AUSTRALIAN MUSEUM SCIENTIFIC PUBLICATIONS

Asmussen, Brit, 2011. Changing perspectives in Australian archaeology, part X. "There is likewise a nut…" a comparative ethnobotany of Aboriginal processing methods and consumption of Australian *Bowenia, Cycas, Macrozamia* and *Lepidozamia* species. *Technical Reports of the Australian Museum, Online* 23(10): 147–163.

doi:10.3853/j.1835-4211.23.2011.1575

ISSN 1835-4211 (online)

Published online by the Australian Museum, Sydney

Changing Perspectives in Australian Archaeology

edited by

Jim Specht and Robin Torrence

Papers in Honour of Val Attenbrow

Technical Reports of the Australian Museum, Online 23 (2011)

ISSN 1835-4211

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Technical Reports of the Australian Museum, Online (2011) No. 23: 147–163. ISSN 1835-4211
doi:10.3853/j.1835-4211.23.2011.1575

Changing Perspectives in Australian Archaeology, Part X

"There is likewise a nut…"[1] A Comparative Ethnobotany of Aboriginal Processing Methods and Consumption of Australian *Bowenia*, *Cycas*, *Lepidozamia* and *Macrozamia* species

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ABSTRACT. As a result of research throughout tropical Australia, much is known concerning the various techniques Australian Aboriginal peoples used to remove toxins from *Cycas* seeds prior to consumption. However, comparatively little is known about the methods used to process *Macrozamia* seeds and if they are regionally or genus specific. This paper describes the methods used to process different *Macrozamia* species, as recorded in Aboriginal and historical accounts throughout the eastern, central and southwestern parts of Australia. A comparative ethnobotany of the processing methods and food uses of the four genera of cycad found in Australia: *Bowenia, Cycas*, *Lepidozamia* and *Macrozamia*, is then presented. This review confirms that although there are many similarities in processing techniques and uses between these genera, there are also important differences, including variations in processing methods partly related to water availability, regional differences in the parts of the plants which were consumed, and contexts of use between different areas of Australia.

ASMUSSEN, BRIT, 2011. Changing perspectives in Australian archaeology, part X. "There is likewise a nut…" a comparative ethnobotany of Aboriginal processing methods and consumption of Australian *Bowenia*, *Cycas*, *Lepidozamia* and *Macrozamia* species. *Technical Reports of the Australian Museum, Online* 23(10): 147–163.

Despite their inherent toxicity when fresh, cycad seeds have been recorded as a food resource in many parts of the world, and various methods have been used to detoxify them prior to consumption (Theiret, 1958; Whiting, 1963; Whitelock, 2002). Following an extensive review of Australian ethnobotanical sources compiled within the last 200 years, and observations made during fieldwork in Arnhem Land, Beck (1992: 135–136, fig. 2–4, 141) classified the traditional methods used to process *Cycas* spp. seeds in Australia as *(1)* brief leaching in water, *(2)* prolonged leaching in water, and *(3)* ageing (Table 1). Beck (1992: 133, 141) proposed that these different techniques had pros and cons in relation to seed availability, storability, taste and convenience. Fresh seeds were only available for a few months at the end of the dry season, in contrast to aged seeds, which were available at all times. The limited seasonal availability of fresh seeds could be extended for several months via prolonged leaching and storage in still water. Seeds that had undergone extended leaching, ageing or were baked into loaves could be stored, while seeds leached only briefly perished quickly. According to Beck, prolonged leaching was the most energy-efficient method, while making loaves of bread was the most energy-consuming method, although these were portable and kept well.

[1] from Hunter's (1793: 478–479) *An Historical Journal of the Transactions at Port Jackson and Norfolk Island.* London: John Stockdale.

Table 1. Beck's (1992) classification of the techniques used to process *Cycas* seeds.

Technique	Process	Duration
Brief leaching	Fresh seeds were collected from female plants. Seeds were always cooked (roasted and cracked) before leaching them overnight in still or running water (Beck, 1992: 135). After cooking, the seeds were sometimes dried, and then either made into flour, sliced finely, or flattened with a stone mortar before leaching. The end product had to be eaten quickly as it would not keep (Beck, 1992: 136).	24 hours. The accounts indicate 24 hours was the minimum required for completion (Beck, 1992:135–136).
Prolonged leaching	Either the kernels of freshly picked seeds or the hard, shrunken kernels of some windfall seeds were treated in this way. The seeds were never cooked before leaching. In most cases the kernels were extracted and dried, pounded, left in a running stream for three to seven days. Still water or specially dug waterholes were also used to leach the seeds. “May be carried out in still or running water” (Beck, 1992: 135). Seeds processed using this technique kept well, and the technique was used to extend seed availability.	More than 24 hours (Beck, 1992: 135).
Ageing	Ageing occurs naturally as a result of the seeds lying underneath the trees for some months, or could be controlled by drying or prolonged storage, or by burying in the ground for several months (Beck, 1992: 141). The technique could be used to extend seed availability.	Several months

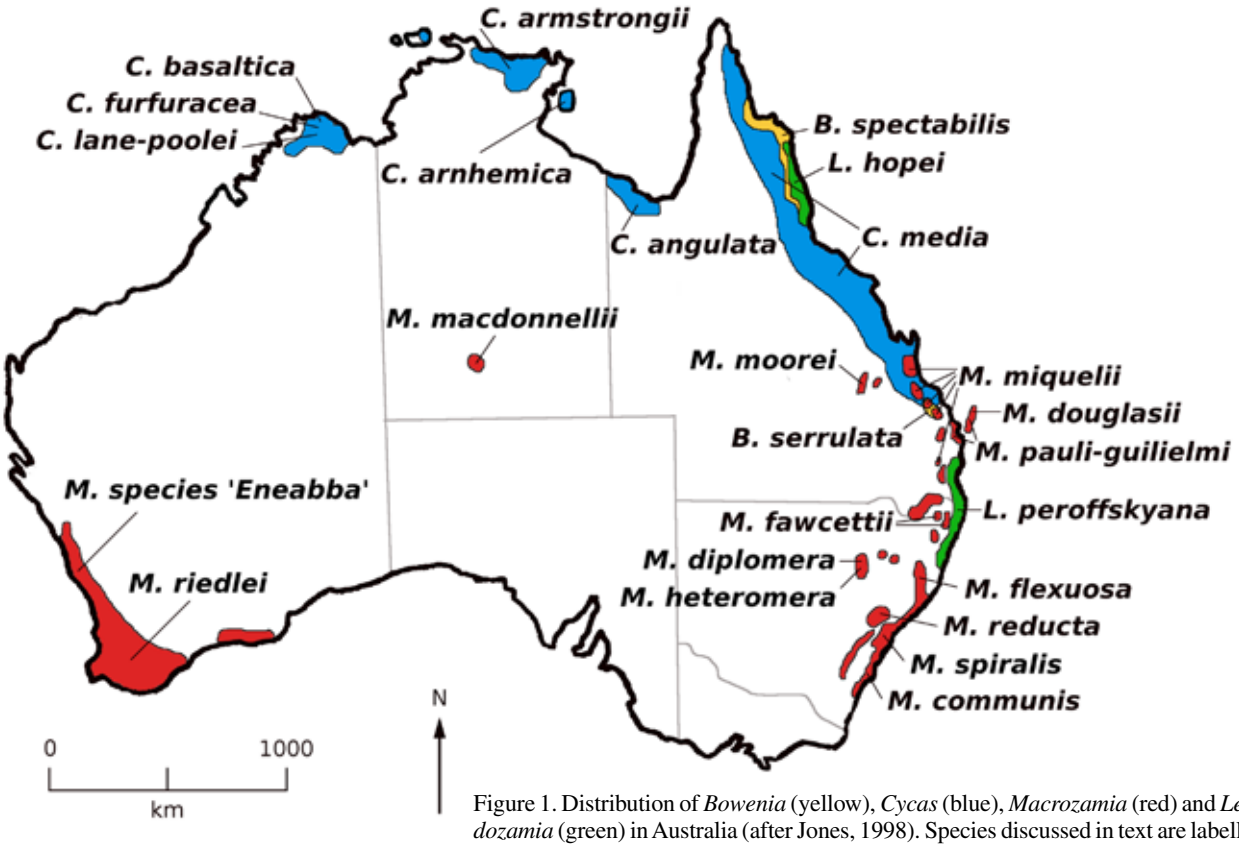

Figure 1. Distribution of *Bowenia* (yellow), *Cycas* (blue), *Macrozamia* (red) and *Lepidozamia* (green) in Australia (after Jones, 1998). Species discussed in text are labelled.

