

THE NATURAL HISTORY OF THREE AUSTRALIAN CYCADS

by

Paul Kennedy

Macrozamia diplomera

Macrozamia diplomera is a small to medium sized cycad that is endemic to New South Wales. It has a subterranean caudex and normally, though not always, has fronds with divided (bifurcated) leaflets.

Macrozamia diplomera grows in north-western New South Wales. It occurs in a dry, flat, sandy and inhospitable broad corridor running roughly to the east and west of the town of Coonabarabran.

Coonabarabran (elevation - 509 meters) has an annual average rainfall of 735 mm spread over 80 rain days. The daily minimum winter temperatures in July of - 3.6° C and maximum summer temperatures, in January of 35.9° C are reached at least once per week. Frost can occur on an average of 76 days per year.

One-third of the annual average rainfall at Coonabarabran falls in summer, with the balance of the rainfall being spread evenly over the rest of the year. The seasonal rainfall pattern is as follows: Summer - 32%, Autumn - 23%, Winter - 22% and Spring - 23%.

If a person familiar with *M. communis* and its geographical size variations were to see a stand of *M. diplomera* for the first time his initial impression would be that he was viewing a stand of small *M. communis* plants. However a distinct color variation from the dark green fronds of coastal *M. communis* plants to a lighter pale green of *M. diplomera* would be evident. A reappraisal of the initial identification would quickly follow when a closer inspection of plants would reveal fronds with divided leaflets.

When dealing with cycads, however, one quickly forms the conclusion that the only consistent factor about cycads is their inconsistency. This is certainly true with *M. diplomera*. A detailed examination of plants within the stand would reveal fronds with three distinct and different types of leaflets. These differing frond and leaflet characteristics, which often occur in various combinations on individual plants within a single stand, are as follows:

- those fronds with only entire leaflets,
- those fronds with predominantly divided leaflets (the most common type),
- those fronds with a combination of divided and entire leaflets.

Given that plants with varying frond and leaflet characteristics grow immediately adjacent to each other and can possess fronds of identical size and number, two alternative methods of identification are possible:

- first, that the stand contains both *M. communis* and *M. diplomera* plants, plus a naturally occurring hybrid, or
- second, that the stand contains *M. diplomera* plants only, albeit with genetically variable leaflets.

I agree with the latter identification on the basis that:

- the nearest stand of pure *M. communis* plants is located several hundred kilometers away, and
- that these leaflet variations are common to three widely separated stands of *M. diplomera*.

Independent support for this method of identification can also be drawn from the fact that *M. heteromera*, which has absolutely no affinity with *M. communis*, also has fronds with leaflets which can be either divided or entire.

The principal characteristics of *M. diplomera* are as follows:

- unbranched subterranean caudex,
- straight, not twisted rachis,
- leaflets which can be either divided or entire,
- leaflets which normally divide very close to the rachis (usually within 1 cm of the rachis),
- leaflets which are angled forward at about 40° to the rachis and which extend horizontally in a flat plane from the rachis,
- lower leaflets which are gradually reduced in size and which tend to sweep forward from the rachis at an acute angle,

- pale green colored fronds, which become dull with age, and
- pale yellow colored calluses at the point where the leaflets join the rachis, though occasionally the calluses can be orange or reddish

The bifurcation of the leaflets is normally a simple division into two parts - which I refer to as "sub-leaflets" for the purpose of clarity. The spread of the sub-leaflets varies from those which are almost parallel to those which are angled, with the angle of divergence ranging from narrow to wide. Infrequently, the leaflet division can vary from the normal division of two sub-leaflets to a double division of four sub-leaflets.

There is also an intermediate stage in which the leaflets divide into two segments, with the first segment again dividing into two sub-leaflets. The second segment remains entire, giving the effect of three sub-leaflets. Occasionally, instead of remaining entire a second segment can be found partially divided, with either a limited apical division or a partial division commencing from between the mid-section and the apex. Very rarely, the leaflet division can result in five subleaflets being formed.

