Australian Quaternary Newsletter

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NATIONAL COMMITTEE FOR QUATERNARY RESEARCH
AUSTRALIAN ACADEMY OF SCIENCE

Since we last reported its activities, the National Committee has met twice. This account is abstracted from the reports of both these meetings, on 12 March 1976, and 4 March 1977.

At the 1976 meeting, because of the many links with geological programmes, the Chairman of the National Committee for Geological Science (Professor M.F. Glaessner) attended by invitation. It was agreed that direct contacts between the two national committees should be maintained on technical matters of mutual concern.

Reports presented at the 1977 meeting included the following. During the 25th International Geological Congress, which was held in Sydney in August 1976, meetings of participants in the IGCP (International Geological Correlation Programme) projects on Holocene Sea Levels and the Neogene/Quaternary Boundary, and of the INQUA Commissions on Quaternary Stratigraphy and on Shorelines were held. The sessions held under Congress Section 12 on Quaternary Geology were well received by large audiences.

During December 1976 a group of six Quaternary scientists with an interpreter, from Institutes of the Academia Sinica, visited Australia at the invitation of the Australian National University. After spending some days in Canberra they were taken on an extensive field trip to Adelaide and Melbourne, and were able to meet many local Quaternary scientists during their tour.

Since the International Union for Quaternary Research became affiliated with ICSU (International Council of Scientific Unions) in September 1974, and reorganisation of its Commissions and Working Groups has been achieved, Australian Quaternary scientists have taken an increasing part in international activities under INQUA auspices and through inter-union collaboration notably in the International Geological Correlation Programme. The Xth INQUA Congress will be held in Birmingham, UK, in August 1977, and as well as further reviewing its general activities, we are informed of the Executive's desire to strengthen collaborative studies in south east Asia and Australasia. Preliminary talks indicate that a joint lead from Australia and New Zealand would be welcome, and contact with the New Zealand member of the Executive (Professor Jane M. Soons, Canterbury) is being maintained in advance of a formal proposal.

The following is a summary of Australian participation in Commissions of INQUA, as at March 1977:

Commission 1 — *Quaternary Stratigraphy*
Corresponding Member - E.D. Gill

Sub-commission on Neogene-Quaternary Boundary - An Australian working group has been appointed.

Sub-commission on Quaternary Stratigraphy of Africa - Dr M. Williams (Macquarie University), Secretary.

Working Group If - Criteria for subdivision of Quaternary - Corresponding member - Professor C.C. von der Borch.

Commission 2 — *Genesis and Lithology of Quaternary Deposits*
Corresponding Member - Dr J.A. Peterson (Monash)

Commission 3 — *Quaternary Shorelines*

Sub-commission 3e - India and the Pacific - E.D. Gill proposes to step down as President at X INQUA, but to serve another four years term as a member.

Commission 4 — *Loess*
Australian nomination of Dr J.M. Bowler (ANU) to be considered at X INQUA.

Commission 5 — *Tephrochronology*
Corresponding Member - E.B. Joyce (University of Melbourne)

Commission 6 — *Palaeopedology*
13 Australians are corresponding members (Blackburn, Bowler, Crook, Firman, Joyce, Litchfield, Mulcahy, Polach, Turchenek, Van Dijk, P.H. Walker, W.T. Ward, Wetherby).

* Working Group 6a - Nature and Genesis of Palaeosols - Dr G.G. Beckmann to be nominated by D.H. Yaalon at X INQUA to replace himself as chairman.

Working Group 6b - Dating of Palaeosols - President: H. Polach (ANU).

Working Group 6c - Soil Stratigraphy - 14 Australians attended meetings in Christchurch, but none has been nominated as member. President: M.L. Leamy, New Zealand.

Working Group 6d - Applied Palaeopedology - Mr J.B. Firman (SA Department of Mines) has been nominated.

Commission 7 — *Neotectonics*
Corresponding Member - Dr J.M.A. Chappell (ANU)

Commission 8 — *The Holocene*
Australian Member - Professor B. Thom (Duntroon)

Commission 9 — *Quaternary Map of Europe*

Also Sub-commission 10a - Map of North West Africa - Not relevant, except as to principles of cartography and legend.

Commission 11 — *Palaeogeographic Atlas of the Quaternary*
Corresponding Member - Dr C.R. Twidale (University of Adelaide)

Commission 12 — *Palecology of Early Man*
Dr Rhys Jones (ANU) has formed a working group for Australia and New Guinea.

Inter-Congress Committee 13 *Palaeoclimatology*
(Expected to become a full Commission at X INQUA) Professor D. Walker proposes to nominate Dr J.M. Bowler to replace himself

Inter-Congress Committee 14 *Relations between INQUA and other organizations concerned with the environment*
Australian Correspondent - Mr M.A.H. Marsden (University of Melbourne)

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EARLY MAN NEWS

The Commission for the Palecology of Early Man has begun to publish a newsletter called *Early Man News*. The commission was formed at the IX INQUA Congress at Christchurch in 1973: its President is Professor H. de Lumley, France; Vice President, Professor I. Ivanova, U.S.S.R.; and Secretary, Professor H. Müller-Beck, West Germany. The main aim of the commission is a better exchange of information in the field of Palecology of Early Man, combining all aspects of the study of Early Man from archaeology as a technical and cultural field, to sedimentology, palaeontology, etc. as fields reconstructing the environment of Early Man.

The first issue of *Early Man News* consists of a range of regional reports, from Eastern Europe, Central Asia, Northern Asia, Eastern Asia, Southern Africa, and Australia. Most of the reports consist of short notes on research projects or sites, but the Australian one, written by Rhys Jones, Head of the Australian working group, is a review of the present state of the subject in Australia and New Guinea.

Copies of *Early Man* can be obtained from H. Müller-Beck, Institut für Urgeschichte, Schloss, D-7400 Tübingen, West Germany.