As a result of Beck's research, much is known about the methods used to process *Cycas* seeds; however, a comparative study of the methods used to process *Macrozamia* seeds and their utility has not been conducted despite archaeological interest in this resource (e.g., Beaton, 1982). Descriptions of *Macrozamia* use from Aboriginal and early historical accounts were examined to address a series of questions.

1 Were *Macrozamia* seeds used in the same way in different parts of the country?

2 Were similar techniques used to process *Macrozamia* and *Cycas* seeds?

3 Was there geographic variation in the methods used to detoxify *Macrozamia* seeds?

4 Given that some techniques use water and others do not, do differences in rainfall explain the choice of method used to process *Macrozamia* seeds?

5 To what extent was the duration of processing extended beyond the minimum required to detoxify seeds?

Additional questions were posed to understand *Macrozamia* resource use from an archaeological perspective.

6 Should the presence of *Macrozamia* in archaeological sites be used as an indicator of seasonality of site use?

7 Were *Macrozamia* seeds a staple food as was the case in some regions for *Cycas*?

8 How does the exploitation of *Macrozamia* compare with that of other endemic cycad genera, such as *Bowenia* and *Lepidozamia*?

Materials and methods

Terminology. *Macrozamia* is one of the four genera of cycads present in Australia: *Bowenia* (family Stangeriaceae, three endemic species); *Cycas* (family Cycadaceae, 26 species); and *Lepidozamia* and *Macrozamia* (family Zamiaceae, two extant endemic and 41 endemic species respectively) (Jones, 1998; Forster, 2004: 85) (Fig. 1). Palm-like *Macrozamia* plants (Fig. 2) grow in open forests and woodlands in subtropical and temperate regions, from the coast to inland gorges in Queensland, New South Wales and Western Australia, and on steep slopes in sheltered valleys in Central Australia (Jones, 1998: 232) while *Bowenia* and *Lepidozamia* grow in sheltered forest locations, including rainforests (Jones, 1998: 105, 226). In *Bowenia*, *Lepidozamia* and *Macrozamia*, female plants produce edible seeds on large cones called strobili (Fig. 3), while *Cycas* seeds are not arranged in cones but hang in a ring below the leaves. Seeds are comprised of three main components: the outer layer of brightly coloured, fleshy sarcotesta; an inner woody sclerotesta; and the internal edible kernel (Jones, 1998) (Fig. 4). Due to taxonomic confusion in some accounts, and changes to taxonomy since the accounts were made, the species named in historic documents have been checked against Jones (1998) and Whitelock (2002) (Appendix 1).

Early historical accounts of *Macrozamia* processing and use. The following accounts of Aboriginal collection, processing and use of *Macrozamia* seeds come from the descriptions of botanists, convicts, ethnographers, explorers, government officials, missionaries and settlers in Queensland, New South Wales and Western Australia. A total of 43 accounts mentioning *Macrozamia* use were found, dating from 1788 to 1979. Of these accounts, 35 provide enough detail to identify the processing method used (Appendix 1).

Figure 2. *Macrozamia communis* plant with seed cone (strobilus). Taken at the Royal Botanical Gardens and Domain, Sydney, 2004. Photograph: Brit Asmussen.

Figure 3. Close up of strobilus on *Macrozamia communis* plant. Taken at the Royal Botanical Gardens and Domain, Sydney, 2004. Photograph: Brit Asmussen.

Five of the 41 currently recognized *Macrozamia* species were recorded in the accounts as being eaten: *Macrozamia communis* (L.A.S. Johnson); *Macrozamia miquelii* (F. Muell.); *Macrozamia pauli-guilielmi* (W. Hill & F. Muell.); *Macrozamia riedlei* (Gaudich); and *Macrozamia spiralis* (Salisb.). In addition, the possible use of four species were identified based on their presence in the same area as the *Macrozamia douglasii* (W. Hill ex F.M. Bailey); *M. flexuosa* (C. Moore); *M. fraseri* (Miq.) (named *M. species Eneabba* by Jones, 1998); and *M. reducta* (K.D. Hill & D.L. Jones) (Appendix 1). Both species of *Lepidozamia*, but only one species of *Bowenia* were recorded as being eaten.

Primary accounts based on observations are preferred, but in some cases it is difficult to identify whether they were informed by previously published descriptions. The methods used to process *Macrozamia* spp. were classified following Beck's (1992) criteria (brief, prolonged or ageing) and departures identified. Statistical tests were applied to explore the effect of rainfall on the choice of processing method. The results are discussed separately for each state to facilitate regional comparisons and to avoid the repetitious (and confusing) use of species names.

Results

Queensland. In Queensland, *Macrozamia* were described as being "used for the purposes of food" (Hill, 1867: 3), and "formed an important article of food" (Turner, 1893: 159–161). The accounts indicate the use of two methods to detoxify kernels. Of the three accounts of prolonged leaching for mainland Wide Bay (Palmer, 1883: 97; Tindale, 1925: 76–77), Turner's account (1893: 159–161) is the most detailed, stating that kernels were placed in a dilly bag in a stream or waterhole for approximately six days before being baked in ashes. Prolonged leaching also appears to have been the only technique utilized on Fraser Island. Bracewell, an escaped convict, indicated that the kernels of seeds were processed after being soaked in a running stream for two days and nights (Simpson, 1843; Davison & Nicholls, 1935: 165) while Miller (Devitt, 1979) indicated that following soaking, nuts were dried, ground and made into cakes and cooked. Other more cursory accounts mention the use of the seed but do not describe processing techniques (e.g., Meston, 1889a: 4; Loyau, 1897: 58, 190; Petrie, 1904: 266; Mitchell in Steele, 1975: 107–109, 356).

In a newspaper article Walter Hill (1867: 3), Colonial Botanist of Queensland, discussed the preparation of *Macrozamia* seeds in Queensland. He argued that "stooping" seeds in water was to make "use of the water as a safe repository for the fruit against the inroads of wild animals, and even themselves… they frequently make a point of depositing the fruit in the nearest lagoon or watercourse, there allowing it to remain until they require it for use." Hill's annotation on the label of a *M. pauli-guilielmi* specimen collected between 1860 and 1870 indicated that he considered the "nuts of this plant are the only food the natives put in store for their use" (Queensland Herbarium, 2007: 7).

