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Hi Friends,

If there is a colour dot on the top left hand corner of this page you are unfinancial and if it happens twice you will automatically be off our list.

I will be in Sydney during November this year doing five talks on cycads and zamiads and also to promote my booklets. Main meeting is Ermington 15th November but the other four Oyster Bay, Hornsby, Peakhurst and Dee Why are also very important. Hope to meet you there.

This newsletter is uniquely different because it tells the story of our plants through the eyes of an American researcher very adequately. I am pleased to see that photos and notes by Brien Bosworth, Ken Adcock and David Roche appear with mine in the PACSOA zamiad booklet.

1990 and 1991 companion booklets are not exactly what I wished for but at least it is a start. Most of SOAP's Australian plants Vol. 13 - 101 booklet is [illegible] Jack Krempin's large hard cover "Palms and Cycads Around the World".

- Len Butt

In the booklet this year is a photo of the true Macrozamia sect. parazamia pauli guilielmi and these next paragraphs will tell the story of us finding it. Three of us set out from Gympie and took the Tin Can Bay - Rainbow Beach road. This is the stated area where the true type occurs.

Rain had been falling but now the sun was out and we stopped at several places to examine the terrain where the white sandy loam was prevalent.

Banksia robur was flowering along with a form of Banksia collina and also Banksia serratifolia. Many wildflowers were in bud, the most abundant being Patersonia. On every occasion great colonies of that small grass tree Xanthorrea macronema dotted the low wallum.

In a side road outside the areas of Cooloola National Park we found great plants of the Restio sedge which looks very fern like. Soon after near the actual edge of the road we found a large two fronded female parazamia with two cones.

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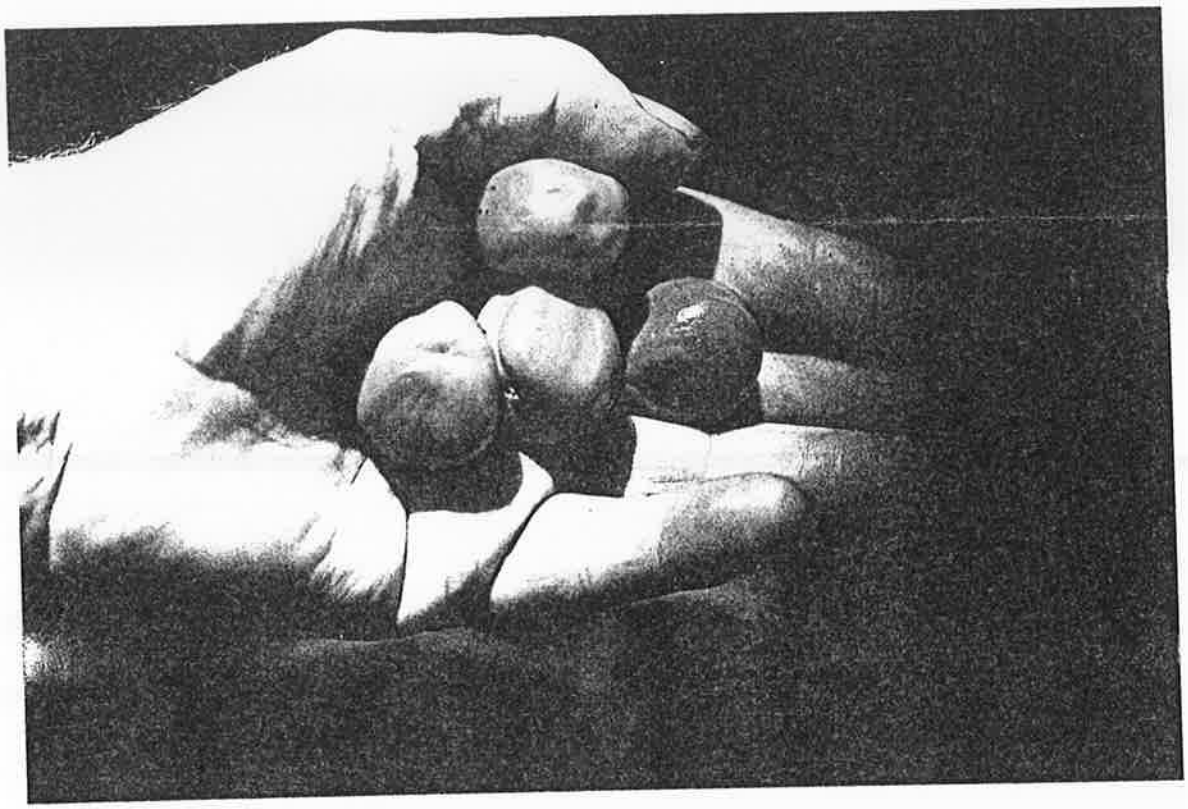
One cone was splitting and showing large orange yellow seed. Although growing in white-ish sand the wallum was full of rocks of a hard sandy nature. Seed from the cone was taken.