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X INQUA CONGRESS, BIRMINGHAM, UK, 1977

The 10th INQUA Congress will be held in Birmingham from 16th to 24th August, 1977. The Chairman of the Organising Committee is Professor F.W. Shotton.

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PROGRESS IN DENDROCHRONOLOGY IN AUSTRALIA: 1974-1977

The Tree-ring Workshop, held in May 1974, was the first time that an effort was made to get together all those interested in dendrochronology in Australia. This meeting was conducted by Wes Ferguson, who was visiting the Department of Biogeography and Geomorphology at ANU. The large attendance indicated that many Australian ecologists, quaternarists, archaeologists and others already had an interest in the subject, and wished to learn more. Published work on dendrochronology in Australia up to that time (and since) had been spasmodic and uncoordinated, and only peripheral to the main thrusts of the subject - chronology-building for dating purposes and climatic reconstruction. Only Don Adamson (Macquarie University) had wood collected (in Tasmania) specifically with these objectives in mind.

I had two field trips to Tasmania in 1974, and visited a number of sites with potential for tree ring studies. On the first of these trips, with Don Adamson and Trevor Bird (Division of Forest Research, CSIRO), we collected trunk segments of Celery-top pine (*Phyllocladus asplenifolius*) from a quartzite ridge called Clear Hill in SW Tasmania. With only a pocket lense we were able to identify narrow rings corresponding to known drought years in a number of trees. Thus the first requirements for a chronology - sensitivity and cross dating - were established.

The discovery that Celery-top pine contained highly sensitive ring sequences was the most significant discovery in Tasmanian dendrochronology up to that time. The species has since been found to cross-date well between sites up to 200 km apart, and perhaps even more significantly, to show some correlations with other species. The Clear Hill record, and another highly correlated but shorter Celery-top record from Holly Range, have been analysed by Val LaMarche at the Tree-ring Laboratory in Tucson, Arizona. The record, beginning in 1554 and ending in 1974, is based on 24 radii from 11 trees and shows not only large year to year variability, but also high amplitude low frequency fluctuations that may reflect secular climatic variability. A preliminary climatic response function, calculated using the multivariate techniques of Fritts *et al.* (1971) indicates a positive growth response to increased early summer precipitation and a negative response to higher than normal summer temperatures. However, one unusual feature of many of the Celery-top cores, a quasi-biennial fluctuation, remains

to be explained. Celery-top pine is found throughout western Tasmania (Fig.1), where precipitation is associated almost exclusively with depressions in the general westerly flow, and where much of the interannual variability in rainfall depends on the location of the subtropical high pressure belt over Australia. In the west it is quite commonly associated with, or found on adjacent sites to, Pencil and King Billy pines (*Athrotaxis cupressoides* and *A. selaginoides*), species which are generally less sensitive but live to greater ages than Celery-top. In eastern Tasmania, where precipitation is much lower and may also be associated with subtropical sources to the north and east, it may act as a key to understanding the ring sequences of *Callitris rhomboidea*. This in turn would help in the interpretation of *Callitris* sequences on the mainland of Australia. The considerable age reached by mature Celery-top, its great sensitivity and wide geographical and ecological distribution make it the central species in Tasmanian dendroclimatology.

In 1974 the Division of Forest Research (CSIRO, Hobart) was interested in using tree-rings to gauge the stress imposed by recent droughts on 'regrowth' eucalypts. Disease problems in eucalypts had not been attributable to individual causes such as root-rotting fungi, insect defoliators or fire. However, it seemed possible that some such causes, operating in concert after a period of environmental stress might have produced the disease effect. Their work in conjunction with LaMarche, has concentrated on the drought sensitive Celery-top, and should produce a chronology from Blue Tier in the north east of the State extending back to the mid-13th century. Advice on sites, and assistance in the field, given by members of this research group to everyone else engaged in Tasmanian dendrochronology has been an important factor in the rapid progress made there.

My main interest in 1974 was in the past histories of forest tree populations - in particular the influence of secular climatic variations on mortality and regeneration at the upper and lower altitudinal limits of the population, hence on altitudinal migration in response to climatic change. For this work I needed species which grew at the altitudinal timberline, were long-lived and could be aged by ring counts. For these reasons I chose the two *Athrotaxis* species, Pencil and King Billy pines. My choice of sites was influenced by the need to develop basic chronologies for the species which could be used in climatic reconstruction. Mount Field was selected as my main study area for Pencil pines, and serious data collection began there in early 1975. Although areas with more extensive Pencil pine populations have since been visited, Mount Field has proved a happy choice; populations at different altitudes on the mountain show cross-dating, and although about 400 cores have since been obtained from Pencil pines in 24 different sites in Tasmania, one of those on Mount Field ('BB') still contains the oldest known living trees of this species (>1000 years). An accurate annual ring chronology beginning in AD 1027 has been developed for Mount Field and shown to cross-date with sites 100 km to the north on the Central Plateau and at Cradle Mountain.

