ENCEPHALARTOS

JOURNAL OF THE CYCAD SOCIETY OF SOUTH AFRICA

TYDSKRIF VAN DIE BROODBOOM VERENIGING VAN SUID-AFRIKA

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COVER / VOORBLAD : ***Encephalartos ghellinckii*: female cones of the coastal form in the National Botanic Garden, Kirstenbosch / vroulike keëls van die kus-vorm in die Nasionale Botaniese Tuin, Kirstenbosch.**

Photo: Piet Vorster

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FROM THE PRESIDENT

This is the last president's contribution of my two-year term. It is only fitting that the Society enters the new millenium with a new president with refreshing ideas. The Society is fortunate to receive Dr P.J. Vorster, plant taxonomist and cycad specialist, as its new president. Dr Piet Vorster is involved with the Department of Botany of the University of Stellenbosch and needs no introduction in cycad ranks. His contributions in our

VAN DIE PRESIDENT

Hierdie is die laaste presidentsbydrae van my tweejarige termyn. Dit is net gepas dat die Vereniging die nuwe millenium met 'n nuwe president met vars, verkwikkende idees binnegaan. Die Vereniging is gelukkig om dr P.J. Vorster, planttaksonoom en broodboomspesialis, as sy nuwe president te kry. Dr Piet Vorster is verbonde aan die Departement Plantkunde van die Universiteit van Stellenbosch en het in broodboomgeledere geen

magazine attest to his passion for cycads and the cycad concern overall. May your term, Dr Vorster, be an especially successful one!

The colour photos that currently adorn our magazine have contributed to the printing expenses of R23 450 for the June colour edition and R11 400 for September's partly coloured edition. I want to request subscribers to compare these two issues and give their opinions to our secretary. Even if readers should be generally satisfied with the cheaper edition, the publication of four such editions per year would entail costs that can not be afforded by the current subscription fees. Once again I am asking for sponsorships or advertisements or ideas for earning extra income.

The past weekend (16–17 October) my family and I were guests of the Northern Cycad Working Group. We have inspected *Encephalartos eugene-maraisii* plants in the Waterberg habitat. It was truly an experience to see twenty-odd healthy plants in nature. Some plants are up to three metres tall and most have formed suckers. Unfortunately there are very little evidence of seedling recruitment.

The Northern Cycad Working Group has already made good progress with their plans to put all the plants, with their particulars, in the specific area on record. The Working Group wants to manage the plants in such a manner that the estimated original number of plants will be seen in the veld again. This is not an easy task. The terrain will not only have to be visited regularly, but especially the female plants, will have to be fenced baboon proof. Previous pollination efforts have indeed been sabotaged by baboons.

The cooperation and support of the owner have already been obtained and the rehabilitation programme will soon be underway. With similar strategies the Working Group also wants to promote conservation elsewhere in its area and make some of the rarer types of cycad more readily available.

Lastly I want to express my sincere thanks towards Dr Isabella Claassen, Prof. Guillaume Theron and Dr Piet Vorster. They are, to a great extent, the pivot that the Cycad Society of South Africa revolves around. They work tirelessly, unselfishly and without payment to maintain and expand the Society and its magazine.

It was really a pleasure to be associated with our Cycad Society and its magazine for two years.

Frederick de Jager

bekendstelling nodig nie. Sy bydraes in ons tydskrif getuig van sy passie vir broodbome en die totale broodboomsaak. Mag u termyn, dr Vorster, 'n uiters suksesvolle een wees!

Die kleurfoto's wat ons tydskrif deesdae versier het daartoe bygedra dat die drukkoste van Junie se kleuruitgawe R23 450 en September se gedeeltelike kleuruitgawe R11 400 beloop het. Ek wil intekenare graag versoek om die twee uitgawes met mekaar te vergelyk en hulle opinies aan ons sekretaris deur te gee. Selfs al sou lesers oor die algemeen tevrede wees met die goedkoper uitgawe sou die publikasie van vier sodanige uitgawes per jaar kostes meebring wat nie uit die bestaande intekengeld gedra kan word nie. Weer eens vra ek u vir borgskappe of advertensies of idees waarmee ekstra inkomste verdien kan word.

Ek en my gesin was die afgelope naweek (16–17 Oktober) die gaste van die Noordelike Broodboom Werksgroep. Ons het *Encephalartos eugene-maraisii* plante in hulle Waterberg habitat gaan besigtig. Dit was werklik 'n belewenis om 'n twintigtal gesonde plante in die natuur te sien. Somnige plante is tot drie meter lank en die meeste het suiers gevorm. Van 'n natuurlike aanwas is daar ongelukkig nie regtig sprake nie. Hopelik verskyn daar binnekort 'n meer volledige verslag met foto's in ons tydskrif.