Seed of the Tin Can Bay Specimen

THE EVOLUTIONARY HISTORY OF AUSTRALIAN CYCADS

By Willie Tang

Geography and Distribution

Australia is a relatively flat and arid continent and most of it is devoid of cycads. As in Africa (11), cycads are primarily confined to moist, mountainous areas and in Australia are concentrated along the eastern and northern margins of the continent (Fig. 2). Indeed, in these restricted areas we find perhaps the highest densities of cycads on the globe. Here cycads often form a dominant part of the vegetation. Why have cycads maintained a greater foothold on this continent than perhaps in any other major landmass on earth? The answer lies in part in Australia's unique geological history and the climate and flora that it has molded over the past 140 million years.

Australia and Gondwana

One hundred and forty million years ago Australia was attached to what is now Antarctica and was a part of the great southern continent of Gondwana (see Fig.1). In this ancient time winds and ocean currents carried the warmth of the tropics deep into the high latitudes and although Australia was closer to the south pole than now it enjoyed a warm climate. The flora and fauna was remarkably similar throughout much of Gondwana and cycads and cycadeoids were numerous and widespread (3).

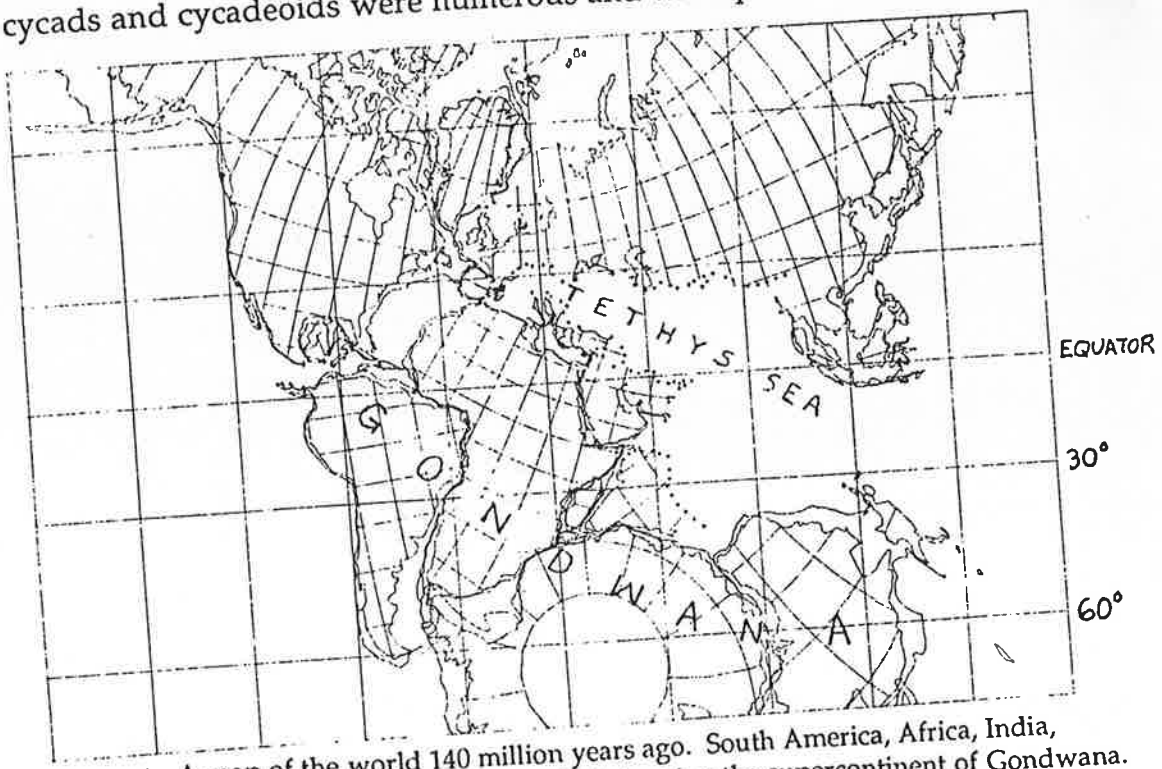
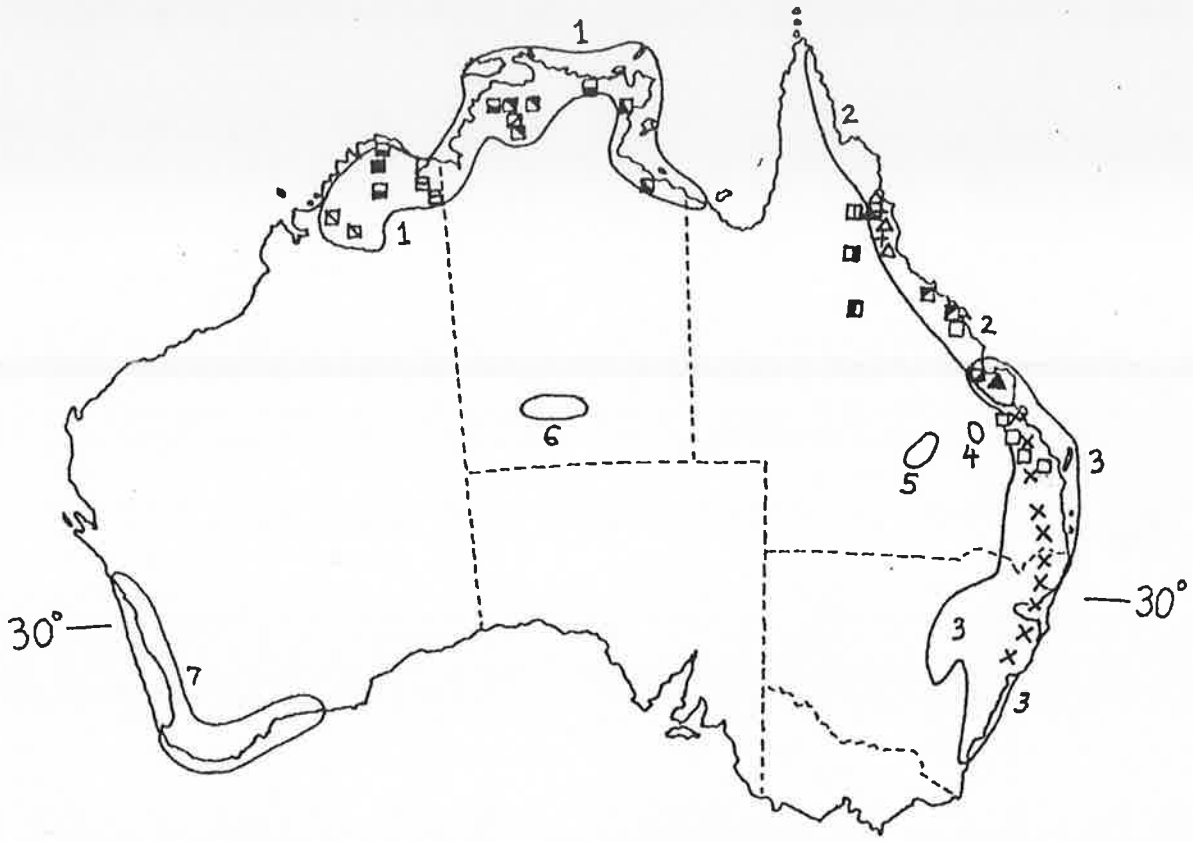