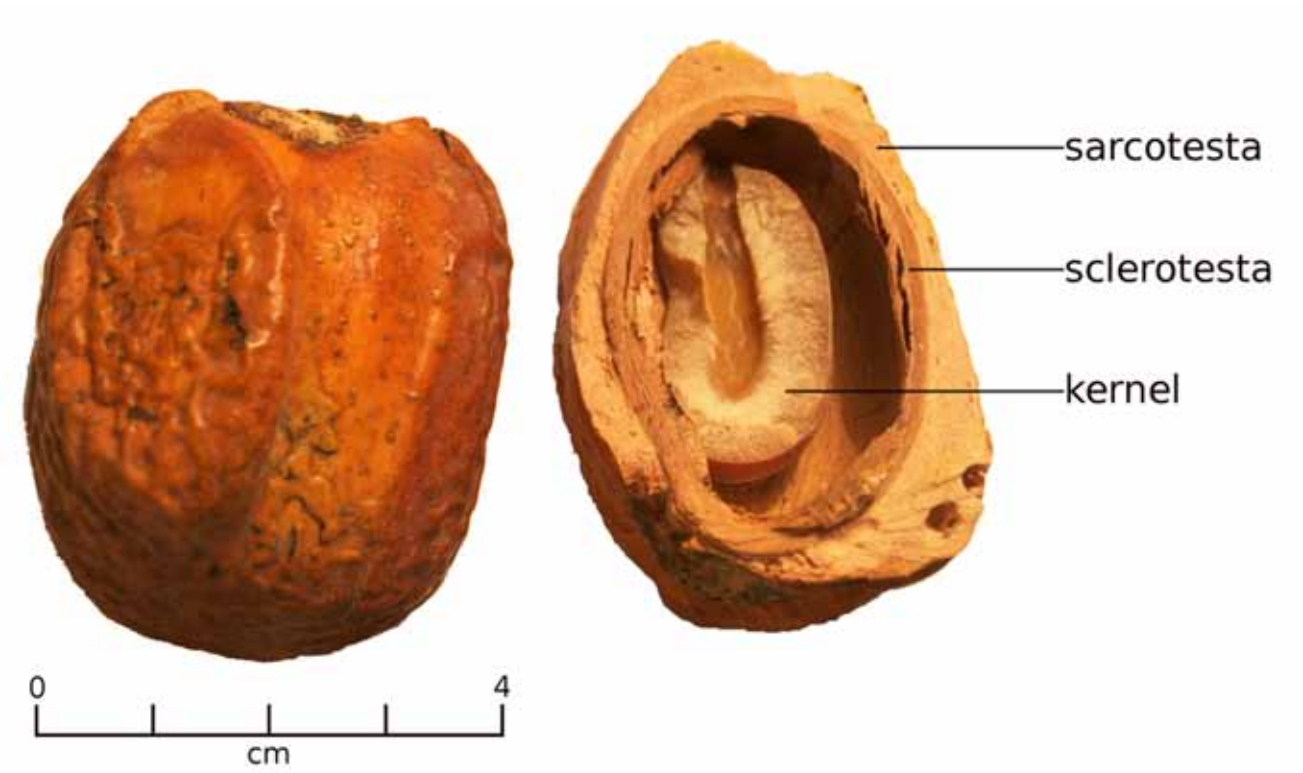

Figure 4. *Macrozamia moorei* seed with sarcotesta and section through seed showing sarcotesta (outer flesh), sclerotesta (woody seed coat) and inner kernel. Collected 2004. Photograph: Brit Asmussen.

Two accounts describe the use of roasting followed by a more extensive period of leaching than was the case in brief leaching of *Cycas* spp. Thozet (1866: 16) indicated that *M. miquelii* seeds were first baked in their shells, which were then cracked. The inner kernels were removed and placed in bags, which were then carried to a stream or pond and leached in water for six to eight days. Gaiarbau, a Dungidau elder of Kilcoy who travelled around the Wide Bay region, also indicated the use of this technique for *M. miquelii* (Symons & Symons, 1996: 80; Winterbotham, no date: 55). This method is hereafter called roasting and extended leaching.

New South Wales. Early observations of *Macrozamia* use occurred on the coast around Broken Bay, Port Jackson and Botany Bay in 1788 (Phillip, 1738–1814[1879]: 160; Bradley, 1786–1792[1969]: 92; Barton, 1889: 286). Although these accounts noted the poisonous nature of the seeds, none indicated the method(s) used to detoxify them.

More detailed accounts, dating from the early to the late colonial period, indicate that kernels were detoxified by prolonged leaching. Backhouse (1843: 542), Elliott (Edgeworth David, 1890: 119), Hunter (1793: 478–479), Jackson (1864: 251), Milford (1876: 296), Moore (1883: 117), Robinson (1844 in Mackaness, 1941), Threlkeld (Gunson, 1974, vol 1: 55), and Walker (1875–1910, vol 5: 34–35) describe the use of this technique, which appears to have been widespread across New South Wales. In these accounts, seeds were placed in still or running water for between three days and two weeks and then consumed, or roasted in ashes or hot coals of campfires. Although Backhouse, Jackson and Moore discussed the use of *M. spiralis,* it is likely some of these accounts concern *M. communis*, the most common species in New South Wales, which was not identified as a species until 1959 (Johnson, 1959; Whitelock, 2002: 250).

Single accounts suggest the use of brief leaching as well as roasting and extended leaching. Atkinson's (1826: 19) description unambiguously describes the use of brief leaching, in which

> they first roast the nuts in the ashes of their fire for a short time, then crack them between two stones, separating the kernels and breaking them also; they then roll up a piece of bark in the form of a tube, and placing some grass or other substance to prevent their escape, immerse them in a running stream for twelve hours.

Backhouse (1843: 380–381) indicates that roasting and extended leaching was used around Newcastle in 1836, where seeds were roasted and pounded and leached in water for two to three weeks. This technique is very similar to that described by Thozet and Gaiarbau in Queensland. Cunningham's (1827: 227) account near the Hunter River is unclear, and may indicate either brief leaching or roasting followed by extended leaching. Moore (1883: 117) mentions that seeds could be eaten following roasting in a fire.

Accounts differ concerning the role and importance of *Macrozamia* spp. in the diet of New South Wales Aboriginal groups. Jackson (1864: 251) commented that seeds were "an article of food in times of scarcity", and Robinson implied seeds were used in subsistence along with the Cabbage Palm (*Livistona australis* (R. Br.)) on the southern ranges in 1844 (Mackaness, 1941: 335). Walker (1875–1910: 34) indicated that "the nuts cause fights amongst the native tribes… who esteem them as a great delicacy," while Cunningham (1827: 221) stated that the seeds were "much relished" near the Hunter River (cf. Maiden, 1889: 41).

Central Australia. The explorer John McDouall Stuart and his party observed seeds from *Macrozamia macdonnellii* (F. Muell. ex Miq), the only species of *Macrozamia* in central Australia, while traversing the MacDonnell Ranges in the early 1860s (Stuart, 1864). Unlike most other *Macrozamia*, there are no accounts indicating Aboriginal use of this species. Latz (1995: 223, 1999: 181) proposes that seeds were not eaten due to the restricted distribution and rarity of the plant, its

infrequent production of large quantities of seed, and because a lack of water made leaching impracticable in arid areas.

Western Australia. All identified accounts from Western Australia describe consumption of the outer sarcotesta of *M. riedlei* rather than the starchy inner kernel. The sarcotesta of fresh *Macrozamia* seeds contain the toxin macrozamin (Ladd *et al*., 1993: 37), which must be removed prior to consumption. Stokes (1846: 131) stated that the flesh was "considered a delicacy," and Ward and Fountain (1907: 211) commented that it was "very much sought after by them, as they are very fond of it."