Die Noordelike Broodboom Werksgroep is reeds ver gevorder met hulle planne om al die plante in die besondere gebied met hulle besonderhede op rekord te plaas. Die Werksgroep wil die plante so bestuur dat die geskatte oorspronklike getal weer in die veld te sien sal wees. Dit is nie 'n maklike taak nie. Die terrein sal nie alleen gereeld besoek moet word nie, maar veral die vroulike plante sal bobbejaanproef omhein moet word. Vorige bestuiwingspogings is juis deur bobbejane gesaboteer.

Die samewerking en ondersteuning van die eienaar is reeds verkry en binnekort behoort die rehabilitasieprogram in volle swang te wees. Met soortgelyke strategieë wil die Werksgroep ook elders in sy gebied bewaring bevorder en van die skaarser soorte broodbome meer geredelik beskikbaar maak.

Ten slotte wil ek my opregte dank uitspreek teenoor dr Isabella Claassen, prof. Guillaume Theron en dr Piet Vorster. Hulle is eintlik maar die spil waarom die Broodboom Vereniging van Suid-Afrika draai. Hulle werk onvermoeid, onbaatsugtig en onbetaald om die Vereniging en sy tydskrif in stand te hou en uit te brei.

Dit was werklik aangenaam om vir twee jaar met die Broodboom Vereniging en sy tydskrif geassosieer te gewees het.

Frederick de Jager

FOCUS ON ... FOKUS OP ...

In each edition of ENCEPHALARTOS, we focus on one cycad species, in the form of an in-depth article in layman's language. In this edition the spotlight falls on:

In elke uitgawe van ENCEPHALARTOS fokus ons op een broodboomsoort, in die vorm van 'n in-diepte-artikel in leketaal. In hierdie uitgawe val die kollig op:

CYCAS TANSACHANA Hill & Yang

William Tang
Fairchild Tropical Garden, 11935 Old Cutler Road, Miami, Florida 33156, U.S.A.

Figure 1 A view of the mountain habitat of *Cycas tansachana*. The slopes are covered with sparse seasonally deciduous forest. The mountain system encloses a hidden valley harbouring wetter vegetation below.

DISCOVERY

This species was first recognized as a distinct taxon in a 1995 expedition in Thailand sponsored jointly by Nong Nooch Tropical Garden (Thailand), Fairchild Tropical Garden, and Montgomery Botanical Center (U.S.A.). Large, recently transplanted specimens were observed at a gas station near the city of Sariburi, by the expedition team, which included the author. The owners of the gas station revealed that these plants had been rescued, after

great effort, from a mountain being quarried for limestone nearby. This species was formally described as *Cycas tansachana* by Ken Hill and Si-Lin Yang in 1999 and is named in honour of Kampon Tansacha, owner and director of Nong Nooch tropical Garden, for his support of *Cycas* research in Thailand.

DISTRIBUTION AND HABITAT

This species is known only from one small limestone mountain system isolated by surrounding plains NE of Khong Khi Sua, in Sariburi province, Thailand (see Figure 1). The climate is seasonally dry. *Cycas tansachana* is found on steep slopes and cliff tops, often wedged into the crevices of hard, sharp limestone rock (Colour Figure 2, p. 9). The vegetation is sparse deciduous forest and species of *Dracaena* and *Euphorbia* are common. The cycads are exposed to bright light, usually in full sun.

DESCRIPTION

1. STEM

Erect or leaning, up to 5 m long, 10–18 cm in diameter, often branching (Colour Figure 1, p. 9). Upper 0.5 m with persistant leaf bases (see Colour Figure 4, p. 9), below this the stem becomes smooth, light grey-coloured, often with distinct rings visible (see Colour Figure 2, p. 9). Stem base is swollen, up to a diameter of 0.9 m, with a pattern of polygonal fracturing (Figure 2).

Figure 2 Close-up of the trunk base of *Cycas tansachana*, showing the polygonal fracture pattern.

2. LEAVES

Numerous in a crown, 1–1.7 m long, deep green and semi-glossy, moderately keeled (Figure 3, Colour Figure 7, p. 10), 65–100 pairs of leaflets, opposing leaflets form 90–140 degree angle, petiole makes up 20–30% of leaf length, with spines on 0–30% of its length. Leaflets in the middle of the leaf are 17–30 cm long x 8–12.5 mm wide, flat, without a spine at the tip, pointing toward the leaf apex at a 60–70 degree angle to the rachis. Basal leaflets abruptly give way to spines.

3. CATAPHYLLS (SCALE LEAVES)

Narrowly triangular up to 5–6 cm long and covered with thick, persistent orange-brown wool.

