**PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY BIENNIAL CONFERENCE**

**Official publication of The Australian Rangeland Society**

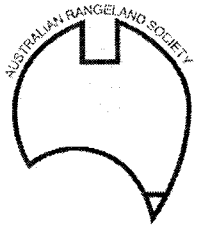


## Form of Reference

The reference for this article should be in this general form;
Author family name, initials (year). Title. *In*: Proceedings of the nth Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).
For example:
Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite *(Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15th Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

## Disclaimer

The Australian Rangeland Society and Editors cannot be held responsible for errors or any consequences arising from the use of information obtained in this article or in the Proceedings of the Australian Rangeland Society Biennial Conferences. The views and opinions expressed do not necessarily reflect those of the Australian Rangeland Society and Editors, neither does the publication of advertisements constitute any endorsement by the Australian Rangeland Society and Editors of the products advertised.




The Australian Rangeland Society

# 10,000 YEARS OF VEGETATION CHANGE IN SEMI-ARID SOUTHWESTERN NEW SOUTH WALES.

*M.L. Cupper*

School of Earth Sciences, The University of Melbourne, Victoria 3010

## ABSTRACT

Fossil pollen records from playa lakes west of the Great Anabranch of the Darling River indicate significant environmental changes have occurred in southwestern New South Wales during the Holocene (last 10,000 years). The modern semi-arid rangeland surrounding the playas bears little resemblance to the vegetation that emerged from the last glaciation. Daisy herbfields and saltbush - bluebush low shrublands dominated the region in the early Holocene. Native pine and casuarinas, probably bull-oak and belah, gradually increased in cover and by *c.* 5,000 years ago the region supported dense woodlands. The presence of bull-oak, now uncommon below the 380 mm annual rainfall band, indicates the climate was considerably moister than at present. Increased aridity or more frequent droughts occurred in the last 5,000 years, possibly due to climatic variability caused by the onset of ENSO-type events. Woodlands contracted, with bull-oak disappearing from the record, and saltbush and bluebush low shrublands expanded. Mallee eucalypts became common in the last few thousand years, probably because of their ability to survive drought. Native pine and belah declined after European settlement, due to clearing, timber cutting and limited regeneration.

## INTRODUCTION

Southwestern New South Wales is a store-house of landscape and cultural history, with internationally-recognized archaeological and geomorphic sites including Lakes Mungo and Victoria. Despite the global importance of the region, its palaeovegetation is largely unknown. The present study has investigated fossil pollen and sedimentary sequences from shallow salinas and dunes of Pine Camp, Tooperoopna and New Bluff Groundwater Discharge Complexes (Figure 1). A vegetation history is presented utilizing the fossil records. This research aims to identify the origin of problems such as salinization and woodland decline within current ecosystems. Palaeoecological changes may be correlated with climatic events or human land management.

## STUDY AREA

Pine Camp, Tooperoopna and New Bluff Groundwater Discharge Complexes consist of playas, locally termed boinkas, surrounded by linear dunefields. They are topographic hollows where saline groundwater has discharged at the surface, producing salinas and associated clay dunes and plains. Most basins were probably eroded by westerly winds at the height of the last glacial period (20,000-14,000 years ago). With the onset of moister climates during the Holocene they again became groundwater discharge and surface water accumulation sites, gradually filling with sediments.

A mosaic of bluebush (*Maireana* spp.) low shrublands, mallee (*Eucalyptus* spp.) tall shrublands and belah (*Casuarina pauper*) - native pine (*Callitris* spp.) - rosewood (*Alectryon oleifolius*) low open-woodlands vegetate the linear dunes. Sheep grazing has been the predominant land use around the playas since European settlement, although small tracts have been cleared in recent decades for grain cropping.

## PALAEOENVIRONMENTAL RECONSTRUCTION

Daisy herbfield and bluebush-saltbush low shrubland phase (early Holocene)

The early fossil sequence from Warrananga salt lake in the Tooperoopna Groundwater Discharge Complex is dominated by pollen from Asteraceae and Chenopodiaceae. This assemblage suggests the landscape was vegetated by low shrubs and forbs. Geomorphic evidence from other sites in

southeastern Australia indicates that desert dunes were last active around 13,000 years ago (Bowler 1980), when they were devoid of vegetation. Daisies and chenopods were probably the initial dune colonizers as the climate began to ameliorate during the early Holocene. Eucalypts comprise most of the tree pollen at this stage, possibly sourced from mallee tall shrubland.