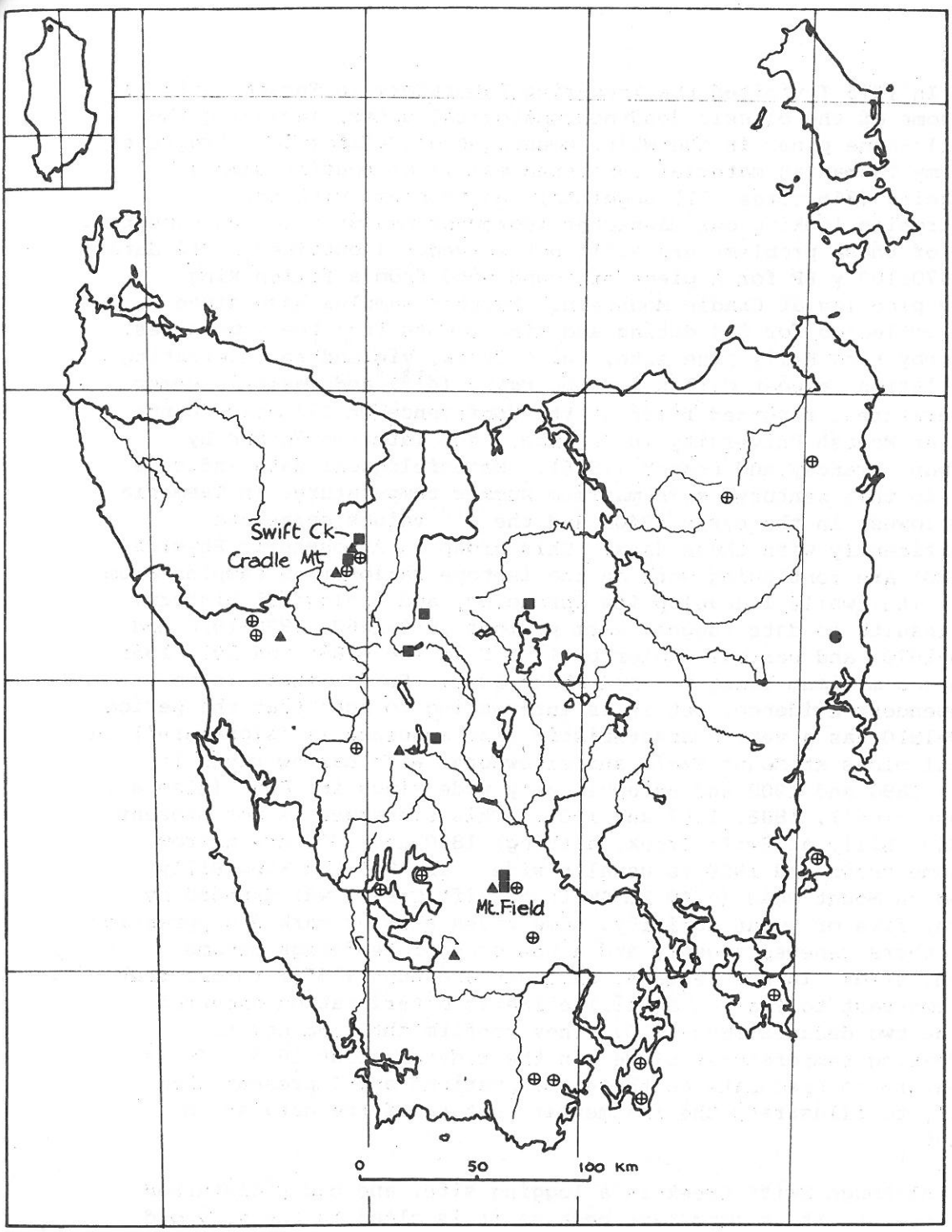

Fig.1

Map of Tasmania showing main dendrochronological sites under investigation by various workers at present.

Solid triangles	:	King Billy pine
Solid squares	:	Pencil pine
Crossed circles	:	Celery-top pine
Solid circles	:	*Callitris*

In 1975 I visited the Tree-ring Laboratory in Tucson, Arizona, and some of the classic dendrochronological sites, including the Bristle-cone pines in the White Mountains of California. Progress with my Tasmanian material consisted mainly of routine sample surfacing (366 cores; 325 segments) and problems with the electronics linking our Bannister increment measurer to the computer. Some of these problems are still not solved. I obtained a C14 date of 1470±100 y BP for a piece of sound wood from a fallen King Billy pine log at Cradle Mountain. Further samples have since been collected for C14 dating and ring counts from the same sites. A nearby King Billy pine site, Swift Creek, yielded an interesting correlation between carbon isotope ratio (δ^{13}) and maximum summer temperatures, reported first at the Conference on Climatic Change held at Monash University in December, and later in *Nature* by Pearman, Francey and Fraser (1976). Meteorological data indicate that in this century, mean maximum summer temperatures in Tasmania were lowest in the early 1940s and the δ^{13} values correlate significantly with these data. This group in Atmospheric Physics (CSIRO) are continuing work on the isotope ratios from samples from this site, while I develop its chronology and ecological history. The results to date suggest warm periods 1850-1860, 1890-1910 and 1960-1970, and periods cooler by 1°-2°C in 1865-1885 and 1925-1955 with the minimum being reached about 1940. So far there is no independent evidence, but it is interesting to note that the period 1890-1910 has a very characteristic ring sequence (a 'signature') in Pencil pines at Mount Field and elsewhere, with narrow rings in 1890, 1898 and 1908 and exceptionally wide rings in 1895, (also a 'frost ring'), 1896, 1907 and 1909. This signature is not present in King Billy at Swift Creek, although 1890 and 1908 are narrow in some trees and 1909 is usually wide. In 1898 the King Billy stand on Mount Read (c.40 km SW from Swift Creek) was damaged by storm, fire or human activity, some trees showing marked suppression and others renewed vigour, and a new crop of seedlings became established. In New Zealand, Salinger and Gunn (1975) report that (in contrast to Pearman *et al.*) climatic deterioration occurred in the two decades 1880-1900. They confirm the tendency to increasing temperatures since (in their data) about 1935. It is premature to speculate on these observations and I present them simply to illustrate the fragmentary nature of the data at the moment.

Although Swift Creek is a logging site, and badly disturbed as a result, it is important because it is close to the very old King Billy pine forest at Cradle Mountain with living trees c. 1000 years, and older fallen logs, and because Celery-top grows on the site and adjacent to it. If the isotopic composition of King Billy can be shown to be a function of summer temperature, and ring width in Celery-top is related to precipitation, then a detailed picture of past climate may emerge for the site.

