sequences, or from different sites, and help identify patterns, or trends (e.g. Waller, 1988; Dodson and Wright, 1989; Rull, 1999). Moreover, they can match fossil pollen assemblages with modern analogues (e.g. Caseldine and Pardoe, 1994; Gaillard *et al.*, 1994). An iterative partitioning method of cluster analysis, namely fuzzy analysis (Bezdek, 1981; Alt, 1990), is able to group similar entities in multivariate data sets. It can also identify situations where the groups replace one another in either space or time, or both. For these reasons, it is worth applying fuzzy techniques to pollen data, because pollen counts, which record changes in frequency of plant species over time, can be regarded as parameters of distinct plant communities. To test the method, we applied fuzzy analysis to a pollen assemblage from Warrananga salt lake in southwestern New South Wales.

Warrananga salt lake is about 20 km east of Lake Victoria, near the Murray and Darling Rivers (Figure 1), a semiarid region with a mean annual rainfall of 265 mm (Bureau of Meteorology, 2000). Bluebush and saltbush (*Maireana* and *Atriplex* spp.) shrublands dominate the surrounding landscape, with belah-rosewood (*Casuarina pauper-Alectryon oleifolius*) low open-woodlands and mallee (*Eucalyptus* spp.) tall shrublands on nearby linear dunes. Lithostratigraphic correlation of a 139 cm core taken from the lake with a dated core indicates the sequence probably represents the full Holocene (Cupper, 1998).

Methods

Field and laboratory analyses

The first author (M.C.) extracted pollen from the Warrananga core using heavy liquid separation (Hart, 1988). At least two hundred pollen grains (on average, 238 pollen grains) were counted for each 1 cm wide sample, at 3 cm intervals.