The division of the leaflets into sub-leaflets has the effect of creating a crowded look on the fronds as the sub-leaflets tend to overlap each other. On those fronds with predominantly divided leaflets, the division of the leaflets often ceases towards the apex of the frond with usually the last few leaflets being entire.

The number of fronds per plant varies, with the average number ranging between 15 and 20. Some plants have as few as five fronds and others as many as 30 or more. The fronds rise to average height of approximately 70 to 90 cm, with a maximum height of approximately 110 cm.

The canopy cover varies in different habitat locations from being predominantly *Callitris* sp. (Australian Cypress pine) to being predominantly eucalypt. *Macrozamia diplomera* tends to also grow in a scattered arrangement of individual plants frequently in extensive colonies. Occasionally, under heavily shaded eucalypt canopy, it may be localized in thickly populated stands.

The coning cycle of *M. diplomera* is very erratic. I have never seen large scale coning at any of the locations which I have observed over a 10 year period. And, I have made regular visits to one of the larger stands. At one location where limited coning had taken place I saw female plants with two cones. Seeds can have a red or yellow colored fleshy covering.

One peculiar feature of *M. diplomera* is that some plants have a 1.2-1.5 meter long whip-cord like tap root. This root extends straight down from the base of the caudex into the sandy soil in which they grow, quite possibly for obtaining extra moisture from the sub-layers of the soil.

Although *M. diplomera* normally has an unbranched subterranean caudex, I have seen a single plant which was growing in an earth bank formed by a road-grader on the side of a dirt road which had three separate heads of fronds at ground level and two underground "suckers" with emerging fronds. The fronds on this plant (which had obviously been damaged in a road grading operation) were substantially smaller than normal fronds.

Near Coonabarabran, *M. diplomera* appears to hybridize naturally with plants which were previously considered to be a form of *M. heteromera*. However, David Jones (*Cycads of the World*, 1993.) has recently identified these as *Macrozamia* sp. 'Southern Pilliga.' One possible explanation for this mingling of species is that seeds of *M. diplomera* were dispersed by emus. These large birds are thought to be attracted to the brightly colored flesh on *Macrozamia* seeds.

It is also interesting to note Jones' comment that the "numerous, obliquely erect leaves" of *M. diplomera* gives the crown "the appearance of a shuttlecock."

Macrozamia diplomera seems closely allied in size and general appearance to the small ("dwarf") *M. communis* plants which grow in the Newcastle-Cessnock area. To a lesser degree, they are allied to the smaller inland forms of *M. communis* (which are geographically isolated from *M. diplomera*). This affinity does not extend to the more robust coastal plants of *M. communis*. Identification of the two species is relatively simple as *M. communis* only has entire leaflets, whereas *M. diplomera* usually has divided leaflets. Additionally, *M. diplomera* has amphistomatic leaflets whereas *M. communis* has hypostomatic leaflets.

Macrozamia diplomera is readily distinguishable from the other divided leaflet species which grow in north-western New South Wales such as *M. heteromera*, *M. sp.* 'Northern Pilliga' and *M. stenomera*. Identification is made easily due to its size, number of fronds, and its straight rachis and leaflets which extend horizontally in a flat plane from the rachis.

This species, and not *M. heteromera*, as suggested by some writers was responsible for a livestock poisoning episode near Coonabarabran in May of 1929. Approximately 2,200 sheep died, reportedly as a result of eating seeds from disintegrating cones. Some observers now believe that the deaths may have been caused by eating the fleshy covering of the seeds, rather than ingesting the actual seeds.

Macrozamia stenomera

Macrozamia stenomera (Section Parazamia) is a small cycad that is also endemic to New South Wales. It has a subterranean caudex and unique multi-

divided leaflets. This species was described in 1959 by Dr L. A. S. Johnson, (a former Director of the Sydney Royal Botanic Gardens) when he undertook a reclassification of the nomenclature of Australian cycads. Dr Johnson found that *M. stenomera*, which had not previously been distinguished from *M. heteromera*, warranted recognition as a separate and distinct species.