Due to the slow progress with material already collected I undertook no further fieldwork in 1976. Professor LaMarch from the Tree-ring Laboratory, Tucson came to CRES (ANU) and carried out

fieldwork in W. Australia, SE Australia and Tasmania. In the latter State he concentrated mainly on Celery-top, and with Bird he collected cores and segments throughout the island. LaMarche examined most of my material early in 1976, and later he visited Mount Field and collected more cores from my oldest stand. I concentrated on developing chronologies from younger sites on Mount Field and on getting the computer programs (RWLST and INDEXA) operating. The first of these rearranges the sets of raw ring width measurements from particular cores and provides various summary data, such as 20 year running means, which allow one to make some judgements about the usefulness of the series and about the form of curve which should be fitted to the raw data for their transformation into indices. The curve fitting option in INDEXA allows for straight lines, exponential or polynomial curves to be fitted. The choice here is a crucial one, but the aim is to maximise that year to year variability which is climatic in origin, rather than related to overall growth (age) or local site disturbances. The program also contains correlations and analysis of variance options. It has been run successfully on the DEC10 at ANU, but we still have some problems when large data sets are involved. I also compiled some basic data on growth rates, tree ages and frost-ring frequencies which were needed for the population histories. Frost-ring analysis relies on the fact that severe frosts occurring at the time of growth initiation in early summer can freeze and distort the newly formed 'early-wood' cells, and these damaged cells can subsequently be identified. Unfortunately the frequency of such frost-rings in trees on any given site cannot be simply related to past climate, as damage is also dependent on trunk diameter. The prevalence of frost-rings at the centres of the trunks of the largest trees on several sites, but not in young trees on the same sites, indicates that the stands originated in relatively open situations. Thus although frost-ring studies may yet be valuable in identifying cold periods in the past, at the moment they are providing only ecological insights. Chris Harwood (Research School of Biological Sciences, ANU) has been studying frost-rings in young *Eucalyptus* trees adjacent to 'frost hollow' plains in the Snowy Mountains and demonstrated an increased frequency and intensity in saplings growing in the open below the inverted timber-lines surrounding the grassy plains.

A 'briefing meeting' and a workshop were held respectively at the start and end of LaMarche's visit and this gave an opportunity to review the advances made in Tasmanian dendrochronology during that time. The first Tasmanian chronologies had been completed, or almost so (Clear Hill, Holly Range (Celery-top); Pandani Grove, Eagle Tarn, Tarn Shelf 'BB' (Pencil pine); Swift Creek (King Billy)). Exceptional drought years had been identified by narrow rings in all species, but different species gave different (but related) chronologies. This suggested that response function analysis of several species growing on the same site might provide a very detailed picture of past climate.

1976 also saw important advances in dendrochronology on the mainland of Australia. LaMarche made numerous collections of *Callitris*, and was able to cross-date at some sites. This material is currently being added to by LaMarche's assistants (Peter Dunwiddie and Desnee Campbell) and will be analysed at Tucson. In November I took advantage of a palynological field trip to visit *Callitris* sites in the arid parts of South Australia and the Flinders ranges. Sites with *Callitris* are now known from localities with a wide range of rainfall and seasonality conditions and a representative selection has been sampled (Fig.2).

John Banks (Department of Forestry, ANU) has sampled a number of species (*Casuarina, Acacia, Eucalyptus*) in the Alice Springs area. He reports also that *Callitris* has been collected from several sites in the Darwin area, and that some of these sites show cross-dating. This study is concentrating on accurately aging the trees, and on the relationships between annual growth and seasonal conditions. A small group in the Research School of Biological Sciences at ANU (Ralph Slatyer, Ian Noble) have collected *Callitris* samples from several arid sites in central NSW and are studying the population dynamics of the species in relation to rainfall. Their sites include Mungo Station (also sampled by Dunwiddie) where the old woolshed, built of *Callitris* in 1869, offers a chance of extending a chronology back into pre-settlement times.

Tropical trees have proved particularly intractable for dendrochronological purposes wherever they have been investigated. In general, due to the relatively non-seasonal nature of the climate, clear annual rings are not found in such species. However bands of varying density certainly do occur in many species, and in some instances (such as in the case of *Callitris* in arid areas) may be related to climatic conditions such as fluctuations in rainfall. In the more humid parts of the tropics prospects for dendrochronology appear bleak, but it is interesting to note that D.I. Nicholson (Department of Forestry, Atherton) has shown that trees in the genera *Agathis*, *Flindersia* and *Xanthophyllum* in Queensland may reach ages in excess of 600 years. The oldest specimen dated was a stump of *Agathis* felled in 1969 and giving a C14 date of 1060±65 (ANU-1071). Although such trees may not be amenable to 'classic' dendrochronological methods, X-ray scanning and isotope analyses could possibly reveal climatic information of great interest to those concerned with rainforest history.

Also in 1976 Banks produced a chronology for Snow Gum (*E. pauciflora*) near timberline in the Brindabellas and was able to use this to identify a change in fire frequency with the arrival of European man in the area. Banks' chronology now goes back to 1700 and he has some older wood. Sites as far apart as Mount Ginini and Schlink Pass (100 km) show cross-dating. Ring sequences in other *Eucalyptus* species have also been used in short term ecological studies, indicating that the genus is not to be discounted in dendrochronological work.