Figure 1. A map of the world 140 million years ago. South America, Africa, India, Antartica and Australia are attached, forming the supercontinent of Gondwana. Modified from (10).

Continental Drift and Climatic Change

In the early Cretaceous (130 million years ago) immense rift valleys like the one we see today in East Africa formed all across Gondwana. Gondwana began the fragmention that was to give shape to the modern continents. In the Southeastern reaches of Gondwana the temperate land bridge between Australia and Antarctica remained for tens of millions of years before Australia separated off to form an island continent in the early Tertiary some 50 million years ago.



KEY

1 General extent of north coast Cycas
2 C. media
3 Main area of Macrozamia
4 M. platyrachis
5 M. moorei (Queensland form)
6 M. macdonnelli
7 M. riedlei
△ Bowenia spectabilis
▲ B. serrulata
\+ Lepidozamia hopei
× L. peroffskyana

Cycas furfuracea
C. basaltica
C. armstrongii
C. pruinosa
C. calcicola
C. conferta
C. angulata
C. cairnsiana
C. sp.'Mt. Surprise'
C. sp.'Glen Idle Blue'
C. normanbyana
C. kennedyana
C. sp.'Marlborough Blue'

Figure 2. The present day distribution of cycads in Australia. Note the concentration of species in the moister mountainous zones along the north and east coasts. Compiled from (1, 2, 6).

With its land bridge severed Australia drifted slowly north like a giant ark carrying its peculiar cargo of flora and fauna. Among these were cycads and newer inhabitants such as the primitive angiosperms and marsupials that managed to cross the Antarctic landbridge before it closed. Many of the mammal and flowering plant families that are familiar to other continents failed to gain a foothold here. In the eons to come Australia's native plants and animals would evolve in isolation to produce the unique flora and fauna we see today.

For much of its history as an island continent moisture laden tropical winds penetrated deep into the heart of Australia. Broadleaf tropical rainforest extended through most of the interior, merging with warm temperate forests on the southern margin. Fossil cycads from the Eocene, some 45 million years ago, from the provinces of Victoria and New South Wales are remarkably similar to those living today in more northerly areas. These included Bowenia (Fig. 3) and Lepidozamia. Another extinct forest cycad, Pterostoma, also existed in these ancient forests (5). A cycad flora probably occupied the whole expanse of a forested Australia.

Figure 3. Bowenia is a forest cycad. Its leaves are shaped like parasols, with a single supporting petiole and numerous wide leaflets splayed out on a single plane. This is a very effective arrangement for capturing light in the shaded understory. Its tuberous stem, often located a half meter underground, may be an adaptation against attack by digging marsupials such as bandicoots (W. Kraa, pers. comm.).

In the late Eocene, some 40 million years ago, climate begins to change. The northernly drift of Australia and South America allow the formation of a cold oceanic current to form around Antarctica, effectively blocking the warm eqatorial currents from reaching the higher latitudes. Climatic belts become more pronounced in Australia. Moist tropical winds begin to be excluded from the interior and there is increased aridity and seasonality of rainfall. From the Mid Miocene, some 15 million years ago, to the present closed forests throughout central Australia are gradually replaced by arid eucalypt woodlands and desert (13). As the forests vanished so did most of their cycads.

Warm Temperate Cycads

In Australia, much as in the case of Africa (11), coastal mountains seem to have been zones of refuge and evolution for cycads. Here, unlike most of the interior, cycads were able to survive and adapt to changing climate. The moisture that mountains capture through orographic uplift of air masses and the diversity of climate zones along their slopes have made them, as in other parts of the tropics and subtropics, centers of cycad diversity.