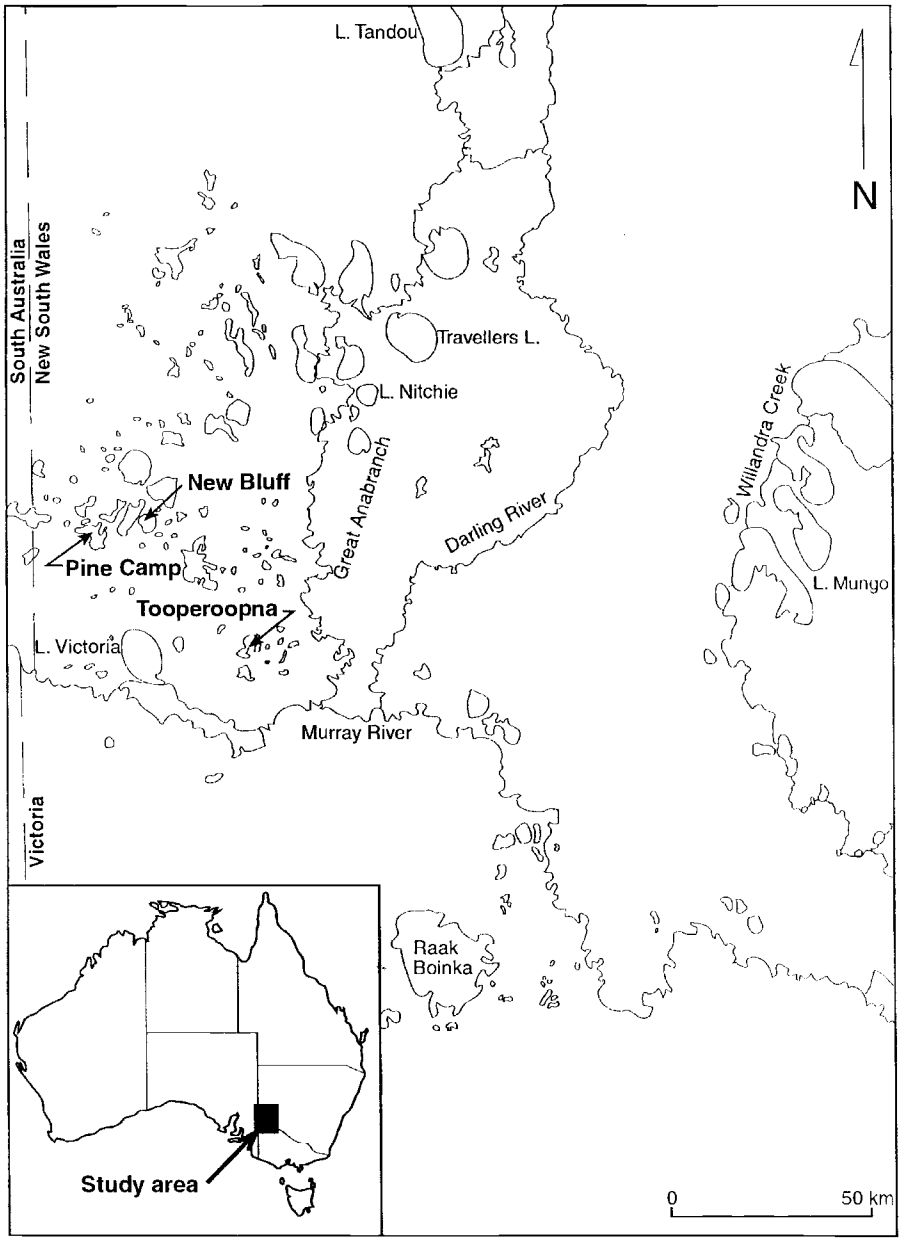



**Figure 1.** Map of southwestern New South Wales and northwestern Victoria indicating the location of the Pine Camp, Tooperoopna and New Bluff Groundwater Discharge Complexes.

**Dense casuarina and native pine woodland phase (mid-Holocene)**

As the climate became progressively moister and soils formed on the dunes, woodland expanded across the landscape. Native pine and casuarina became prominent and daisies and chenopods declined. High Poaceae pollen percentages suggest a grassy understorey in the woodland communities and an open vegetation structure. Wattle, hop-bush, tea-tree and emu-bush pollen is abundant in the record, indicating that tall shrubs formed an understorey component in the woodland.

Belah was probably the dominant casuarina species, and it is the only living representative of the Casuarinaceae in the region. Modern belah pollen is similar morphologically to most of the casuarinaceous pollen in the salina sequences, although distinctively large grains in the Warrananga record, and also at Bells Grove salt lake in the Pine Camp Groundwater Discharge Complex, may be derived from bull-oak. This suggests that the casuarina woodland composition in the mid-Holocene was different to that of today and that climatic conditions were possibly moister, as bull-oak presently favours the sub-humid regions of southeastern Australia.

**Casuarina and native pine woodlands decline as chenopod shrublands expand (late Holocene)**

The most noticeable changes in the late Holocene are a decrease in casuarinas after *c.* 5,000 years ago and a similar decrease in native pine in the last 2,000 years. One explanation for the demise of casuarina is that fires were more prevalent in the ecosystem, indicated by high carbonized particle frequencies in the period up to *c.* 2,000 years ago. Woodland casuarinas are fire-sensitive and belah in particular does not store seed in the soil (Auld 1995). A switch to more frequent and intense fire regimes will cause local decline or extinction of the species.

It is more likely that the woodland decline was due to increasing aridity during the late Holocene. Certainly, chenopods, common in the more arid regions of southeastern Australia, increase significantly. Eucalypts also increase in this phase; the mallee eucalypts are particularly well adapted to periods of water stress, with a source of stored water in the underground lignotuber. Belah is quite drought-tolerant but bull-oak is more common in the 380-630 mm annual rainfall band (Doran & Hall 1983). The disappearance of bull-oak during this phase may be attributable to the inability of the taxon to survive in a deteriorating climate.