Macrozamia stenomera grows in north-western New South Wales in an area centered principally around the Nandewar Range (located approximately 50 km east of the town of Narrabri). Normally it grows under a eucalypt canopy as scattered individual plants or occasionally in small colonies.

Narrabri, with an elevation of 212 meters, has an annual average rainfall of 660 mm spread over 64 rain days. The daily winter minimum temperatures in July of -0.8° C and summer temperatures of 37.6° C, are reached at least once per week. Frosts can occur on an average of 29 days per year. One-third of the annual rainfall at Narrabri occurs during summer, with the balance of the rainfall being spread evenly on a seasonal basis over the remainder of the year. The seasonal rainfall pattern is as follows: Summer 33%, Autumn 22%, Winter 21% and Spring 24%.

There is no official weather station on the Nandewar Range. However, the climate where *M. stenomera* grows on the higher altitudes of the range is significantly cooler and wetter than in nearby Narrabri. According to local sources, the temperature on the upper altitudes of the ranges can be 10 degrees cooler than Narrabri. The annual rainfall is considerably higher, averaging approximately 1,100 mm annually. High winds, frequent frosts and occasional snow (4-5 times per year) are also encountered on the upper altitudes of the ranges.

Macrozamia stenomera occurs at elevations of up to 1,450 meters (4,500 feet) on steep, sometimes sheer, generally north-facing rocky slopes. It is a true mountain dweller and subject to extreme weather conditions.

The principal characteristics of *M. stenomera* are as follows:

- subterranean caudex,
- initially upright frond which is normally twisted, sometimes irregularly, and which often has a moderately curved apical section,
- multi-divided leaflets, which extend from a short stem that twists at the base so that the leaflets face upwards towards the apex of the frond,
- new fronds which are initially a distinctive light green color, but which undergo a color transformation with age and ultimately become faded bluish-green color, and pale yellow to orange calluses at the bases of the leaflets.

In contrast to *M. diplomera* and *M. heteromera*, which have leaflets that generally divide into two sub-leaflets, *M. stenomera* has much narrower leaflets that normally divide from two to four times to form four to eight sub-leaflets (sometimes more). Like *M. diplomera*, *M. stenomera* can have both odd and even numbers of sub-leaflets (some of the segments remain entire). The largest number of sub-leaflets that I have observed on a single leaflet is 13. The multi-divided leaflets give the fronds and plants a very bushy appearance. This makes it extremely difficult to clearly distinguish the leaflets. Even in habitat, unless a close-up thorough examination of the frond structure is undertaken, details of the leaflets are obscure.

Because of the bushy appearance it is virtually impossible to capture details of the frond in a photograph. To overcome this problem, I have photographed a frond with only every sixth pair of leaflets remaining on the rachis (portion of a frond with leaflets). This effect gives a better impression of the leaflet detail to those who may not have seen *M. stenomera* in the field.

The frond and leaflet characteristics on *M. stenomera* are complex and hard to describe. The average number of fronds per plant ranges from about four to six; with some plants having as few as two fronds and others ranging up to a maximum of 14. The fronds rise to an average height above ground level of approximately 50 to 70 cm and range up to a maximum height of approximately 90 cm. Each frond has a short petiole (naked stalk of a frond) which extends from the rachis at approximately 70 degrees. The petiole is twisted at the base so that the leaflets face upwards towards the apex of the frond. The individual leaflets are divided at their bases near the attachment to the rachis. This is a major structural division from which there are two main 'arms' of each leaflet (roughly in the shape of a "V"). A variable number of further divisions then occurs, ultimately producing between four and 13 sub-leaflets. As a consequence, the sub-leaflets are densely crowded and overlap each other and accentuate the bushy appearance of the multi-divided leaflets (see end-on photograph of frond).