Three techniques appear to have been used to detoxify the sarcotesta: prolonged leaching, ageing, and prolonged leaching followed by burial. Hammond (1933: 28) and Edwards (1894: 233) both noted the use of salt water. Edwards stated it was "not uncommon" to find seeds "suspended by a string attached to a stake on the sea beach," but also noted that seeds could be "soaked" "in shallow brooks." These accounts respectively indicate that the sarcotesta was soaked for "some days" to "a couple of weeks" According to Hammond (1933: 28), following treatment in salt water the sarcotesta "resembled a tomato in colour and taste." Moore (1842: 23) indicated the sarcotesta was "usually roasted" prior to consumption.

Six accounts include the use of ageing techniques, in which seeds were collected and buried, after which the sarcotesta was consumed (Armstrong, 1836; Backhouse, 1843; Drummond, 1862; Edwards, 1894; Hassell, 1936, 1975; Salvado & Stormon, 1977). Drummond (1862: 27) reported seeds could be buried for one month, while Salvado was vague, suggesting they were buried for "a certain time" (Salvado & Stormon, 1977: 165). Most accounts imply that seeds only were buried, though Salvado indicated that whole strobili were buried (Salvado & Stormon, 1977: 165). Most Europeans who tasted the sarcotesta following burial found its taste to be agreeable. For Salvado, the sarcotesta was "pleasant" and "very much to my taste" (Salvado & Stormon, 1977: 165, 213), and Hassell (1936: 705) described it as "resembling dates" but tasting "like olives." Only Drummond (1862: 27) found it to be "rancid" like "train oil."

Grey (1841: 296) and Moore (1842: 32) also described the use of prolonged leaching and burial of seeds. Following their collection in March, seeds were soaked in a shallow pool of water for several days, and were buried in the ground, where they remained for two weeks (Grey, 1841: 296). Following detoxification, the flesh was eaten "both raw and roasted" (Grey, 1841: 296). The flesh was an "agreeable and nutritious article of food", and Aboriginal people were "very fond of it" (Grey, 1841: 295). This technique was only recorded in the southwest. Brough Smyth (1878: 215) stated the technique had "been carried undoubtedly from the northeast to the northwest", although he did not elaborate.

The holes, called *mordak* (Grey, 1840: 88), in which seeds were placed are described in several accounts. The holes were "about the depth that a person's arms can reach, and one foot in diameter" (Grey, 1841: 296), "a couple of feet deep" (Salvado & Stormon, 1977: 161), or "about three to four feet deep" (Hassell, 1975: 24–25). They were lined with rushes, filled with seeds, sprinkled with sand and covered with "the tops of grass tree" (Grey, 1841: 296). Most accounts describe the burial of seeds in dry sand (Grey, 1841: 296), while Moore's (1842: 39) is the only account describing "moist earth." Grey (1841: 64) indicates that four of these large *mordak* holes could be found in one area. The accounts differ concerning whether these holes were also a form of storage. Grey (1841: 64), while "on the point of perishing for want of food," discussed "stealing" from a "buried store of *By yu* nuts," calling it "hidden food". Dixon *et al*. (1992: 115) suggest Noongar people "often buried a store of nuts [sic] to be kept for up to several months, so as to maintain an almost constant supply of the foodstuff throughout the year", but no historical accounts were found in support of this. Armstrong (1836: 793–794) stated that placing seeds in holes, or "pitting" should not be considered "provisioning for the future… because the nut is considered not to be wholesome until it has undergone that process."

Hassell, a settler who lived at Jerramungup between 1878 and 1886, stated that although plants did not grow in the area, the "fruit" was obtained from the "interior" through trade. The seeds were prepared for trade by taking the "stones out, which are never eaten, as they retain the poison, and string the fruit on rushes" (Hassell, 1975: 24–25). While Hassell's account is unclear, she may have been describing the removal of the sarcotesta from the sclerotesta and the stringing of sarcotesta onto rushes. Gregory (1887: 131–132) indicates that claims could be made on seeds, when he wrote "a native discovering a Zamia [sic] fruit unripe will put his mark upon it and no other native will touch this; the original finder of the fruit may rest perfectly certain that when it becomes ripe he has only to go and fetch it for himself." Grey (1841: 298) observed that if a group's land was:

> deficient in any particular article of food, such as, *by yu*… he makes a point of visiting some neighbour, whose property is productive in this particular article… numerous families appear to have an acknowledged right to visit at the period of the year when this article is in season, though they are not allowed to come there at any other time.

Gray (1840: 22) defined *by yu* as "the nut of the Zamia [sic] tree, when enveloped with pulp" [i.e. sarcotesta].

Discussion

Having reviewed the data, I now turn to a discussion of the questions raised at the beginning of the paper.

(1) Were seeds used the same way in different parts of the country? While people in most regions consumed kernels or products made from them, the accounts from southwestern Australia indicate a unique use of *Macrozamia*: the consumption and trade of the sarcotesta. While consumption of *Cycas* sarcotesta (Harvey, 1945: 191) and trade and storage of prepared slices of *Cycas* seeds (Bradley, 2006: 126) has been documented in the Northern Territory, the consumption and trade of *Macrozamia* sarcotesta was apparently unique to the southwest of Western Australia. Ladd *et al*.'s (1993: 39) research on the poisonous macrozamin content of a range of cycad species indicates that the Noongar people utilized the most toxic part of *M. riedlei* seeds, and discarded the least toxic part. The sarcotesta of *M. riedlei* contains a relatively high amount of macrozamin at 3.88% of fresh weight, comparable to that found in the kernels of *M. miquelii* and *M. moorei* (F. Muell) (3.88% and 3.72% of fresh weight respectively), which contain the highest macrozamin content of six tested *Macrozamia* species (the other three were *M. diplomera* (F. Muell.), *M. fawcettii* (C. Moore), and *M. heteromera* (C. Moore)). In contrast, the macrozamin content of *M. riedlei* kernels was the lowest of these *Macrozamia* species, comprising approximately 0.4% of fresh weight.

These data raise a further interesting question. Why detoxify and consume the sarcotesta, which is the most toxic part of the resource? Calorifically, it is less useful (16% of fresh seed weight, 4.4 grams per seed, 0.7 kg per cone) than

the kernel, which has greater resource potential (67% of fresh seed weight, 18.3 grams per seed, 2891.4 grams kernel weight [158 seeds per cone]) and is the least toxic part (Ladd *et al*., 1993: 39–40). The answer may lie in taste preferences and social utility in terms of beneficial trade relationships. The sarcotesta has a very high water (53%) and oil content (14% [28%+]) and a moderate food value of about 25% oil and polysaccharides, though the oil component would be quickly lost "in any process which disrupted the tissue, leaving other material … of little food value" (Ladd *et al*., 1993: 39–40). However, European descriptions of the taste and appearance of the sarcotesta after processing indicate that oils did survive the treatment process. The length of time required to detoxify the sarcotesta (two weeks to one month) is not long enough to detoxify the kernel. Although the defleshed seeds could have been reburied for several months to complete the detoxification of the kernel, or the sclerotesta removed and kernels leached, evidently this was not done.