4. REPRODUCTIVE STRUCTURES

Male cones ovoid, yellow, 25–35 cm long x 11–13 cm wide, cone scales have a prominent, sharply upturned spine (Figure 3, Colour Figure 4, p. 9). Female sporophylls flattened on the apical half, 6–7 cm wide, with edge deeply divided to form 40–60 comb-like spines 18–25 x 1–1.5 mm (Colour Figure 3, p. 9). The tip of the sporophyll ends in a spine, 3–5 cm long, distinctly bigger than the lateral spines. Young female sporophylls are covered with the same thick orange-brown wool as the scale leaves, but these may weather off with age. Mature seeds have a smooth yellow fleshy outer coat and a smooth hard inner coat.

AFFINITIES

Cycas tansachana belongs in the section *Indosinensis* of the genus *Cycas*. It is part of the *Cycas pectinata* complex, which ranges from Eastern India across S.E. Asia to China and Vietnam. Unlike *Cycas pectinata* proper, which is a species found in the foothills of the Himalayas in cooler, moister climates at altitudes typically above 1000 m, *C. tansachana* is a lowland species. Its mountain habitat does not rise above 500 m above sea level and the plants appear to be subjected to drought and high temperatures. It's closest relatives are other cliff dwelling *Cycas*: *C. clivicola* subspecies *clivicola* found in lower peninsular Thailand and adjacent Malaysa and Myanmar and *C. clivicola* subspecies *lutea* found on the Cambodian-Thai border across to Vietnam. *Cycas tansachana* can be distinguished from these other taxa by its keeled leaves and the thick persistent orange-brown wool in its stem apex (see Tang *et al.* 1997 for a photographic comparison of the species).

CONE BEETLES AND POLLINATION

Cycas cones in Thailand and S.E. Asia are inhabitated by two kinds of beetles: *Xenocryptus* (family Languriidae, tribe Xenoscelini) and weevils of the genus *Tychiodes* (family Curculionidae, subfamily Cossoninae). Preliminary study indicate that each *Cycas* species has unique species of beetles associated with their cones (Tang *et al.*, in press). Cones of *C. tansachana* were found to harbour a distinct species of *Xenocryptus* and

Figure 3 Male cones, female sporophylls, and leaf of *Cycas tansachana* collected from habitat.

three distinct species of *Tychiodes*. These beetles are the suspected pollinators of the species. The beetle fauna of *Cycas tansachana* cones supports the opinion that this species has been isolated at this locality from other *Cycas* for a long period of time. This isolation has allowed both the cycad and its beetles to evolve features that make them distinct from related species in the region.

Figure 4 Large scale quarrying of the habitat of *Cycas tansachana* threatens the future of the species.

CONSERVATION STATUS

The mountain system which *C. tansachana* inhabits is privately owned, and large sections are being levelled for limestone gravel mining (Figure 4). The gravel is in high demand nearby in the capital city of Bangkok, which is built on gradually sinking ground of a river delta. Gravel is used in large quantities to raise the foundations of all buildings being constructed in the area. The entire habitat is slated for destruction and it is estimated that the entire mountain system will be levelled in 200 years. The surface of this mountain system, on which *C. tansachana* lives, will likely be destroyed first. Because of quarrying activities and pressure from plant collectors this species should be regarded as threatened.

CULTIVATION

Seeds of this species have been distributed under the name *Cycas* "Saraburi", *C.* "mahidole" and *C.* 'tansachii". Seedlings under nursery conditions appear slow growing. Experience with related cliff dwelling *Cycas* suggests that this species requires excellent drainage and that if given the right conditions, will grow rapidly. It does best in sunny tropical or subtropical conditions and once

established will endure high temperatures and drought. Large plants can be viewed at Nong Nooch Tropical Garden near Pattaya, Thailand.

ACKNOWLEDGEMENTS

The author thanks Kampon Tansacha and Nong Nooch Tropical Garden for logistical and financial support, and Poonsak Vatcharakorn, Si-Lin Yang, and Michael Perry for assistance in the field.

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ARTICLES / ARTIKELS

INSECT VISITORS AND POLLINATION OF CYCAD CONES: A GLOBAL VIEW

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ARE THERE ANY INSECTS IMPORTANT TO CYCADS?

Many gardeners view insects as pests that should be killed on sight. Research on cycad cone insects in the last 15 years, however, has revealed that certain beetles play important roles in pollinating cycads. Most conservationists and biologists who work with cycads now understand that without such beetles, the future existence of cycads in the wild would be in doubt.

The study of insect pollination of cycads began in South Africa early in the 20th century. South African botanists Pearson (1906), Rattray (1913) and Marloth (1914) were the first to publish detailed observations of beetles on cycad cones and to speculate on how insects might accomplish pollination of *Encephalartos*. Except for a limited study in pollination by Baird in 1939 on *Macrozamia riedlei* in Australia, over seventy years would pass before cycad pollination would again receive serious scientific attention. During this hiatus, the opinion of Charles Joseph Chamberlain, an authority on gymnosperms, would dominate. Chamberlain (1935) concluded, with little evidence, that cycads, like other gymnosperms, were wind-pollinated. His influence was so strong that it appears to have suppressed inquiry on the topic, even decades after his death.