The palaeoenvironmental record from southwestern New South Wales indicates heightened aridity or seasonality after *c.* 2,000 years ago. New Bluff salt lake was dry, suggesting that recharge rates and water tables were lower. Increased aeolian sand entering the salina sedimentary sequences and formation of clay dunes indicates landscape instability, caused by frequent droughts or longer-term aridity during this phase. Disturbance is also indicated by a peak in hop-bush pollen.

Native pine decreases markedly in the last *c.* 2,000 years, possibly due to greater seasonal variation in climate. Frequent droughts of 6-7 months duration probably limit native pine distribution in semi-arid and arid Australia (Clayton-Greene 1981). Adult trees are killed by severe drought and will not resprout. They do not maintain a soil seedbank and their seeds will only germinate, and seedlings survive, after several years of above-average rainfall. Thus death of native pine (due to either severe water-stress or natural senescence) during a dry phase will cause their local extinction.

An arid phase in the late Holocene has been identified by other studies in the semi-arid and arid interior. Lake Tyrrell is dry *c.* 2,200 years ago (Luly 1993), the lunette at Lake Victoria is destabilized *c.* 1,500 years ago (Hudson & Bowler 1997), dunes are reactivated at Cobar from 2,500 to 640 years ago, in the Strzelecki and Simpson deserts from 4,000 to 700 years ago and near Broken Hill from 3,000 to 1,000 years BP (Wasson & Donnelly 1991). McGlone *et al.* (1992) attribute the increasing climatic variability during the late Holocene to the onset of El Niño/Southern Oscillation (ENSO) cycles, beginning *c.* 5,000 years ago and fully developed by 3,000 years ago.

**Europeans settle southwestern New South Wales (1840s - Present)**

Decreased native pine and casuarina in uppermost pollen samples was probably caused by European settlers clearing woodlands, particularly for timber fenceposts and construction materials. Eucalypts are little affected by settlement, probably due to the low economic value of the timber of mallee species. Invasive pasture grasses and expanding grainfields are shown by increased Poaceae.

Browsing by herbivores probably also contributed to the reduced abundance of tree and tall shrub pollen in the recent record. Seedlings and vegetative shoots are eaten by rabbits, cattle and sheep,

along with kangaroos that have flourished with the expansion of introduced grasses. Trees and tall shrubs will not regenerate under such browsing pressure (Cheal 1993). As adult trees senesce or die during drought, the woodland contracts further.

## ACKNOWLEDGEMENTS

This research is partially funded by an Australian Postgraduate Award. Prof. Jim Bowler and Drs Andrew Drinnan, Bert Roberts and Ian Thomas provided advice and assistance. Rod Baird, Bob Duncan, Phil Halton, Greg Pollard and Len Wilson are thanked for allowing access to their properties.

## REFERENCES

Auld, T.D. (1995) Soil seedbank patterns of four trees and shrubs from arid Australia. *J. of Arid Environ.* 29: 33-45.

Bowler, J.M. (1980). Quaternary chronology and palaeohydrology in the evolution of Mallee landscapes. *In* 'Aeolian Landscapes in the Semi-Arid Zone of South Eastern Australia.' (Eds R.R. Storrier and M.E. Stannard). Australian Society of Soil Science, Wagga Wagga, NSW. pp. 17-36.

Cheal, D.C. (1993). Effects of stock grazing on the plants of semi-arid woodlands and grasslands. *Proc. R. Soc. Vict.* 105: 57-65.

Clayton-Greene, K.A. (1981). 'The Autecology of *Callitris columellaris* F. Muell. and Associated *Eucalyptus* spp. in South-eastern Australia.' Unpublished PhD Thesis, The University of Melbourne.

Doran, J. and Hall, N. (1983). Notes on fifteen Australian *Casuarina* species. *In* 'Casuarina Ecology, Management and Utilization.' (Eds S.J. Midgley, J.W. Turnbull and R.D. Johnston). CSIRO, Melbourne. pp. 19-52.

Hudson, J. and Bowler, J.M. (1997). 'The Cultural Heritage of Lake Victoria - Geomorphology, stratigraphy and sand resources.' Environmental Impact Study, MDBC, Canberra. 87 pp.

Luly, J.G. (1993). Holocene palaeoenvironments near Lake Tyrrell, semi-arid northwestern Victoria, Australia. *J. Biogeogr.* 20: 587-598.

McGlone, M.S., Kershaw, A.P. and Markgraf, V. (1992). El Niño/Southern Oscillation climatic variability in Australia and South American palaeoenvironmental records. *In* 'El Niño. Historical and Palaeoclimatic Aspects of the Southern Oscillation.' (Eds H.F. Dizz and V. Markgraf). Cambridge University Press, Cambridge. pp. 435-462.

Wasson, R.J. and Donnelly, T.H. (1991). 'Palaeoclimatic reconstructions for the last 30,000 years in Australia - a contribution to prediction of future climate.' CSIRO, Canberra. 48 pp.