(2) Were similar techniques used to process *Macrozamia* and *Cycas* seeds? This review has identified both similarities and differences in the methods used for these two genera. The three processing techniques for *Cycas* seeds (Beck, 1992) were also identified for *Macrozamia*. As was found by Beck for *Cycas*, the most commonly recorded method used to process *Macrozamia* seeds was prolonged leaching ($n = 21$). Ageing techniques were less common ($n = 6$). Only one unambiguous account of brief leaching was identified. A range of different techniques were identified for *Macrozamia.* Seeds could undergo roasting followed by extended leaching ($n = 3$), prolonged leaching followed by burial ($n = 2$), or roasting only ($n = 2$).

(3) Was there geographic variation in the distribution of specific methods to detoxify *Macrozamia* seeds? Multiple methods were used in each state. Two methods were used in Queensland, four each in New South Wales and Western Australia. Where kernels were processed, prolonged leaching was the most commonly used technique (Queensland [$n = 6$], New South Wales [$n = 11$]). Roasting and extended leaching occurred in Queensland (n = 2), whereas in New South Wales ($n = 1$) there was only one account of brief leaching and one of roasting. In Western Australia, where the majority of accounts concern sarcotesta, ageing was the dominant method ($n = 6$), followed by prolonged leaching ($n = 4$). Prolonged leaching and burial was restricted to Western Australia ($n = 2$) and there was one account of roasting. Geographic differences in processing techniques are also indicated for *Cycas* species. For example, ageing techniques for *Cycas* seeds were restricted to the Northern Territory ($n = 2$), and brief techniques did not occur outside of the Bloomfield River and Lower Tully regions of Queensland (Beck, 1992: table 2).

(4) Given that some techniques use water and others do not, do differences in rainfall explain the choice of method used to process *Macrozamia* seed? To identify whether the choice of processing method was related to rainfall, the median annual rainfall (MAR, 5th decile: Bureau of Meteorology, nd) was collated for each region where a processing method was recorded. The median is the preferred measure of "average" rainfall by meteorologists. The MAR for all years for the location of observation was used, rather than the rainfall for the year of observation, due to the lack of annual rainfall records in the early years in most locations (refer Appendix 1). The longest rainfall records closest to the location were used (Table 2).

The average MAR for each processing method was calculated. When both genera were combined, there was no significant relationship between rainfall and processing method (Kruskal–Wallis $\chi^2 = 12.04$, $df = 6$, $n = 49$, $p = 0.061$), but when they were considered separately, the results were significant for *Cycas* (Kruskal–Wallis $\chi^2 = 7.86$, $df = 3$, $n = 14$, $p = 0.049$) but not for *Macrozamia* (Kruskal–Wallis $\chi^2 = 6.84$, $df = 5$, $n = 35$, $p = 0.233$).

The relationship between MAR and the use of dry methods (those not using water, i.e. ageing and roasting) and wet methods (those using water, i.e. brief, prolonged, roasting and extended leaching, leaching and burial and very prolonged leaching) was also examined (Table 3). Cases using salt water were excluded from the analysis. Data was combined from *Macrozamia* ($n = 37$) and *Cycas* ($n = 10$) to increase the sample size. Dry techniques had an average MAR of 540.9 mm, wet techniques had an average MAR of 768.9 mm, a significant difference (Mann-Whitney $U = 93.5.0$, $n = 35$, $Z = –2.384$, $p = 0.017$). This suggests that decisions about the choice of processing technique were influenced by the availability of water, however, it should be noted that the sample size is small and there are limitations of using regional rainfall MAR as a proxy for water availability.

(5) To what extent was the duration of processing extended beyond the minimum required to detoxify seeds? The accounts for *Cycas* indicate that seeds prepared using only brief leaching were consumed almost immediately. There were, however, several options for artificially extending the availability of this food resource: prolonged leaching; storage of seeds in still water for up to five months; baking of bread; and the use of naturally or artificially aged seeds (for example, through burial). When the two accounts of very prolonged leaching for *Cycas* are excluded, the mean time that *Macrozamia* kernels underwent prolonged leaching is only slightly longer than that reported for *Cycas* spp. (Table

Table 2. Average median annual rainfall (MAR, in mm) by processing method and genus. *NR* = technique not recorded. MAR from Bureau of Meteorology 1858–2008: http://www.bom.gov.au /climate/data/weather-data.shtml

method	*Bowenia*	*Cycas*	*Lepidozamia*	*Macrozamia*
brief	1308 (n = 1)	1471 (n = 3)	NR	597 (n = 1)
prolonged	NR	676 (n = 7)	NR	735 (n = 21)
ageing	NR	786 (n = 2)	NR	602 (n = 6)
roasting and extended leaching	NR	NR	838 (n = 1)	630 (n = 3)
prolonged leaching and burial	NR	NR	NR	600 (n = 2)
roasting	NR	NR	838 (n = 1)	475 (n = 2)
very prolonged leaching	NR	774 (n = 2)	NR	NR

Table 3. Average median annual rainfall (MAR, in mm) by dry and wet processing methods and genus. *NR* = technique not recorded. * Excluding cases where *Macrozamia* was processed in salt water. MAR from Bureau of Meteorology 1858–2008: http://www.bom.gov.au /climate/data/weather-data.shtml

method	*Bowenia*	*Cycas*	*Lepidozamia*	*Macrozamia*	*Macrozamia** and *Cycas*
dry	NR	422 (n = 2)	838 (n = 1)	570 (n = 8)	540 (n = 10)
wet	1308 (n = 1)	891 (n = 12)	838 (n = 1)	708 (n = 27)	768 (n = 37)

4). While leaching seeds for seven days does not considerably extend the preservation of seeds, the use of roasting and extended leaching clearly does. Only Hill's (1867: 3) account suggests the storage of seeds in water, although he does not indicate the length of time. Comparatively few accounts describe the end products made from processed seeds. Turner (1893: 159) observed a "paste," which was cooked in a similar way to damper. Miller (in Devitt, 1979) mentioned cakes, and Backhouse (1843: 542) "a rough paste." Only Elliott referred to large cakes 15 inches in diameter that were consumed when hungry (Edgeworth David, 1890: 119). Ageing techniques were used to detoxify the sarcotesta, rather than the kernel. While it is possible that aged, non-toxic seeds were collected from beneath plants, this was not indicated in the accounts. Early accounts do not discuss storage after initial processing.

Given these results, *(6)* can *Macrozamia* in archaeological sites be used as a seasonal indicator? The accounts indicate different temporal patterns of collection between regions. In Western Australia, Grey (1840: 16), Moore (1842: 22) and Drummond (1862: 27–28) indicate autumn was the season for eating *by yu* (Table 5). Seeds buried in *mordak* holes were recovered between April 13 and 17 (Grey, 1841: 61, 63, 102). Grey (1841: 296) and Drummond (1862: 27) indicated that seeds were buried for two weeks to one month respectively. Hassell (1936, 1975) records a substantial burial period of eight to nine months, prior to trade of the sarcotesta to other groups, but she does not elaborate on whether buried seeds were dug up during this period. The immediate collection of strobili and seeds may have been necessary, given the propensity of various animals to consume it and disperse fresh seeds (Burbidge & Whelan, 1982: 64–65).

The accounts from New South Wales indicate that seeds were collected during several seasons (Table 6). If the months in which observations of seed processing and tasting by Europeans are accurate indicators of the times when seeds were actually processed, it occurred throughout the year: March and April (autumn); July (winter) and November/ December (summer). The accounts from Queensland indicate seeds were used in autumn (March: Bracewell in Simpson, 1843; April: Mitchell in Brown, 2000; May: Petrie, 1904). *Macrozamia* seeds, therefore, are not a reliable archaeological indicator of restricted seasonal use or occupation (e.g., Beaton, 1982: 51; Lampert & Sanders, 1973: 107; McDonald, 1992: 15, 134; Poiner, 1976). There were no accounts describing the use of aged *Macrozamia* seeds but, as Beck and Webb (1992: 79) have suggested, aged seeds could have been used and discarded at any time of the year. It should also be noted that in New South Wales, southern populations of *M. communis* produce seed slightly later than northern populations (Kennedy *et al*., 2001: 15), further complicating the archaeological use of seeds as a seasonal marker.