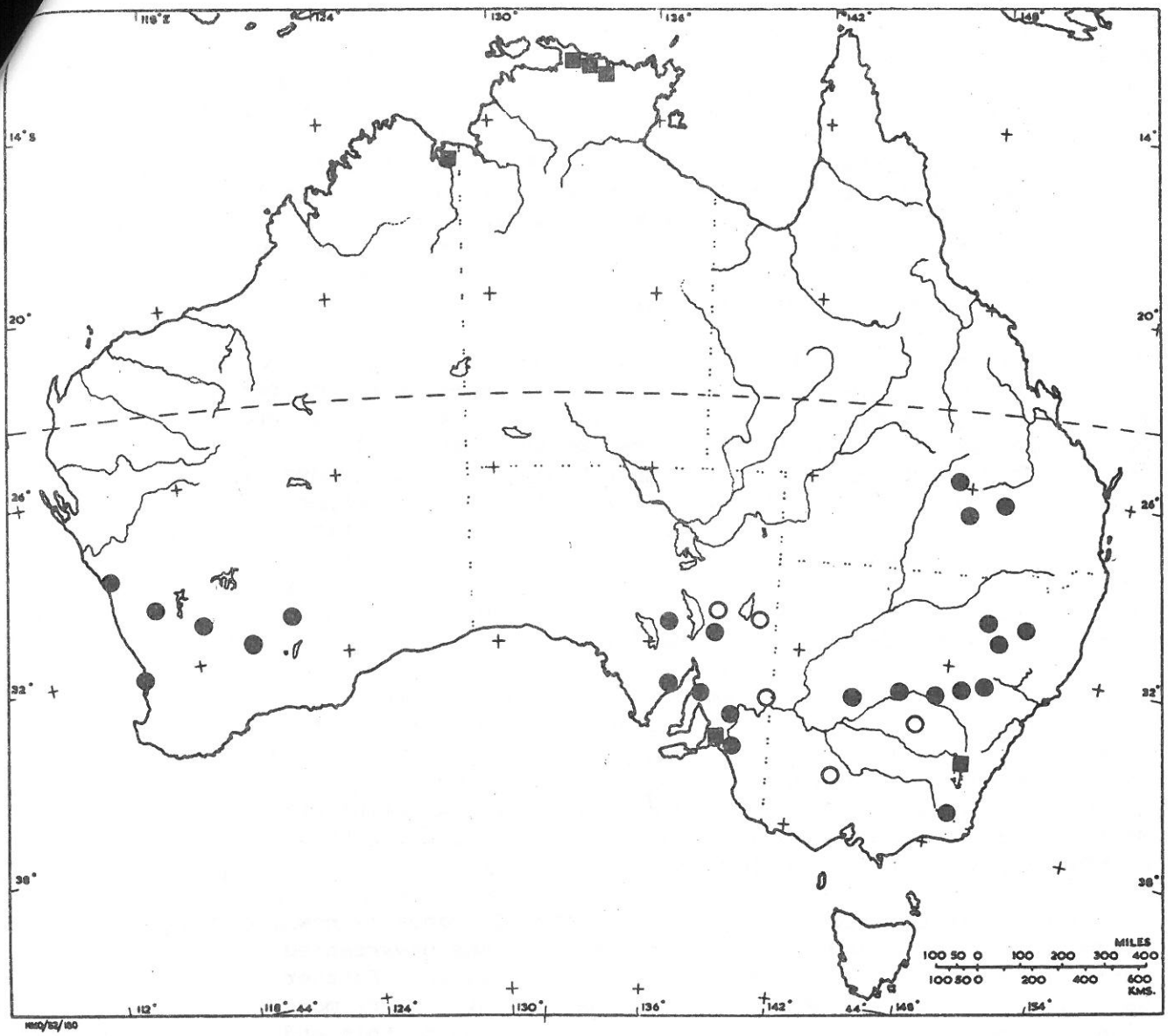

Fig.2

Callitris sites. Solid circles; sites from which cores and/or segments have been collected for analysis at Tucson by LaMarche, Campbell and Dunwiddie. Open circles; sites reconoitred by Ogden in November 1976. Solid squares; sites from which cores and/or segments have been collected by Banks and Hillis.

Podocarpus lawrencei is a small shrubby conifer where it occurs with *E. pauciflora* in the Brindabellas, but it also occurs at timberline in the Snowy Mountains and Victorian Alps, in the subalpine shrubberies of Tasmania, and as a small tree in East Gippsland rainforest. Both Banks and myself have made some preliminary observations on the species which indicates that it could be of value in providing additional data on the history of the Snow Gum stands. It could also be valuable in more general climatic reconstruction in the mountains of southeastern Australia because of its broad ecological tolerance and wide geographical range, including Tasmania.

Experimental work with the Tasmanian conifers was initiated in 1976 by Trevor Bird and myself. The first experiments covered germination and establishment of King Billy pine, then the growth of seedlings and cuttings of all three species (King Billy, Pencil, Celery-top) at different temperatures in growth chambers. The CSIRO Atmospheric Physics group also set up similar experiments, aiming to assess the effect of temperature on photosynthetic fractionation of the carbon isotopes. The results to date suggest that the effect is small. Bird is extending his study to the field, obtaining basic growth rate data by the use of dendrometer girth bands at Mount Field.

I undertook further fieldwork in Tasmania in February 1977. My main aim was to visit areas where Pencil pine grew in some abundance but which I had not already seen, in the hope of developing my population history work so that it would be relevant to the whole species population rather than simply to Mount Field. A theoretical and analytical framework for this approach has now been developed.

The dendrochronological site coverage of Tasmania is now adequate, and the investigation of new sites seems unwarranted until the material already at hand is fully analysed. Further sampling from some of the known sites, particularly where more than one species is present, may be desirable, and to this end *Nothofagus gunnii* was sampled in a Pencil pine stand at Mount Kate and Celery-top sampled at Swift Creek, Waldheim (P. Dunwiddie) and Mount Field (T. Bird), on my recent trip. There may also be a case for investigating some of the other endemic Tasmanian conifers, particularly Huon pine (*Dacrydium franklinii*) which is known to live to a great age and *Podocarpus lawrencei* which occurs also on the mainland. Bird has a sample of Huon pine with >2200 rings from the Gordon River. Information on other species and other sites has been collected in passing by those working in Tasmania. A few sites where conifer logs have been preserved by burial beneath sediments are known, and may prove valuable in extending the chronologies back in time beyond c. 1000 years.