Along the eastern margin of Australia we find a warm temperate cycad flora merging gradually with a tropical one as we move north up the coast. The warm temperate cycads are found mainly in New South Wales and are dominated by species of Macrozamia (Fig. 2, 4). This genus is divided into two sections: section Parazamia, with eight representatives, is characterized by dwarf species, and section Macrozamia, with four species in this area, is charactered by larger size and is considered to be more primitive (6). This genus as a whole is adapted to seasonally dry, fire-prone eucalyptus woodlands and are usually found on poor, often siliceous soils. A few members of this genus extend into the edge of the tropics, but are replaced ecologically by species in the genus Cycas as we move north. Indeed, the most tropical Macrozamia, M. miquelii, is often found side by side with Cycas in the zones where the two genera meet, apparently occupying the same ecological niche. One of the most northerly species, M. platyrachis, although found well above the Tropic of Capricorn is confined to a high plateau whose climate is decidedly cooler and more temperate than would be expected at that latitude.

There are two other cycad genera of the warm temperate zone. Lepidozamia peroffskyana inhabits the wetter forests of the coast. As we move south to north we find that this species is confined to higher and cooler elevations (W. Kraa, personal communication), indicating that too much warmth is a limiting factor. These forests experience cool winters with brief periods of subfreezing temperatures. Bowenia serrulata is a subtropical forest species with a few disjunct populations extending into the tropics (1). Again as we found with M. platyrachis and L. peroffskyana, these northerly populations are confined to high elevations where the climate similates that of a more temperate zone. These relict populations stranded on cool tropical mountains suggest that in the past, perhaps when Australia was situated in a