Numerical analyses

Counts for each pollen taxon were converted to percentages of the total

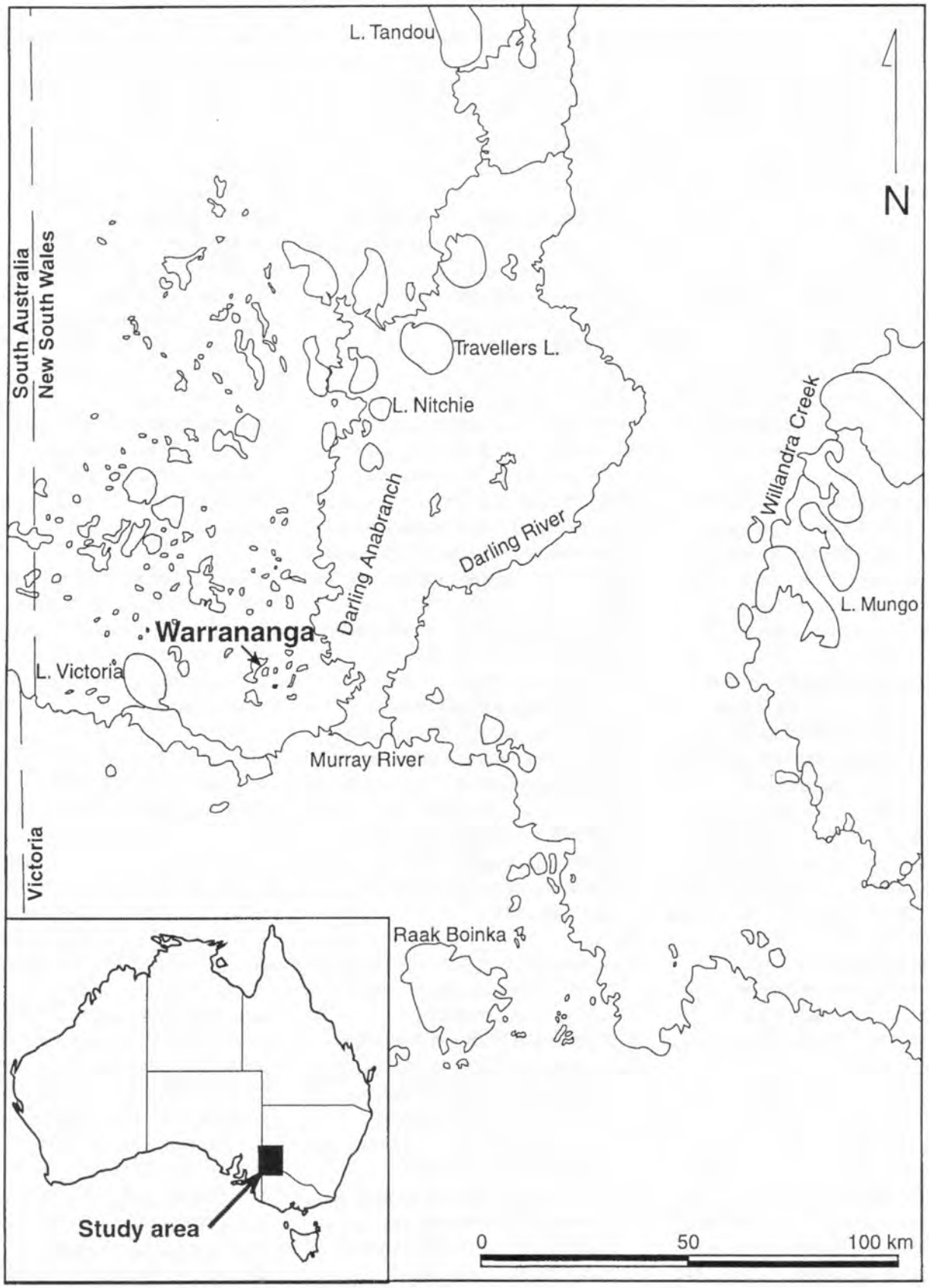

Figure 1. Map of southwestern New South Wales and northwestern Victoria showing the location of Warranaga salt lake. (Adapted Brown and Stephenson 1991).

sum of identified pollen grains. Pollen percentages for individual taxa were accepted as attributes that describe real plant communities. Fuzzy analysis was used to discover what plant communities might exist in the entire data set.

The numerical program for fuzzy analysis (Ward *et al.*, 1992) takes all samples and assigns them randomly to groups. The groups are then progressively refined, by altering the sample membership values until the differences between the groups are maximised. Standardised Euclidean distances are used to measure dissimilarity. Major groups are separated satisfactorily when the same optimal result is given by repeated analysis. Objective function values are calculated for each analysis and the smallest objective function value indicates the optimal solution.

In fuzzy analysis the objects being placed in groups are regarded as having a potential membership, to a greater or lesser degree, in every group that is formed. The extent of membership in a group can range from zero to one. A zero membership shows that the object is not a member of a group, whereas a membership score of one indicates membership in one group only. Shared group memberships (or transitions between groups) are indicated by intermediate values. The scores for group membership and the averages for each group are outcomes of the analysis.

The overall averages for the measured attributes describe the final groups. These are weighted averages and are termed centroids, the means being weighted by the group membership scores. They describe the general features of the groups. As at least two groups are given by a fuzzy analysis, it can be that the groupings are forced on a uniform population. Outcomes have to be examined, therefore, to check whether no subdivision might be the best solution. The results of a series of fuzzy analyses that examine an increasing number of groups can help with this problem. Expert judgment and perhaps other data may also be required.

Results

The Warrananga data set consisted of forty-six sample depths each with thirty-four variables (taxa). Pollen percentages of the main taxa are summarised in an area graph (Figure 2a). We decided to treat the thirty-four taxa as being equally significant in defining a group, standardising their ranges on a scale of zero to one. Different settings of the fuzzy parameter were explored, as recommended by Ward *et al.* (1992). The value of 1.10 was selected as being appropriate for the data set, as settings of 1.00 did not yield a fuzzy result and settings greater than 1.20 had outcomes that failed to separate groups. Three optimal groups were regularly identified (objective function value of 1258.42). The numerical analyses were repeated several times to check this result and in the re-runs it became clear that one of these three groups was composed of two smaller groups close by one another in multivariate space. The four groups that appeared in these re-runs gave an improved objective function value (1182.18).