Extension of the Tasmanian chronologies, and a determined effort to extend the insights gained there to the mainland should be the next stage in the development of dendrochronology here. In the high country of Victoria, southern NSW and the ACT, *Eucalyptus pauciflora*, *E. stellulata* and *Podocarpus alpinus* offer some possibilities, but also present special difficulties. Much interest lies in the recent climatic history of the arid zone, and for this *Callitris* seems to be the only species with a wide potential.

This account has reviewed the main recent developments in dendrochronology with which I have had some involvement. Some small projects, and some peripheral to the main theme have not been mentioned. A few research efforts which I am merely aware of may not be covered adequately or at all. Anyone feeling left out should write in protest to me, so that by the time the next review is attempted, perhaps for the Tree-ring Society Newsletter, a more balanced account of Australian dendrochronology can be compiled.

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RADIOCARBON DATING OF MARINE MOLLUSC SHELLS

A study of the potential usefulness and problems in the dating of marine shells has been undertaken by the Sydney University Radiocarbon Laboratory. Aspects which have been studied so far include :

1. Determination of the "apparent age" or reservoir effect for Australian coastal waters. This effect is caused by the slow exchange time for carbon dioxide between the atmosphere and surface ocean water. Measurements of the carbon-14 activity of shells collected alive between 1875 and 1950 from several locations gave a mean reservoir effect of 450±35 years. This quantity should be subtracted from all reported shell ages for Australian sites. All marine shell ages reported by the Sydney and ANU laboratories will be in years BP, corrected for isotopic fractionation but not for the reservoir effect (Gillespie and Polach 1976).

2. Measurements of the carbon-14 activity of marine shells collected alive in 1973 from various Australian coastal locations. Significant differences were found between East Coast samples, with a mean activity of +106.8±2.3% modern, and Southern Coast samples with mean activity of +119.2±3.5% modern. This difference is probably due to non-uniform absorption and distribution of nuclear explosion-produced carbon-14. Thus contemporary marine shells cannot be used as a modern reference standard.

3. Comparison of charcoal and shell paired samples from Australian midden sites. For 30 such pairs, when shell ages were calculated with corrections for both isotopic fractionation and the reservoir effect as above, the mean age difference was 170 years. This is considered quite good agreement considering the nature of middens, and means that shell can be used with confidence for dating when charcoal is lacking. However, it is important to check all shell samples for carbonate mineralogy before dating, since some species recrystallize and can thus give false ages due to the incorporation of foreign carbon (Gillespie and Temple 1977). All samples used in this work have been reported (Gillespie 1977).

The shell dating program is continuing with extentions to contemporary estuarine shells and freshwater shells. Anyone who has, or can get, paired samples of charcoal and freshwater shells in datable quantities is invited to contact the author.

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QUATERNARY GEOLOGY IN WESTERN AUSTRALIA

Eric van der Graaf has sent the following report on some work on Quaternary shoreline features and tectonism carried out by members of the Geological Survey of Western Australia.

On the Cape Range peninsula a series of four emerged Pleistocene marine terraces with marine and aeolian deposits has been mapped by W.J. Eric van de Graaf, Peter D. Denman and Roger M. Hocking. Surveying established that the older three terraces are distinctly warped due to continuing folding of the Cape Range Anticline. The most recent terrace is probably also slightly deformed but the evidence is inconclusive. The significance of the warping is that it proves important folding is still taking place in the area.

Further to the south in the Lake MacLeod area, north of Carnarvon, two different levels of shoreline terraces have been recognised, and at Cape Cuvier there is again clear evidence of warping of a coral reef terrace on the flanks of the anticline.

Herbert H. Veeh from Flinders University has agreed to date suitable coral samples with the U/Th method during 1977.

Fieldwork on Quaternary shoreline features in the Carnarvon Basin will continue during 1977 and 1978.

In the southern Carnarvon Basin there is also evidence that Quaternary tectonism has occurred in coastal areas. In the Shark Bay area Phillip E. Playford and Anthony E. Cockbain consider emerged, dead stromatolites around Hamelin Pool to be evidence of Holocene uplift. This uplift is an expression of the continuing folding of the anticlines and synclines which they believe to underlie the peninsula and embayments in the Shark Bay area.

In their bulletin on the geology of the Perth Basin, Playford, Cockbain, and George H. Low discuss the Quaternary to late Tertiary shoreline deposits on the Swan and Scott Coastal Plains. They conclude that tectonism associated with uplift of the Darling Plateau and/or movement along the Darling Fault is likely to have been partly responsible for the migrating shorelines, although eustatic changes of sea level were also important.

Playford is also studying the Quaternary deposits of Rottnest Island. Previous workers there have concluded that the evidence at Rottnest points to eustatic high sea levels during the past 6000 years. However, it now appears that tectonism rather than eustatism could have been responsible for the abrupt regression that evidently occurred in the Rottnest area some 5000 years ago. Playford has also concluded that the 0.7 m and 1.5 m elevated platforms and notches at Rottnest are older than the 3 m platform and notch, whereas previous workers had considered them to be younger.

Rod N. Cope's work in the southern Perth Basin and south coast areas concentrated on geomorphological evidence for late Tertiary and Quaternary epeirogeny along the Jarrahwood Axis and Ravensthorpe Ramp.

The gentle northward tilt of the Yoganup shoreline which is one of the shorelines with important heavy mineral deposits described by John L. Baxter, is probably due to gentle warping centred on the Jarrahwood Axis.