Unlike *M. diplomera* and *M. heteromera*, which do not always maintain a pattern of consistently divided leaflets, the leaflets on *M. stenomera* are virtually always divided except sometimes toward the tip of the frond where the last few leaflets can be either divided or entire. Divided leaflets also occur in juvenile plants and seedlings but are not as numerous.

The coning cycle of this species is irregular. Seed cones are usually solitary, although I have seen plants with two seed cones. Seeds can have either red or yellow outer covering. The yellow seeds are an attractive lemon yellow, sometimes with a green segment where the sporophylls had opened up as the cone ripened prior to disintegrating.

The highest peak on the Nandewar Range is Mt Kaputar, which is 1,525 meters high and now forms part of the Mt Kaputar National Park. The view from the peak of Mt Kaputar is quite spectacular and a visitor information sign indicates that on a fine day up to 10% of New South Wales can be seen. Kangaroos and multi-colored feral goats are often sighted within the confines of the National Park.

Macrozamia stenomera has close affinities to *M. heteromera* and, to a lesser extent, *M. sp. 'Northern Pilliga'* ("Cycads of the World" by David Jones). All three species are small in stature and have divided leaflets. However, *M. stenomera* has narrower, multi-divided leaflets compared with the normal simple or sometimes double division of the other two species. It consistently maintains the multi-divided leaflets, whereas *M. heteromera* and *M. sp. 'Northern Pilliga'* can have fronds with a combination of divided and entire leaflets. In addition, from a strictly botanical point of view, *M. stenomera* has hypostomatic leaflets (stomata on the lower surface) whereas the latter two species have amphistomatic leaflets (stomata on upper and lower surfaces).

Lepidozamia peroffskyana

Lepidozamia peroffskyana is a large cycad which is endemic to eastern Australia and which grows in both northern New South Wales and southeastern Queensland. It has a distribution which stretches over approximately 600 km of coastal and near coastal areas and which extends from near Taree on the midnorth coast of New South Wales to near Nambour, north of Brisbane, in Queensland.

Climatic information relating to Murwillumbah, Coffs Harbour and Taree - which are situated near the extremities and the center of the New South Wales distribution range of *L. peroffskyana* - and covering altitude, annual average rainfall, number of rain days and frost days per year, and minimum and maximum temperatures reached at least once per week in July and January, respectively, is as follows:

	Altitude (meters)	Annual Average Rainfall (mm)	Rain Days	Frost Days	Temperature July min.	Range Jan. max.
Taree	5	1178	116	10	1.3°C	33.3°C
Coffs Harbour	5	1708	144	6	2.6°C	28.9°C
Murwillumbah	18	1687	156	4	3.6°C	32.1°C

Over 60% of the annual rainfall covering the New South Wales distribution range of *L. peroffskyana* falls in summer and autumn, but on a seasonal basis the

rainfall pattern is very uniform with 50% falling in spring and summer and 50% falling in autumn and winter. The percentage seasonal rainfall pattern is as follows: Summer: 32%, Autumn: 32%, Winter: 18% and Spring: 18%.

Lepidozamia peroffskyana is the tallest cycad in New South Wales. It normally grows in large dense stands, sometimes in abundance. I use the term "in abundance" to describe situations in which adult plants grow so prolifically that the fronds of numerous plants growing very close together actually overlap each other.

It grows in abundance at altitudes of 500 to 700 meters near Dorrigo, which is the wettest town in New South Wales, with an annual average rainfall of approximately 2,000 mm (80 inches) spread over 149 rain days. Detailed weather information, apart from rainfall statistics, is, unfortunately, not available for Dorrigo. Forest areas near Dorrigo are heavily infested with leeches, ticks, and mosquitoes.

This cycad normally grows under a eucalypt canopy in habitats ranging from stabilized sand dunes and sand hills near the ocean to steep slopes of mountain ranges adjoining the sometime narrow coastal plains belt. On the mountain ranges it grows in areas of wet sclerophyll forest bordering on rainforest, while in proximity to the ocean it can be found in either depauperate littoral rainforest or open scrubby forest.