The three-group analyses identified thirteen taxa as major components: *Leptospermum*, *Eucalyptus*, Casuarinaceae (<28 m diameter), Casuarinaceae (>28 m diameter), *Callitris*, Myoporaceae, Sapindaceae, Chenopodiaceae, Pittosporaceae, Asteraceae (Liguliflorae), Fabaceae, Poaceae and Cyperaceae. An examination of a subset of the data that consisted only of these thirteen variables gave substantially the same result as before. It was evident, however, that the less abundant taxa were contributing to the group definitions and for this reason subsequent analyses were based on the full data set.

The four-group membership scores for each sampled depth are given in Table 1 and plotted against depth in Figure 2b. Centroid values are given in Table 2.

Discussion

When analysing the pollen data, we were aware that percentages are interdependent, that is, all taxa are susceptible to changes in the absolute abundance of any one taxon (Yarranton and Ritchie, 1972). However, percentages reflect the relative importance of the pollen taxa (Birks and Gordon, 1985) and are a reliable quantitative measure of vegetation. Prentice (1988) has shown that pollen percentages are subject to less irrelevant variability within and between sampling sites than absolute values.

Our fuzzy analysis detected acceptable groups in the pollen assemblage and helped to identify phases where they replaced one another through time. The four fuzzy groups represent distinct ecological phases.

Groups 4a and 4c are dominated by two types of woodland, distinguished mainly by the Casuarinaceae. Casuarinaceae pollen with a diameter greater than 28 m are dominant in Group 4c, but very much reduced in Group 4a. Larger grain size (>28 m) Casuarinaceae pollen may belong to *Allocasuarina luehmannii*, with pollen less than 28 m in diameter probably derived from *Casuarina pauper*. *Casuarina pauper* is the more xeromorphic of the two, and the only representative of the Casuarinaceae in the modern flora of the region. It survives with less than 150 mm annual rainfall, whereas *A. luehmannii* is common to the 380-630 mm rainfall band (Doran and Hall, 1983, Ladd, 1989). Group 4a also has a low representation of tall shrubs such as *Leptospermum*, *Hakea*, *Exocarpus* and Gyrostemonaceae. These factors, along with the prominence of mallee eucalypts in Group 4a, are indicative of a drier-climate woodland than Group 4c.

Table 1. Membership scores for each sampled depth as reported by fuzzy analysis.

Depth (cm)	Group 4a	Group 4b	Group 4c	Group 4d
0	0.011	0.032	0.003	0.953
3	0.000	0.046	0.000	0.954
6	0.001	0.187	0.000	0.813
9	0.012	0.005	0.000	0.983
12	0.003	0.024	0.000	0.973
15	0.000	0.000	0.000	1.000
18	0.995	0.001	0.000	0.004
21	0.935	0.019	0.021	0.025
24	1.000	0.000	0.000	0.000
27	0.997	0.001	0.000	0.001
30	0.959	0.004	0.000	0.037
33	0.946	0.022	0.009	0.023
36	0.006	0.016	0.002	0.977
39	0.008	0.002	0.000	0.990
42	0.000	0.000	0.000	1.000
45	0.001	0.068	0.000	0.931
48	0.000	0.006	0.000	0.994
51	0.021	0.083	0.003	0.893
54	0.000	0.977	0.000	0.023
57	0.001	0.972	0.000	0.027
60	0.000	0.000	0.000	1.000
63	0.000	0.978	0.000	0.022
66	0.001	0.996	0.000	0.003
69	0.005	0.091	0.064	0.840
72	0.000	0.001	0.000	0.999
75	0.000	0.690	0.000	0.310
78	0.715	0.189	0.013	0.083
81	0.006	0.019	0.968	0.007
84	0.000	0.998	0.000	0.002
87	0.000	1.000	0.000	0.000
90	0.882	0.081	0.010	0.027
93	0.006	0.959	0.033	0.002
96	0.004	0.004	0.987	0.005
99	0.002	0.018	0.977	0.003
102	0.001	0.000	0.998	0.000
105	0.000	0.016	0.978	0.005
108	0.000	1.000	0.000	0.000
111	0.000	0.000	0.000	1.000
114	0.000	0.998	0.000	0.002
117	0.000	0.001	0.000	0.999
120	0.001	0.002	0.000	0.997
123	0.000	0.026	0.000	0.974
126	0.000	0.004	0.000	0.996
129	0.009	0.024	0.003	0.965
132	0.002	0.003	0.000	0.995
135	0.000	0.000	0.000	0.999