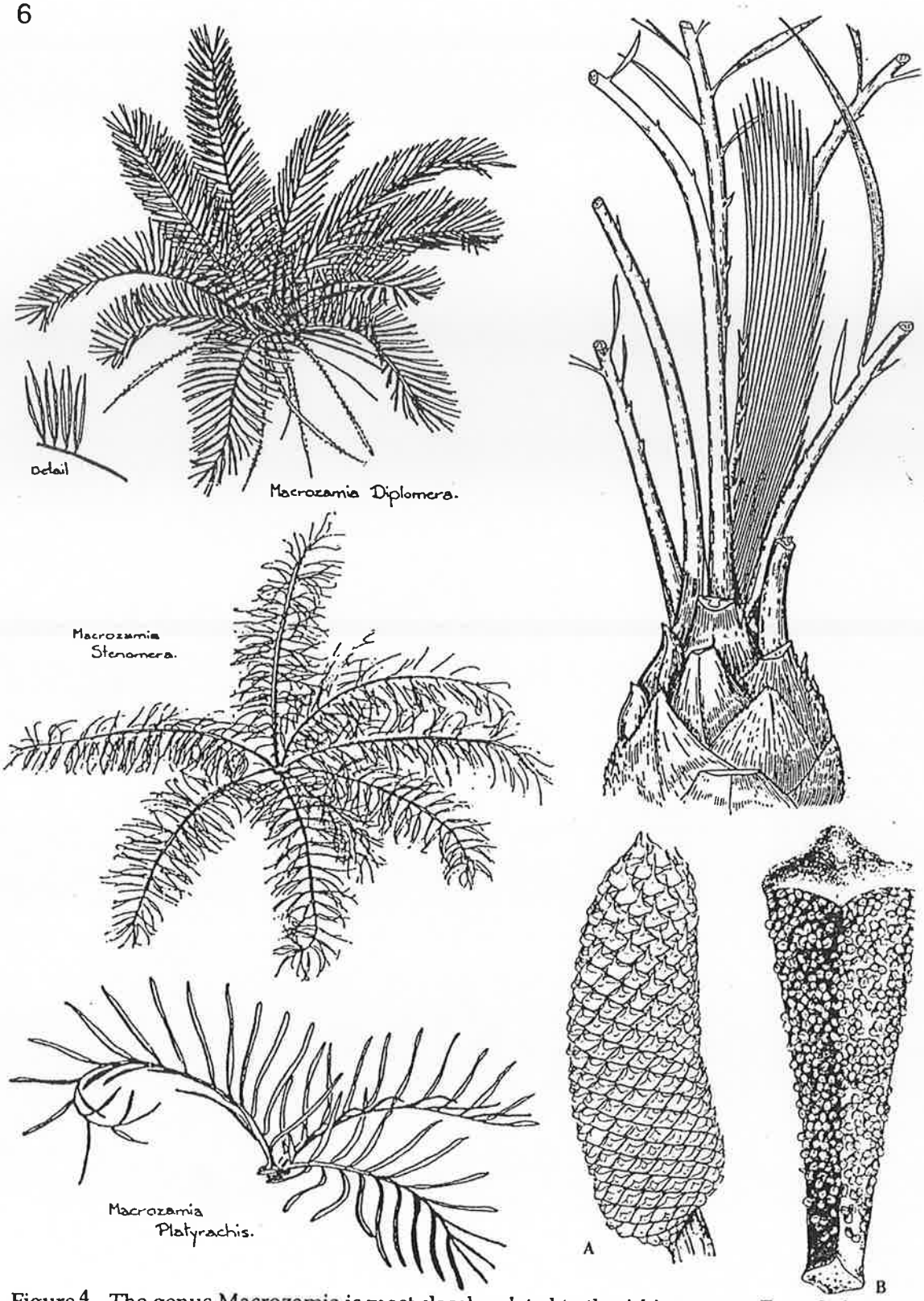


Figure 4. The genus Macrozamia is most closely related to the African genus Encephalartos a to Lepidozamia. The ancestral cycad stock of these three was probably found throughou most of Gondwana. Time and evolution has molded Macrozamia for life in drought and fi prone habitats. The trunk of most species is subterranean or partly so and surrounded by a protective layer of leaf bases. Distinctive features include a glandular, white to red swelling at the junction of leaflet and rachis and a single spine on the cone scales. Leafle are forked in some species and arranged in a spiral pattern along the rachis in others. Figures are from (7, 9, 14).

more southerly position, much of the northeastern coast was more temperate.

Why does this warm temperate zone of Australia possess such a high diversity of cycads? The answer perhaps lies in the absence of severe winter cold. In the northern continents arctic air masses often sweep deep into the interior devasting tender vegetation (see 8). Australia is surrounded by ice free oceans that have buffered the continent from hard frosts, perhaps for eons.

Tropical and Arid Zone Cycads

In the tropical zones to the north we find ecological counterparts of the warm temperate cycad flora. Cycas, with more than a dozen species (2, Fig. 2,5), is found in seaonally dry, fire-prone habitats much like the more temperate Macrozamia species. Two remarkable rainforest species in the northeast coast, Lepidozamia hopei and Bowenia spectabilis, are the tropical counterparts of their more temperate cousins to the south. These two species are perhaps the only cycads outside of the Americas to inhabit the understory of true tropical rainforest (12).

Cycas is the only cycad genus not unique to Australia. The evolutionary center of Cycas is southeast Asia and there is an ocean dispersed form, C. rumphii, found from Africa across most of the Indo-Pacific islands and coastlines. Are the Australian Cycas part of a Mesozoic flora that once ringed the ancient Tethys Sea (see Fig. 1) or are they perhaps descendants of a sea-dispersed Cycas that originated from Asia? Only genetic analysis can solve this riddle. The most abundant and widespread tropical species in Australia is C. media which inhabits cliffs and pockets of drier vegetation along most of the east Queensland coast. Inland from its range we find a number of more stunted Cycas populations, including C. cairnsiana, C. sp.'Mt Surprise', and C sp.'Glen Idle Blue', with narrow leaflets and glaucous blue foliage. These are probably relatives of C. media that have managed to adapt, independently, to the aridity that has pushed most other cycads out of Australia's interior. The north zone of the continent is inhabited an array of Cycas species adapted to arid climates or climates of alternating drought and wetness. Among these are C. conferta, which has overlapping leaflets, C. furfuracea, which has leaflets that are hairy underneath and C. angulata, which can attain a height of 10 meters, among the tallest of all cycads. Some species are adapted to particular soil types: Cycas basaltica to soils derived from basalt and C. calcicola to limestone.