The principal characteristics of *L. peroffskyana* are:

- (1) a tall columnar trunk, normally standing 0.6 to 1.8 meters above ground level and ranging up to 35 cm in diameter (but with some plants having trunks reaching up to 5 meters above ground level),
- (2) a maximum of approximately 50 to 60 very glossy, dark green fronds which range up to 2 to 3 meters in length,
- (3) an untwisted rachis,
- (4) entire leaflets, which rise in an arching manner from the rachis but then tend to droop - with the median leaflets extending at right-angles to the rachis and the apical and lower leaflets extending (from the rachis) at approximately 30 and 120 degrees, respectively, and
- (5) seeds with reddish flesh; though seeds with yellow flesh also occur in some stands.

Lepidozamia peroffskyana usually has an unbranched trunk, though in some stands it is not uncommon to find multiheaded plants or plants with branched trunks - with some plants having as many as five separate trunks. This tendency for

plants to branch occurs in some stands, but in other disjunct stands there are no plants at all with branched trunks.

The tallest *L. peroffskyana* plant that I have seen in New South Wales (see habitat photo) was a plant which branched, 1.8 meters above ground level, into two separate trunks, which were, respectively, 3.1 and 3.3 meters long - thus making the overall height of this particular plant a little over 5 meters.

A unique feature of this cycad is its rare capacity to produce sporophylls holding three seeds, as opposed to the normal two seeds. The three-seeded sporophylls, which are normally only found in the basal area of a cone, have two seeds sitting side by side with the third seed placed above (and in the middle of) the other two seeds so as to form a triangular pattern.

Seeds of *L. peroffskyana* are the largest seeds of any New South Wales cycad and measure up to 6 cm long and 3 cm in diameter.

New fronds of are produced in flushes and often rise in an upright manner (with furled leaflets) for a considerable portion of their ultimate length before the leaflets begin to unfurl. The leaflets on new fronds are a distinctive bronze but change to glossy dark green as the fronds reach full size and undergo a hardening process.

During the relatively short period of time in which new fronds reach full size and harden-up, the leaflets are extremely glossy and shiny - so much so that the sunshine is brilliantly reflected by the numerous new fronds, especially when all the plants in a stand have produced new growth after a fire.

With age, the fronds tend to arch and produce a graceful palm-like appearance. The leaflets on *L. peroffskyana* rise alternately from the midline of the rachis, as opposed to the leaflets on various *Macrozamia* species which rise (or extend laterally) from the edges of the rachis. In contrast with most *Macrozamia* species, the leaflets on this cycad do not have a prominent callus at the point where they join the rachis; nor do fronds have sharply tipped leaflets like *M. communis* or spiny leaflets-appendages like *M. johnsonii* (formerly known as the New South Wales form of *M. moorei*).

Additionally, the sporophylls on female cones of *L. peroffskyana*, as opposed to some *Macrozamia* species, do not have elongate spines - though the sporophyll ends are pointed and generally bent sharply outward and sometimes downward; and, in some respects, could be said to have a rudimentary spine.

Both male and female cones are large and, in contrast with *Macrozamia* cones, do not have a peduncle.

Female plants usually have solitary cones, though plants with two cones are not uncommon (see habitat photo of two adjacent female plants, each with two cones). Female cones of *L. peroffskyana* are the largest cones of any New South Wales cycad and, when mature, measure up to 50-60 cms long and 20-25 cms wide.

One unusual feature of mature female cones is that it is possible, with some difficulty, to break away the sporophylls from their own stalks (which remain attached to the central axis of the cone) and leave the seeds intact on the cone, whereas the sporophylls on various *Macrozamia* species, together with their stalk and seeds, usually break away from the cone at the point where the stem joins the central axis.

It is thus possible to photograph a mature seed cone with all, or most, of its seeds intact on the cone, but without the protective covering provided by the sporophylls.

Like female plants, male plants can also have one or two cones, though plants with two cones are uncommon. Male cones open up in an unusual spiral fashion and distend when about to shed pollen. Prior to distending, male cones measure up to 50-60 cms long and 10-12 cms wide. When cones are fully distended they can reach up to approximately 1 meter in length.