Group 4b has a casuarinaceous element, but is distinguished by native pine (*Callitris* spp.) and Poaceae. This suggests an opening-up of the vegetation from woodland to open-woodland. Abundant native pine and grasses indicates relatively moist climatic conditions compared to today, although conditions were possibly drier than at the height of the Group 4c woodland phase.

Group 4d is shrubland and herbfield dominated by members of the Chenopodiaceae and Asteraceae. It predominates in the early part of the record prior to the establishment of woodland and also expands with the decline of tree cover in the late Holocene.

The graphed results in Figure 2b display a sensible sequence. The occurrence of grassy native pine and casuarinaceous open-woodland (Group 4b) both above and below casuarinaceous woodland (Group 4c) suggests ecological

Table 2. Centroid values of the Warrananga pollen taxa for the four groups.
Centroids are averages of the pollen percentage for each taxon that occur within the four groups, weighted by the group membership scores. They describe the general features of the groups.

Pollen taxon	Group 4a	Group 4b	Group 4c	Group 4d
	0.3011	0.9842	1.2280	0.3260
Leptospermum				
Eucalyptus	5.7597	2.0927	3.5560	3.1763
Other Myrtaceae	0.4257	0.0673	0.3337	0.1571
Casuarinaceae (<28 μm)	13.9561	4.1698	4.8903	2.6576
Casuarinaceae (>28 μm)	1.5528	3.3035	9.3057	1.1980
Callitris	2.5213	7.2262	4.0324	2.7177
Pinus	0.0018	0.0070	0.0007	0.1136
Myoporaceae	0.6043	0.3200	0.4523	0.3815
Sapindaceae	9.5198	5.5069	9.9068	2.7051
Acacia	0.0609	0.3376	0.1518	0.0411
Cassia	0.0542	0.0034	0.0006	0.0363
Hakea	0.1051	0.1405	0.2546	0.0027
Other Proteaceae	0.0536	0.1479	0.0028	0.0335
Pittosporaceae	0.5194	0.2435	0.1806	0.1967
Exocarpus	0.0612	0.0029	0.3220	0.0738
Santalum	0.0001	0.0001	0.0846	0.0000
Gyrostemonaceae	0.0020	0.0891	0.2561	0.1275
Chenopodiaceae	34.8550	42.7323	39.0602	51.8637
Rhamnaceae	0.0003	0.0012	0.0001	0.0412
Malvaceae	0.3725	0.0002	0.0000	0.0203
Zygophyllaceae	0.1046	0.0486	0.0022	0.0018
Asteraceae (Tubuliflorae)	19.2272	18.2156	11.8913	26.8024
Asteraceae (Liguliflorae)	0.0533	0.0012	0.1586	0.0004
Fabaceae	0.4126	0.2112	1.0165	0.3642
Epacridaceae	0.0003	0.0008	0.0001	0.0204
Scrophulariaceae	0.1723	0.0848	0.4057	0.2170
Haloragaceae	0.3280	0.0859	0.1726	0.2000
Sterculiaceae	0.1021	0.0074	0.0008	0.0014
Violaceae	0.0002	0.0948	0.0000	0.0375
Plantaginaceae	0.3680	0.0537	0.0008	0.0210
Poaceae	7.3214	11.4372	7.9735	5.0402
Cyperaceae	0.0464	0.8112	1.4274	0.3898
Cyatheaceae	0.0003	0.0041	0.2468	0.0140
Other Pteridophyta	0.1638	0.0817	0.1516	0.0774

succession. Native pine was displaced by Casuarinaceae during the mid-Holocene, when the tree cover thickened. As conditions became drier, the structure of the community opened up, and native pine regained some of its ecological advantage.