There are two exceptions to the general distribution pattern of Australian cycads. Macrozamia macdonnellii is found deep in the arid center of the continent in the Macdonnell Ranges. This is one of only a few mountain systems in the interior of Australia. Its gorges and drainage channels concentrate enough water for this one species of cycad to have

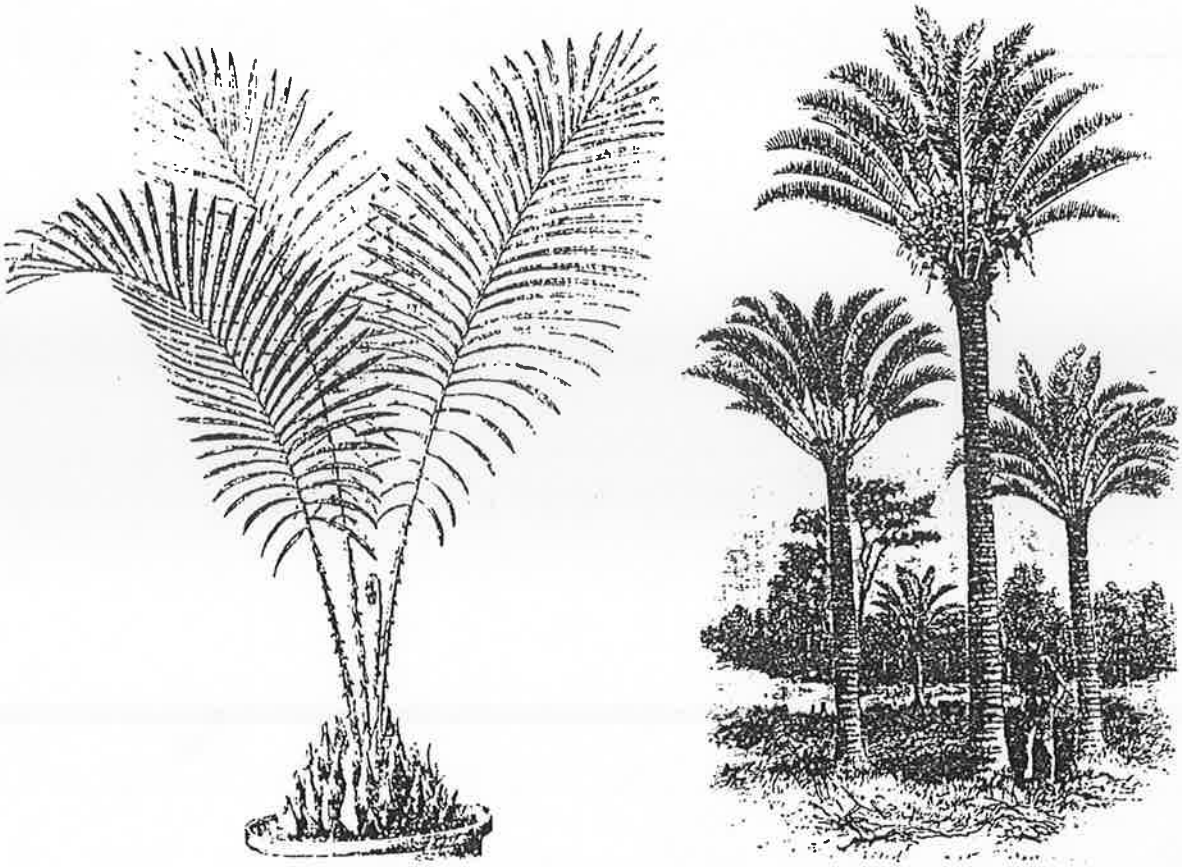


Figure 5. The Australian Cycas, although less diverse in stem, leaf and reproductive structures than those of Asia, show a wider range of adaptations to aridity and seasonal drought, including deciduous leaves and glaucous blue foliage.