Natural regeneration of *L. peroffskyana* in the wild is evidenced by the large numbers of seedling plants which can often be seen growing in the vicinity of parent plants; though, on average, very few of these seedlings ultimately grow to maturity.

It is also noticeable that the average size of plants can vary in different habitat locations - for example, plants at Mt. Tamborine (in southeastern Queensland) are generally taller and more robust than plants at Dorrigo, even though at both locations the plants grow on steep slopes of mountain ranges which border the coastal plains, at a distance of less than 40 km from the sea.

Even though Mt Tamborine and Dorrigo are some 250 km apart, the reason for the size variation is undoubtedly edaphic, it relates to the physical and chemical characteristics of the soil. It is not due to climate, as stands of *L. peroffskyana* which grow in a rather widespread, though localized, pattern over almost its entire range, are usually subject to nearly uniform climatic conditions (apart from some populations which are located near the extreme southern part of the New South Wales distribution).

Populations of this cycad are often found in State Forests and are subject to planned periodic burn-offs by the Forestry Commission.

The trunks and crowns of this tall cycad are often host to epiphytic plants such as *Platyserium bifurcatum* (elkhorn), *Asplenium australasicum* (bird's-nest

fern) and *Davallia* species (hare's-foot ferns). In the Byron Bay area, somewhat unusually for a cycad, *L. peroffskyana* grows alongside the Australian native palm, *Archontophoenix cunninghamiana* (the "bangalow" palm).

Lepidozamia peroffskyana is probably the most widely cultivated New South Wales cycad as it is fast growing, has extremely attractive fronds, and makes an excellent potted plant or garden specimen.

From time to time adult and semiadult plants, which have obviously been collected from the wild, are available for sale in nurseries. In my opinion, there is an inherent risk in purchasing such plants as they may well be infested with the potentially destructive weevil, *Tranes internatus*.

The damage which can be caused to cycads by this weevil was the subject of an article on "Cycad-Insect Relationships" in Issue No 34 of "Palms & Cycads." In this article mention was made of reports of the problems caused in California in the late 1970's and early 1980's by *T. internatus*, which was suspected of having been introduced into the U.S., during the late 1960's, in the caudices of imported Australian cycads.

Further historical evidence of the activities of *T. internatus* is available by reference to an article written, over 100 years ago, in 1886, by J. O. Westwood in a Belgian entomology Journal. In this article, Westwood described (and illustrated) the ravages caused by larvae identified as *T. internatus* which had been found in the caudex of an imported Australian cycad in the city of Ghent. The relevant plant which was described as "*Zamia corallipes*," was probably either *Macrozamia spiralis* or *M. communis*, though there is insufficient evidence in the article to positively identify the particular *Macrozamia* species involved.

The weevil was thus capable of surviving a lengthy surface trip to Europe in the early 1880's and, also, of withstanding probable fumigation when imported into the U.S. in the late 1960's) and was then able to reproduce in a new and quite different environment.

Three conclusions about *T. internatus* are suggested from the above:

- (1) that adult weevils apparently live deep inside cycad caudices, possibly in tunnels created by larvae, and can resist most normal insecticide treatments,
- (2) that when removed from their own environment, the weevils are probably isolated from their natural enemies and are able to freely multiply, and
- (3) that there appears to be an extremely long time interval between the arrival of this weevil in a home garden and its emergence as an identifiable problem.

Having recently observed the weevils breeding in an immature female cone of *L. peroffskyana*, it is my opinion that purchasing plants collected from the wild (or the removal of any cycads from the wild) is a little like a lottery. You are taking a chance. If you happen to end up with a plant which is weevil infested, you unknowingly may have a mini-ecological 'time-bomb' on your hands and in your garden!

Lepidozamia peroffskyana is most closely related to *L. hopei*, the only other species in the genus. The much broader and darker green fronds of *L. hopei* render the two species easily distinguishable.