Conclusion

Fuzzy analysis assisted in elucidating vegetation changes expressed in the Warrananga core. After the development of woodland in the mid-Holocene, representation of Casuarinaceae declined and chenopod shrubland expanded. Casuarinaceae recovered prior to European settlement, but the woodland composition altered, with mallee eucalypts and less tall shrubs. The analysis also revealed transitional phases of grassy open-woodlands, suggesting ecological succession. This study indicates the considerable potential of fuzzy analysis in interpreting fossil assemblages and we believe that it merits further testing on other pollen data sets.

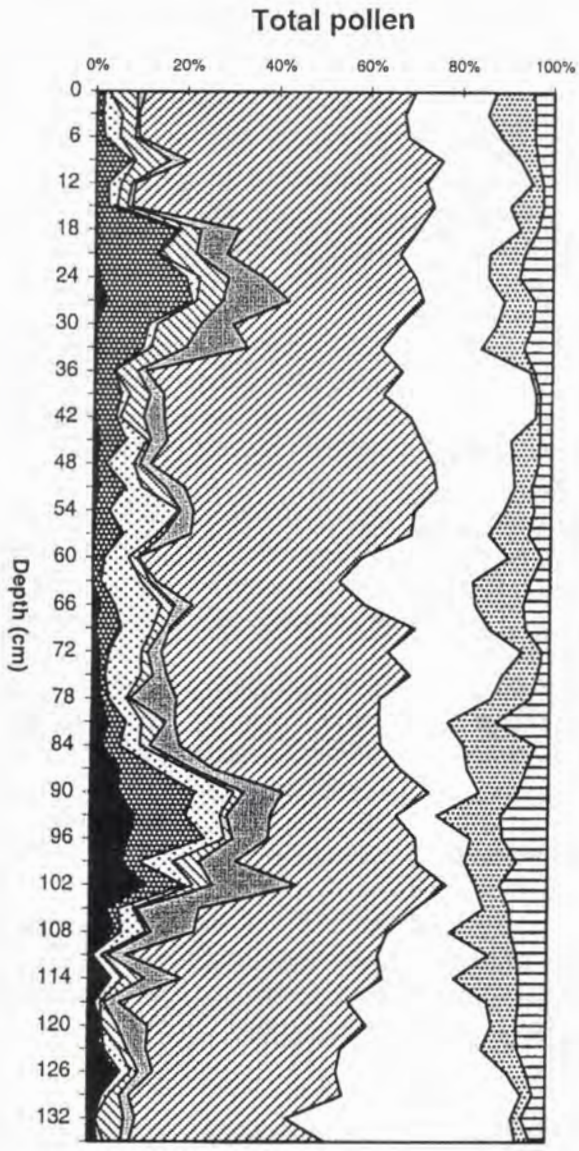

Figure 2a. Pollen counts for the main taxa expressed as percentages of the total pollen sum.