(7) Were *Macrozamia* seeds a staple food as was the case in some regions for *Cycas* (Beck, 1992: 133)? In relation to plant foods, the term staple has been defined as a "regularly collected, dependable resource" (Beck, 2006: 298), or "forming an important part of the diet for at least a part of the year" (Horsfall, 1987: 237). *Macrozamia* species have been viewed as a staple resource, due to the large number of seeds produced on strobili and the argument that seed production could be stimulated through the use of fire (Beaton, 1982). However, fire may not have been a reliable trigger of masting events, at least for some species (Asmussen, 2009; Jones, 1998: 65), and forager use may have been largely determined by natural production. For example, cone production in *M. communis* has been characterized as "sporadic" (Ornduff, 1990: 97). In an 11-year study, *M. communis* were found to cone in an irregular, non-cyclical and non-synchronous manner at the population level (Kennedy *et al*., 2001: 16). Given this lack of reliability and synchronicity in coning, *Macrozamia* may have been available only in specific places and in certain years. For example, Atkinson (1826: 19) stated it produced nuts "at certain seasons," while Robinson's (1844, in Mackaness, 1941: 335) statement that seeds were "collected in large quantities" may only relate to plant reproduction in the year of observation. There is little ecological data on the frequency of seed failure over large

Table 4. Duration of leaching (in days) by genus and processing method. NOTE: Processing times and methods for *Cycas* after Beck (1992: table 2 and references therein). Data for *Bowenia*, *Lepidozamia* and *Macrozamia* from Appendix 1.

genus	method	n	minimum leaching	maximum leaching	average leaching
Bowenia	brief	1	1	1	1
Cycas	brief	3	1	1	1
	prolonged	7	2	9	5.86
	very prolonged	2	30	150	120
Lepidozamia	roasting and extended leaching	1	3	3	3
Macrozamia	brief	1	0.5	0.5	0.5
	prolonged	8	2	14	6.81
	roasting and extended leaching	3	2	21	9.83

Table 5. Comparison of the accounts of the collection and processing of western Australian *Macrozamia riedlei* seeds and their natural period of availability. Data for the reproductive cycle of *M. riedlei* from Baird (1939: 155).

season	month	reproductive stage	recorded use	use in trade
Spring	Sep	Pollinated		
	Oct			
	Nov			
Summer	Dec			"gather the seeds and buried them… They were left there from early summer to mid-winter… for trading purposes the stones, which are poisonous, were removed and the fruit strung on rushes. The plant grows only in the interior and was traded to the coast (Hassell, 1975: 24).
	Jan			
	Feb	Fertilized	February–March: *Burnur* or *Burnuro*, the *By yu* or Zamia-fruit [sic] season (Moore, 1842: 22).	
Autumn	Mar	Seed fall	"Women collect the nuts in the month of March… place in shallow pool of water, they leave them to soak for several days… they dig… *mordak* holes… and fill them up with nuts" (Grey, 1841: 296). "… ripe in March" (Stokes, 1846: 131). "… Zamia [sic], produces a nut which… is eaten after considerable preparation" (Moore, 1842: 32).	
	Apr	Seeds on the ground	April–May: *by yu ngannoween*, season for eating *by yu* (Grey, 1841:16); "stones of which they find lying about the fireplaces" (Grey, 1841:295). Kaiber obtains nuts from *Mordak* holes (Grey, 1841: 61, 63, 102); Grey eats roasted *by yu* nuts—20 April (Grey, 1841: 91–93). "Chief article of food in the Autumn" (Drummond, 1862: 27–28).	
	May	Seeds on the ground	"fruit of the Zamia [sic] tree… in full season in the month of May" (Moore, 1842: 23).	
Winter	Jun–Jul			
	Aug			

Table 6. Comparison of the accounts of the collection and processing of New South Wales *Macrozamia* spp and their natural period of availability. Data for the reproductive cycle of *M. communis* from Ballardie (1984: 22), Ballardie & Whelan (1986: 101), Beadle *et al*. (1986: 90), Brough & Taylor (1940: 496–497) and Kennedy *et al*. (2001: 15).

season	month	reproductive stage	recorded use
Spring	September		
	October	Pollinated	
	November		"there is likewise a nut… soak it… for seven days… they roast it in the embers" (Hunter, 1793: 478–479).
Summer	December		
	January	Fertilized	
	February		
Autumn	March	Mature	"In a cove we met with a kernel which they prepare… they are a kind of nut growing in bunches somewhat like a pine top" (Bradley, 1786–1792[1969]: 92). "… they also use a nut… I tasted some at Broken Bay and thought them good" (Bradley, 1786–1792[1969]: 134–135) [Bradley at Broken Bay, 2–10 March 1788].
	April		"… they likewise roast and pound the seeds of *Zamia spiralis*" and then "place the mass for two or three weeks in water… after which it is eaten" (Backhouse, 1843: 380–381).
	May		
Winter	June	Seedfall	
	July		"they eat the kernels of that fruit which resembles a pine-apple" (Phillip, 1738–1814[1789]: 135). "Today… we met with *Zamia spiralis*… red coats are fixed under scales forming the outside. The blacks place these nuts under stones, at the bottom of water… they are afterwards converted to food (Backhouse, 1843: 294). *Zamia* [sic] on the ranges; the nuts… hang in clusters… in preparing them for food the Natives bruise the kernel to a pulp and soak them in water: the nuts are collected in large quantities" (Robinson, 1844 in Mackaness, 1941: 335) [Bega].
	August		

areas; however, the available data suggests that widespread failure of seed production may occur for some species (Asmussen, 2009).

(8) How does the exploitation of *Macrozamia* compare with other endemic genera, such as *Bowenia* and *Lepidozamia*? *Lepidozamia* seeds appear to have been utilized in a similar way to *Macrozamia*. Bennett (1871: 4) described the use of *Lepidozamia peroffskyana* (Regel) on the Manning River in northern New South Wales: "it must first be roasted, then bruised, and afterwards steeped for about three days in water." Leiper (1984: 39; also Symons & Symons, 1996: 77) states that "the kernels were crushed into flour. It was then washed in running water for a week and then cooked on hot coals and eaten," but does not provide references. If these two accounts are correct, they respectively indicate the use of roasting followed by extended leaching and prolonged leaching to detoxify *L. peroffskyana* kernels.

Early sources documenting the use of *Lepidozamia hopei* (Regel) seeds were not found, but present-day Ngadjonji elders state that the large seeds were eaten in the north Queensland rainforests (Ngadjon Elders, nd). Cairns Botanical Gardens (nd: 2) records that "seeds were roasted, crushed and leached in water to render them edible." Jones (1998: 228) reports that seeds were collected and eaten near Ingham, and old plants were found with notches in their trunks to aid seed harvesting. Hill and Osborne (2001: 9) included a photograph of footholds cut in the trunk of a tall (13.7 m high) female *L. hopei* plant. Similar footholds have also been observed on *Cycas angulata* plants (Levitt, 1981: 48; Bradley, 2006: 128).