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Van de Graaf, W.J.E., P.D. Denman and R.M. Hocking 1976 Emerged Pleistocene marine terraces on Cape Range, Western Australia. *West. Aust. Geol. Survey.* Annual Report 1975, p. 62-70

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K-H Wyrwoll, Department of Geography, University of Western Australia, has been carrying out work focussing on the sedimentology and paleohydraulics of two alluvial fills which are widespread in the Geraldton area of Western Australia. Various problems which have arisen in the interpretation of the alluvial fills required the work to be extended as far north as Exmouth Gulf. This has resulted in the recognition of a widespread arid event. The two fills, and associated aeolian and colluvial deposits, seem to provide a useful outline of the sequence of late Quaternary

events in this part of Western Australia. Preliminary results of the study which are published, are listed below.

Wyrwoll, K-H 1977 Late Quaternary events in Western Australia *Search* vol. 8, no. 1-2, p. 32-34

Wyrwoll, K-H and D. Milton 1976 Widespread late Quaternary aridity in Western Australia. *Nature* 264, p. 429-430

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PALYNOLOGY AT MONASH UNIVERSITY

Peter Kershaw (Department of Geography, Monash) is continuing his research into the vegetation record from Lynch's Crater on the Atherton Tableland, Queensland. Detailed results from the pollen analysis of the top 20 m of the sediment - covering the last 65,000 years or so - have been published (Kershaw 1976) and analyses completed on material down to 40 m from the surface.

From estimates of sedimentation rates and comparison of the derived precipitation curve with dated temperature curves resulting from the oxygen isotope analyses of deep sea cores, the sequence is considered to cover the last 123,000 years. An attempt has been made by Charles Barton (Earth Sciences, ANU) to locate the Blake magnetic reversal in the sediment and provide a much firmer basis for dating the record but results are, so far, inconclusive.

On the assumption that the estimated timescale is correct, the pollen data indicate the presence of complex rainforest around the site, under rainfall at least as high as today, from 123,000 years ago until about 79,000 years BP. Higher rainfall and temperature peaks occurred between 123,000 and 116,000 years BP and between 88,000 and 80,000 years BP - the former being the most pronounced. Complex rainforest gave way to moist Araucarian forest between 79,000 and 76,000 years BP with a sharp decrease in rainfall. It is estimated that the area then never received more than half the present day mean annual rainfall until about 9000 years BP. This part of the world has clearly experienced 'arid glacial' and 'pluvial interglacial' periods.

It is hoped that the record will be extended further in the near future. Preliminary results of a seismic survey of Lynch's Crater by Skip Rhodes (Department of Biogeography and Geomorphology, ANU) suggest that there are at least another 7 m of sediment to be recovered.

The Geography Department is also supporting pollen analytical research projects nearer to home. Results are emerging from studies by Honours and MA students on the vegetation of Mt Buffalo, Victoria - a project designed two years ago in connection with the Quaternary

Studies course at Monash University. A core from Bunyip Bog - a small raised valley bog on the western edge of the Buffalo Plateau - provides a record through the last 12,000 years or so (Binder 1976). Results generally support those previously obtained from other studies in the South-eastern Highlands.

The absence of woody vegetation around the site prior to 10,000 years BP suggests that the tree line was at least 600 m below its present level and therefore mean annual temperatures must have been at least 3°C lower than today. A subsequent rapid rise in temperature is evidenced by the presence of wet sclerophyll forest elements and woody vegetation within the swampy hollow. A period of environmental irritability just prior to 2000 years BP is suggested by a deposited sand and gravel band within the core - possibly the result of periglacial activity on the valley slopes. A final phase of rapid bog growth, associated with an extension of bog vegetation, within the last 2000 years can be explained by an increase in effective precipitation.

A second site on the east side of the Plateau, which is stratigraphically similar to Bunyip Bog, is being examined by Janet Williams, an MA student.

References

Binder, R. 1976 Stratigraphy and pollen analysis of a subalpine peat deposit on Mt Buffalo, Victoria. Unpubl. BA (Hons) Thesis. Geography Department, Monash University

Kershaw, A.P. 1976 A Late-Pleistocene and Holocene pollen diagram from Lynch's Crater, North-eastern Queensland, Australia. *New Phytol.* 77, p. 469-498

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VICTORIAN QUATERNARY GROUP

Meetings of the VQG planned for 1977 are :

Friday June 24: Seminar "Hillslopes and Landslides".

Friday July 22: Seminar "Erosion of Limestone Coasts and Landscapes".

Friday November 25: Research Reports - 1977 Post-graduate students.

Saturday December 10: Excursion "Soils and Land-unit Mapping on the Basalt Plains North of Melbourne".

Further details will be published regularly in the Newsletter of the Victorian Division of the Geological Society of Australia, and in the Bulletin of the Archaeological Society of Victoria.

An up-to-date list of meetings of the VQG will be kept by the organisers named below who may be telephoned for further information :

E.B. Joyce Department of Geography Melbourne University	3416523 or 3416520
N.J. Rosengren Department of Geography Melbourne University	3416329 or 3416341
J.A. Peterson Department of Geography Monash University	5412920 or 5412929

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OTHER MEETINGS OF INTEREST

Archaeological Society of Victoria:

Thursday May 5: "Man-environment relationships in Western Victoria" (Mrs Julie Carter and Mr Gary Presland)

Thursday June 2: "The Lake Turkana Hominids", "Fission-Track Dating" (Dr Angus Martin) (Dr Andrew Gleadow)

Thursday July 7: "The Invasion of South America" (Dr Paul Ossa)

All meetings are at 8:00 p.m. in the Sisalkraft Theatre, Architecture Building, University of Melbourne.

For further information contact: Dr Wayne ORCHISTON, Department of History, University of Melbourne; 341 5950.

The Riverine Plain:

A Symposium will be held at Griffith, N.S.W. on July 28-29 and an excursion on July 30. For further information contact: Dr Jim Bowler, Department of Biogeography and Geomorphology, Australian National University, CANBERRA.