survived and adapted to desert life. Among these adaptations are the glaucous bloom of the leaves that help reflect heat and prevent moiture lo and the extremely large seeds, the largest among cycads. Undoubtedly the reserves in the seed help young plants establish themselves in this area of uncertain rainfall, perhaps by allowing them to form deep taproots to take advantage of subsurface moisture. In the southwest coast is another unus highly variable species, M. riedlei. This is the only cycad that dwells in a mediterranean climate zone, where there are wet winters and arid summ Johnson (6) believes that these two species of Macrozamia are the descenc of a once more widely distibuted cycad.

Coexistence of Cycads and Human Beings

The aborigines who inhabited Australia for 40 thousand years befo the arrival of European settlers appear to have cohabitated with cycads without detriment to either. Cycas seeds were important to the diets of r aboriginal groups. Under the scant century or two of European settlemei however, cycads have not fared well. Much land has been cleared for agriculture and urbanization. Bowenia spectabilis, a common understor plant in rainforest vegetation, must have once been extremely abundant vast areas now covered by sugarcane. Perhaps the most detrimental acti of all has been cattle ranching. In the arid, marginal lands where most cy

are found and where cattle production is most inefficient, the Australian government has promoted cycad eradication programs for nearly a century because of their toxicity to cattle. Perhaps because of their original abundance, cycads can still be seen in large numbers in much of coastal eastern Australia, however, there is clearly a need for protection of these remarkable inhabitants of a remarkable continent.

Acknowledgements

I am indebted to Will Kraa and Marie Trefeu for showing me the Australian cycads in the field and allowing me to appreciate them in their natural setting first-hand.

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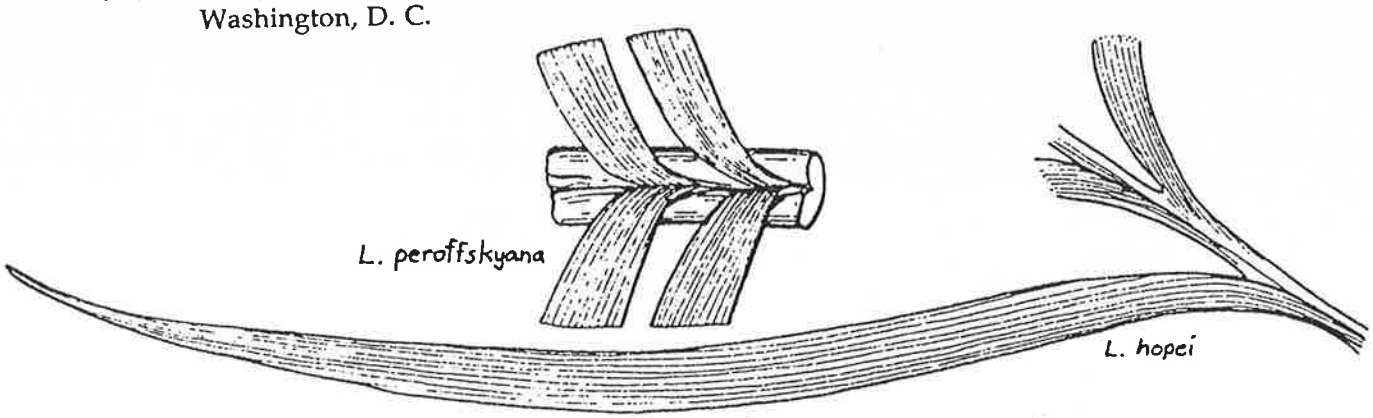

Figure 6. Lepidozamia occupies a niche similar to that of large rainforest palms and is very similar in this respect to Dioon spinulosum of Mexican rainforests (12). Figure is from (4).