While *Bowenia* species also produce seed, most accounts of their use refer to the consumption of the roots and rhizome (a horizontal underground stem). Accounts relate to the most widely distributed of the three species endemic to Australia: *Bowenia spectabilis* (Hook), which is a fern-like understory plant common in rainforests from Cooktown to Tully (Jones, 1998: 105; Wilson, 2002: 11). Bailey (1883: 501, 1906: 188) stated that the "yam-like root was used largely for food… after being cooked." Horsfall (1987: 61) notes that it required "roasting and leaching.."

There were also geographic differences in its use. Roth states that the "rootstock" was eaten at Cape Grafton on the Bloomfield River, but not at Cooktown (Roth, 1901: 10), while according to Meston (1889b: 61, 1904: 16), the "thick yam-like root" was used at Bellenden-Ker. Banfield (1908: 169) recorded that the "hard rhizome… [was] allowed weeks to decompose", although no other details are given. Harris states that the rhizomes were harvested in the dry season (May–October), before the seasonal peak of tree nut availability between October and December (Harris, 1989: 378). The early accounts do not describe the methods used to process the seeds. A recent description from the Cairns Botanical Gardens (nd: 2), states that the seeds were processed using the brief leaching technique, in which seeds were "roasted, crushed and soaked in water for 24 hours and roasted again in hot ashes before eating" (cf. Leiper, 1984: 18).

There are good practical reasons why the non-seed parts of *B. spectabilis* were used. Female plants very rarely produce strobili; no more than 5% of the plants in three populations surveyed between 1994 and 1999 produced a female cone (Wilson, 2002), and there is an average of five to ten years between reproductive events by female plants (G. Wilson, pers. comm.). A single strobilus contains between 22–90 seeds, depending on the size of the plant (Whitelock, 2002: 55), and few intact cones are found because foraging animals often break them apart (Wilson, 2002: 12), despite the sarcotesta giving off an "unpleasant odour" (Jones, 1998: 106). Thus, *B. spectabilis* cones are infrequently produced and contain fewer seeds than *L. hopei* or *C. media* (R. Br), which also grow in the region (Wilson, 2002: 14).

Additionally, *Bowenia* seeds are the most toxic of all the cycads. Ladd *et al*.'s (1993: 39, Table 1) analysis showed that the macrozamin content in mature kernels of unspecified *Bowenia* species comprised 4.83–5.04% fresh weight—the highest of any cycad, and second to the sarcotesta of *M. riedlei* (3.88% fresh weight). This toxicity may explain the unique use of the rhizomes and why seeds underwent two processing cycles. The carrot-shaped roots (Chamberlain, 1912: 422) of *B. spectabilis* contain 17.2–29.1% carbohydrate per 100 grams (average value of 23.2%) (Miller *et al*., 1993: 38). While not as productive as the seeds of *L. hopei* or *Bowenia serrulata* (W. Bull), which contain 41.7% and 81.2% carbohydrate respectively (Miller *et al*., 1993: 80, 38; values unavailable for *B. spectabilis*), utilizing the rhizomes was as productive as using carbohydrates in the seeds of *M. communis* (14.4%) (Miller *et al*., 1993: 84). In contrast to seeds, which mature between April and June (Whitelock, 2002), rhizomes are available throughout the year. The rhizomes of male and female plants, however, may have been exploited differently. Rhizomes of male plants are more succulent during and immediately after the wet season, whereas the size, succulence and starch content of female rhizomes generally increases with time, rather than seasonally (G. Wilson, pers. comm.).

Conclusion

This review indicates that despite a superficial similarity of appearance, there were important differences in the processing and use of seeds from *Bowenia, Cycas, Lepidozamia* and *Macrozamia* within traditional Australian economies. While the three processing techniques used for *Cycas* were also used on *Macrozamia* seeds, the kernel of *Macrozamia* was also detoxified via extended leaching following roasting, and the sarcotesta was detoxified using a combination of prolonged leaching and burial. Regional variations in use also occurred: the sarcotesta and the kernel of *Cycas* and *Macrozamia* were consumed; the rhizomes of *Bowenia* were consumed in the rainforests; the sarcotesta of *Macrozamia* was traded in Western Australia; and bread made from *Cycas* was used in ceremonies in the Northern Territory. It appears that the starch in trunks of *Macrozamia* plants was not utilized (Mueller, 1883; Clarke, 2008: 27).

As was the case for *Cycas*, specific methods of preparation varied from place to place and are likely to have differed in accordance with taste preferences, the scheduling of other tasks, the potential for storage (Beck, 1992), and the availability of water. Processing techniques were widely known prior to European contact and kernels of many species were used, but written records were not made or do not survive. In contrast to *Cycas* seeds, no historic accounts suggest the use of *Macrozamia* seeds to support large gatherings. Seeds were collected in different seasons of the year and could be used when aged, so the presence of seeds in archaeological sites does not necessarily serve as a seasonal indicator. Furthermore, the variability in seed production in *Macrozamia* spp. suggests that it may not have been a reliable resource in any given year.

Although ethnographic texts can be a "potentially a mischievous reflection of pre- or immediately post-contact societies" (Veth, 2006: 68), when carefully examined and used, such accounts can provide rich and detailed information concerning general patterns of resource use.

ACKNOWLEDGMENTS. Many thanks to Dr Gary Wilson (Senior Technical Officer, Australian Tropical Herbarium (CNS) James Cook University, Cairns) for discussions and providing information and references concerning *Bowenia spectabilis*; Val Attenbrow for forwarding the Anna Walker and Edgeworth David references; and Susan Mercer (State Library of New South Wales) for transcribing Anna Walker's original text. Thanks also to Paul McInnes, Tam Smith, Sarah Robertson, Jim Specht, Jenny Atchison and Peter Matthews for their comments on a prior version of this paper.

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Appendix 1

Accounts of *Bowenia*, *Cycas*, *Macrozamia* and *Lepidozamia* processing in Australia. *Species unspecified in original text, identified here by location; † species cited in account, § literature citation incorrect based on distribution or taxonomic revision. Median Annual Rainfall (MAR) and weather station code from Bureau of Meteorology. Methods: *A,* ageing; *B,* brief; *P,* prolonged; *VP,* very prolonged; *REL,* roasting and extended leaching; *PLB,* prolonged leaching and burial; and *R,* roasting. Location for Atkinson after Binney (2005: 295–296), and for Grey & Hammond after Meagher (1974: 54). ‡ MAR for "unknown" locations were taken as the average median rainfall range for areas in which *M. communis* (Weather Station 66006) and *M. riedlei* grow (Jones, 1998). *C.—Cycas, Ca.—Catakidosamiea, E.—Encephalartos.*