The Murray-Darling River System:

A Symposium organised by the Royal Society of Victoria will be held at the Society on the afternoon and evening of October 13.

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FOURTH BIENNIAL MEETING OF THE AMERICAN QUATERNARY ASSOCIATION

In October 1976, the Department of Geology, University of Arizona at Tempe hosted the 4th AMQUA Meeting. The theme was: *Hot and Cold Deserts during the Last Glaciation.* John Andrews and Roger Barry co-chaired the program committee.

As with previous meetings, the program committee has produced a very useful Abstracts Volume. This volume is distributed to all members of AMQUA. The volume contains an extended abstract of the presidential address, this year by David Hopkins. It was entitled: *A model for ancient population movements in and through Beringia.* Hopkins notes that although when sea level is high Bering Strait becomes a narrow focus for human intercontinental dispersals, its role as a barrier to human movements has probably been exaggerated. The postulated ice-barrier isolating Beringia from central North America may have existed only briefly. This review highlights the difficulties North Americans are still encountering in documenting diffusion patterns from Asia.

Of the remaining 160 pages of the volume, 90 are devoted to the theme, the rest to abstracts associated with miscellaneous Quaternary subjects presented in posted sessions. The presented papers were on topics such as :

1. Hot and cold desert climates and climatic change.
2. Climatic interpretation from ice cores.
3. Pluvial lakes in hot and cold deserts.
4. Stream regimes in hot and cold deserts.
5. Wind-blown silt in hot and cold deserts.
6. Flora and fauna in hot deserts.
7. Steppe tundra and its climatic significance.
8. Man in the steppe tundra.

An interesting technique used for each topic was to include an abstract of the discussant who has reviewed the key paper in a particular session. For instance, Troy Péwé's paper on 'Wind-blown dust in hot and cold deserts during the last glaciation' is reviewed by Jerry Brown of CRREL (Cold Regions Research and Engineering Laboratory). I found this to be a useful insight into the problems facing Quaternary workers in America, and not having been present at the meeting, there is some indication of the type of arguments that could have been generated.

Some of the papers are supported by illustrations and most contain useful bibliographies.

These abstract volumes produced by AMQUA are tremendous value. It is worth $4.00 membership per year to receive a volume every other year. If you would like further information about AMQUA or the 1976 volume please write to me.

B.G. Thom

Department of Geography
Faculty of Military Studies
Royal Military College
Duntroon CANBERRA

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INSTITUTE FOR QUATERNARY STUDIES: UNIVERSITY OF MAINE AT ORONO

The editors have recently received a copy of the Institute's brochure outlining its present activities.

Quaternary studies at the University of Maine stress interdisciplinary teaching and research. The Institute is staffed by members of the Department of Anthropology, Botany and Plant Pathology, Geological Sciences, and Oceanography. Staff include: Harold Borns (glacial geology); Robson Bonnichsen (archaeology); Ronald Davis (paleoecology-limnology); George Denton (Quaternary geology); Terence Hughes (glaciology); W. Karlen (Quaternary geology); D. Sanger (archaeology).

The Institute offers the degree of Master of Science in Quaternary studies. This is an interdisciplinary program which, along with concentration in one area, includes an integrated course structure involving archaeology, glaciology, Quaternary geology, Quaternary paleoecology and interdisciplinary seminars of broad interest. A thesis is required which embodies original research in one or more of the disciplines included in the Institute. The Master of Science program is sufficiently flexible to permit an interdisciplinary course structure tailored to the needs of the individual student. The course structure designed by the Institute offers undergraduate students a unique opportunity to obtain a strong interdisciplinary base from which to pursue graduate work in fields related to Quaternary studies. Interested and qualified upperclass undergraduate students may enroll in most of the courses listed below and thus may accumulate a minor concentration of Quaternary courses.

Information on graduate teaching and research assistantships and further information about graduate and undergraduate programs in Quaternary studies may be obtained from:

Dr Harold W. Borns, Jr.
Institute for Quaternary Studies
University of Maine at Orono
Orono, Maine 04473
USA

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CORRECTION

In Australian Quaternary Newsletter No. 7, April 1976, Joe Jennings' article on Quaternary stratigraphy in China included a table listing the Quaternary glacial sequences in the Jolmolungma (Mt Everest) area. Unfortunately one of the interglacial stages was omitted, and the table is reprinted here in full.

Q1	Shisha Pangma (Gasianthan) Gl.	Small valley glaciers with snowline at 6200-7000 m. Uplifted 3000 m since snowline depression cf. with now 2000 m. Temperature 13°C lower than now.	Early Pleistocene
	Phari Igl.	Lake deposits at 4500 m on top of Q1 glaciofluvials and overlain by Q2 till. Broad leaved forest (warm humid) followed by alpine brushwood meadow steppe (cold humid).	
Q2	Niehnien-Hsungla Gl.	Piedmont glaciers reaching onto Tibetan plateau; valley glaciers only on S side. Snowline about 6100-6700 m. Uplifted 2000 m so snowline depressed 1300-2000 m cf. with now. Temp. 10°C lower than now.	Middle Pleistocene
	Chiapula Igl.	Lake deposits at 5000 m overlain by Q3 and Q4 tills. Mainly gymnosperm forest pollen but with higher proportion of angiosperm trees at base. Palaeosols develop. Mammals like todays. Succession of cold, humid to warm to cold, dry conditions.	

Q3	Cholmo Lungma Gl.	Valley glaciers but reaching lower down than Q2 piedmont glaciers. Terminal moraine at 4950 m. Uplifted 1400 m. Temp. on N side 5-6°C lower than now; 3°C lower on side.	Late Pleistocene
	Yali Igl.	Climate similar to the present but Hypsithermal.	Holocene
Q4	Chunpote (Rongbud) Gl.	Last 5-7000 years colder and drier than before. Neoglacial.	