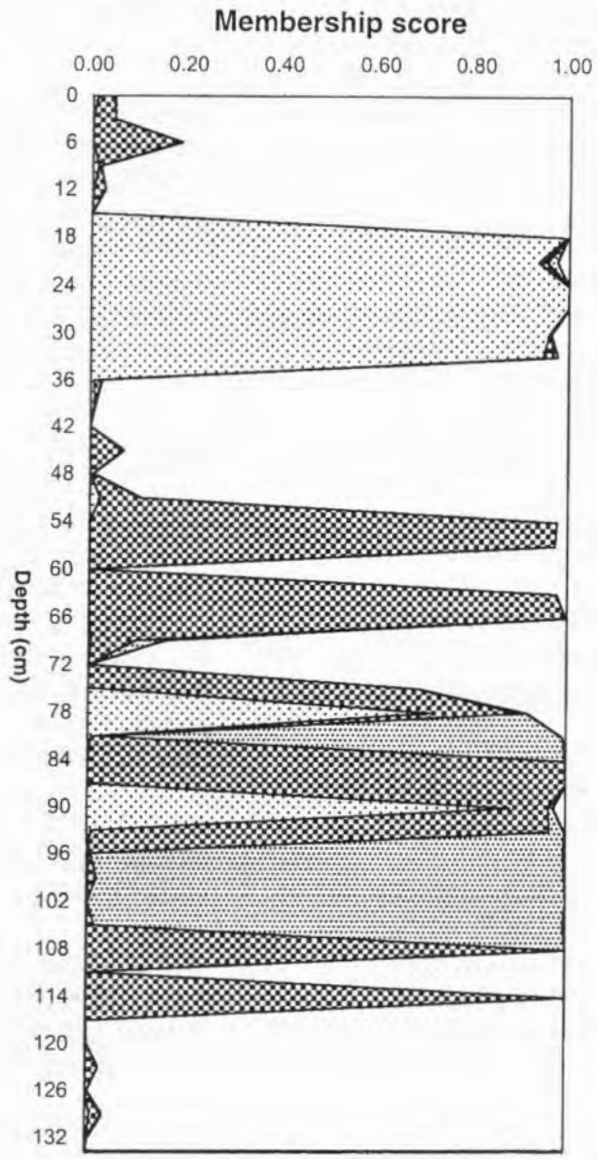

Figure 2b. Graph of membership scores for four groups plotted against depth.

Acknowledgements
Thanks are due to Rod Baird (Tooperoopna Station), Bob Duncan (Dunedin Park Station) and Greg Pollard (Warrananga Station) for providing access to their properties.

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Instructions to authors

This mostly applies to those submitting research papers. However, the formatting information will also be of use to those submitting research/conference reports and other material.

Preparation of the text

a) The manuscript should preferably be prepared using a word processor, with single spacing using either Abadi MT Condensed Light or Ariel font. The document should have at least a 2 cm page margin.
b) Please provide an abstract of no more than 200 words.
c) Please include on the title page the name(s) of the author(s), their affiliations, fax and email numbers. In the case of more than one author, please indicate to whom the correspondence should be addressed.

References

a) References in the text should consist of the surname of the author(s) followed by a comma then the year of the publication in parentheses. eg. (Quaternarist, 2000) (Quaternarist and Palynology, 2000)
b) The reference list should contain all authors of a paper, the year of publication, the title of the article/chapter, the full name of the journal or book (if relevant) italicised, page numbers. See examples below.

Quaternarist, A.B., 2000. The top twenty field sites in Australia. *Journal of Field Studies*, 62 (2), 191-200.

Quaternarist, A.B. and Palynologist, C.D., 2000. The top twenty field sites in Australia. In A.N. Smith (editor). *A Guide to Happy Quaternary Studies*. Fun Book Company, Sydney. 109-146.

Quaternarist, A.B., Palynologist, C.D. and Geomorphologist, E.F., 2000. *A Guide to Happy Quaternary Studies*. Fun Book Company, Sydney. 300 pp.

Tables and figures

a) Tables and figures should be compiled on separate sheets and should be numbered according to their sequence in the text.
b) Both table and figure captions should be supplied on a separate sheet.
c) Figures should be constructed taking into account the possible need for reduction.

Submission of manuscript

a) Authors are requested to provide the names and addresses of two potential referees.
b) All manuscripts should be sent in duplicate to the editor (see below for address)
c) Submission of an article is understood to imply that the article is original and unpublished and is not being considered for publication elsewhere.
d) Final versions of the article should be submitted in electronic format as a word file (PC is preferred). These can either be sent on floppy disk (which will be returned at a later date) or as an attachment using email. In the case of the latter, the file will need to be in PC format as the editor's stupid computer cannot read Macintosh files sent as attachments!
e) Final tables should be sent as separate word files.
f) If possible, final figures should be sent as bmp files scanned at 400 dpi. If you do not have access to a scanner, then please submit good quality versions on paper.
g) Address for submission:

Kate Harle
Environment Division (Bld 34)
ANSTO
PMB 1 Menai
NSW 2234

Email: khz@ansto.gov.au

Quaternary Australasia

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Volume 18 Number 1