original species identification	species as det. by Jones (1998)	state	observation location	MAR	weather station #	MAR years	date of observation	method	water type	days leached	reference
*	*B. spectabilis*	QLD	Cardwell to Cooktown	1308	031010	1882–1957	nd	B	unknown	1	Cairns Botanical Gardens, nd
*	*C. angulata*	NT	Boorolola	422	014710	1889–1978	<1945	A	none	—	Harvey, 1945
*	*C. angulata*	NT	Boorolola	422	014710	1889–1978	<1945	A	none	—	Harvey, 1945
†	*C. armstrongii*	NT	Yirrkala	773	014502	1936–1975	<1987	P	running then still	7–9	Isaacs, 1987
§ *C. angulata*	*C. arnhemica*	NT	Groote Eylandt	783	014506	1921–1989	<1981	P	running	2–3	Levitt, 1981
§ *C. angulata*	*C. arnhemica*	NT	Groote Eylandt	783	014506	1921–1989	<1981	B	running	1	Levitt, 1981
§ *C. angulata*	*C. arnhemica*	NT	Groote Eylandt	783	014506	1921–1989	<1981	P	running	8–9	Levitt, 1981
§ *C. angulata*	*C. arnhemica*	NT	Groote Eylandt	783	014506	1921–1989	<1981	EP	still	30–150	Levitt, 1981
§ *C. media*	*C. arnhemica*	NT	Blythe River	765	014400	1958–2008	1982	EP	still	150	Meehan & Jones, 1977
§ *C. media*	*C. arnhemica*	NT	Blythe River	765	014400	1958–2008	1972	P	running	7	Meehan & Jones, 1977
*	*C. basaltica, C. furfuracea* or *C. lane-poolei*	WA	Glenelg River	727	001021	1941–2005	<1936	P	running	7	Love, 1936
†	*C. media*	QLD	Bloomfield River	1069	031103	1912–1977	1894–1901	B	running	1	Roth, 1901
†	*C. media*	QLD	Lower Tully	2563	032042	1925–2009	1894–1901	B	running	1	Roth, 1901
*	*C. media*	QLD	Herbert-Burdekin	386	033001	1886–2009	1882–1883	P	running	4–5	Lumholtz, 1889
*	*C. media*	QLD	Rockhampton	512	039082	1871–1953	<1883	P	still	3–4	Palmer, 1883
† *Ca. macleayii*	*L. peroffskyana*	NSW	Manning River	838	060023	1887–2007	1863	R	none	—	Hill, 1867
*	*L. peroffskyana*	NSW	Manning River	838	060023	1887–2007	<1871	REL	unknown	3	Bennett, 1871
*	*M. communis*	NSW	Port Jackson	772	066062	1858–2009	1790	P	still	7–8	Hunter, 1793
*	*M. communis*	NSW	Sutton Forest/Berrima	597	068045	1870–2009	<1826	B	running	5	Atkinson, 1826
† *Zamia spiralis*	*M. communis, M. flexuosa* or *M. reducta*	NSW	Newcastle	763	061055	1862–2009	1836	REL	unknown	14–21	Backhouse, 1843
† *Zamia spiralis*	*M. communis* or *M. flexuosa*	NSW	Lake Macquarie	763	061377	1863–2009	1825	P	still	7–14	Threlkeld in Gunson, 1974
*	*M. communis*	NSW	Maitland	545	061034	1902–1994	<1890	P	still	3–4	Edgeworth David, 1890
†	*M. spiralis*	NSW	Newington Estate	616	066064	1894–1972	<1875–1910	P	unknown	3	Walker, 1875–1910
*	*M. communis*	NSW	Bega	488	069002	1879–2009	1844	P	unknown	—	Robinson, 1844, in Mackaness, 1941
†	*M. communis*	NSW	Beecroft Peninsula	703	068034	1889–2004	1973	P	unknown	—	Lampert & Sanders, 1973
*	*Macrozamia* sp	NSW	Unknown	767	066006‡	1885–2009	<1876	P	running	—	Milford, 1876
† *M. spiralis*	*M. communis* or *M. spiralis*	NSW	Unknown	767	066006‡	1885–2009	<1883	P	running	—	Moore, 1883
† *M. spiralis*	*M. communis* or *M. spiralis*	NSW	Unknown	767	066006‡	1885–2009	<1883	R	none	—	Moore, 1883
†	*Macrozamia* sp	NSW	Unknown	767	066006‡	1885–2009	<1864	P	unknown	—	Jackson, 1864
†	*M. communis* or *M. spiralis*	NSW	East of Sydney	767	066006‡	1885–2009	1835	P	unknown	—	Backhouse, 1843

original species identification	species det. by Jones (1998)	state	observation location	MAR	weather station #	MAR years	date of observation	method	water type	days leached	reference
† *M. spiralis*	*M. spiralis* or *M. communis*	NSW	Unknown	767	066006‡	1885–2009	<1914	P	unknown	8	Bennett, 1871; Cleland, 1914
*	*M. miquelii*, *M. pauli-guilielmi* or *M. douglasii*	QLD	Wide Bay	615	040172	1900–1987	<1893	P	running or still	6	Turner, 1893; 1899
† *M. miquelii*	*M. miquelii*, *M. pauli-guilielmi* or *M. douglasii*	QLD	Wide Bay	615	040172	1900–1987	1880's	REL	running	2–8	Gaiarbau, in Symons & Symons, 1996
*	*M. douglasii*	QLD	Fraser Island	1093	040081	1915–1987	1840	P	running	2	Simpson, 1843
† *E. miquelii*	*M. miquelii*	QLD	Rockhampton	512	039082	1871–1953	<1866	REL	running or still	6–8	Thozet, 1866
*	*M. miquelii*, *M. pauli-guilielmi* or *M. douglasii*	QLD	Wide Bay	615	040172	1900–1987	<1883	P	unknown	—	Palmer, 1883
† *M. miquelii*	*M. miquelii*, *M. pauli-guilielmi* or *M. douglasii*	QLD	Wide Bay	615	040172	1900–1987	<1925	P	running	—	Tindale, 1925
*	*M. douglasii*	QLD	Fraser Island	1093	040081	1915–1987	1979	P	running	—	Devitt, 1979
*	*M. douglasii*	QLD	Fraser Island	1093	040081	1915–1987	<1935	P	running	—	Davison & Nichols, 1935
§ *E. spiralis*	M. riedlei or *M.* sp *Eneabba*	WA	New Norcia	350	009033	1882–2009	1846–1851	A	none	—	Salvado & Stormon, 1977
*	*M. riedlei*	WA	King George Sound	967	009500	1887–2009	<1862	A	none	—	Drummond, 1862
†	*M. riedlei*	WA	Inland	625	average‡	na	1878–1886	A	none	—	Hassell, 1936, 1975
*	*M. riedlei* or *M.* sp *Eneabba*	WA	Perth to Pinjarra	648	009596	1887–2009	c.1860	P	unknown	14	Hammond, 1933
*	*M. riedlei* or *M.* sp *Eneabba*	WA	Perth	600	009034	1876–1992	1831	P	unknown	—	Moore, 1842
*	*M. riedlei* or *M.* sp *Eneabba*	WA	Swan River	600	009034	1876–1992	1839	PLB	still	—	Grey, 1840, 1841
*	*M. riedlei* or *M.* sp *Eneabba*	WA	Perth to Drakesbrook	719	009614	1935–2009	<1894	P	running	—	Edwards, 1894
*	*M. riedlei* or *M.* sp *Eneabba*	WA	Perth	600	009034	1876–1992	<1842	PLB	unknown	—	Moore, 1842
*	*M. riedlei* or *M.* sp *Eneabba*	WA	Perth to Drakesbrook	719	009614	1935–2009	<1894	A	none	—	Edwards, 1894
*	*M. riedlei*	WA	Perth to Guildford	624	009022	1877–1954	1838	P	unknown	—	Backhouse, 1843
*	*M. riedlei*	WA	Perth to Guildford	624	009022	1887–1954	1838	A	none	—	Backhouse, 1843
*	*M. riedlei* or *M.* sp *Eneabba*	WA	Perth area	600	009034	1876–1992	<1836	A	none	—	Armstrong, 1836
§ *Zamia media*	*M. riedlei*	WA	200 miles NE of Perth	183	010018	1926–2008	1890	R	none	—	Ward & Fountain, 1907