INSECTS ON CYCAD CONES

In the 1980's and 1990's a global survey of insect visitors to wild cycad cones was undertaken: North and Central America (Tang 1987a; Vovides 1991a; D. Clark & D. Clark, pers. comm.; O'Brien, pers. comm.), Africa (Donaldson *et al.* 1995, Donaldson 1997, Oberprieler 1995, Vorster 1995), Australia (Ornduff 1991a, b; Forster *et al.* 1994; Chadwick 1998), and Asia (Tang *et al.*, in press; R. Singh, pers. comm.). Before presenting these findings in detail, it is important to note that in wild plants we would expect to find many incidental insect visitors. Chadwick's survey of insects and other invertebrates on *Macrozamia communis* (1998), for instance, lists many insects that he encountered only once or twice over years of observation, many of these only on stems and leaves. By taking into account frequency, location, flying ability, life-cycle, and overall shape of such insects, we can narrow down the list of possible cycad pollinators. Several patterns become apparent.

The most striking pattern is: one beetle group is a frequent visitor to cycad cones in all major cycad regions of the world. They are beetles of the family Languriidae, tribe Xenoscelini. They are found on *Zamia* and *Ceratozamia* in the New World, *Encephalartos* in Africa, *Cycas* in Asia, and *Cycas* and *Macrozamia* in

Table 1 Weevils found on cycad cones in various regions of the world. After Oberprieler (1995)

Geographic region	Cycad genera	Weevil group*
south Asia, north Australia	*Cycas*	*Tychiodes* (Cossoninae) (Colour Figures 6, p. 9; 8, p. 10)
eastern Australia	*Lepidozamia, Macrozamia*	*Tranes* (Molytini)
eastern Australia	*Bowenia*	*Milotranes* (Molytini)
Africa	*Encephalartos*	*Amorphocerus, Porthetes* (Amorphocerini) *Antliarhinus, Platymerus* (Brentinae)
North and Central America	*Dioon, Zamia*	*Parallocorynus* (Colour Figure 9, p. 10), *Rhopalotria* (Oxycorininae)

*Genus followed by subfamily or tribe of weevils in parenthesis.

Australia (see Table 1). These cycad regions were once connected in a vast, homogenous flora on the supercontinent of Pangea during the Paleozoic and early Mesozoic era over 200 million years ago (Delevoryas 1975). It appears that these xenosceline beetles have an ancient association with cycad cones that began sometimes in this period. With the break up of Pangea and continental drift this cycad flora became fragmented and isolated on each continent. The cycads of each continent evolved down different paths, but retained their symbiotic xenosceline beetles. Today the xenosceline beetles are distinct on each continent with different species inhabiting different cycads. They include the genera *Pharaxonotha, Hapalips, Xenocryptus* (Colour Figure 5, p. 9) and other undescribed genera.

A second pattern is also apparent. Oberprieler (1995) describes how distinct groups of snout weevils (Curculionidae) have adapted to live on cycad cones in separate regions of the world (Table 1). Each cycad genus and region has its own weevils, distinct from those in other regions. These weevils are relative newcomers, from the cycads' ancient perspective. They have probably colonized cycad cones only within the last tens of millions of years.

Other insect groups found in fresh cycad cones, but having limited distributions include: beetles of the family Boganiidae in the genera *Metacucujus* and *Paracucujus* on *Encephalartos* and *Macrozamia* respectively (R.A. Crowson, pers. comm.), beetles of the family Biphyllidae, genus *Biphyllus*, on several species of *Cycas* in Thailand, and an unusual genus of Thysanoptera, *Cycadothrips*, on *Macrozamia* (Chadwick 1998, Mound *et al.* 1998).

EXCLUSION EXPERIMENTS

Once identified, the effectiveness of the suspected pollinator must be evaluated. Some of the most convincing evidence for insect pollination come from exclusion experiments, where only insects, only wind, or both are excluded from female cones during the pollination period. Norstog *et al.* (1986) was the first to start such experiments on cycads with cultivated plants of *Zamia furfuracea*, followed by experiments on wild populations of *Zamia pumila* (Tang 1987), *Macrozamia riedlei* (Connell & Ladd 1993), *Encephalartos cycadifolius* (Donaldson *et al.* 1995), and *E. villosus* (Donaldson 1997). When analyzed statistically the results have shown that beetles contribute wholly or at least partially to successful pollination in these species.

Another method of study was conducted by Donaldson *et al.* (1995) and Donaldson (1997), who marked suspected beetle pollinators with florescent powder and released them near female cycad cones. After cutting open the female cones and examining them under florescent light, they convincingly demonstrated how the beetles had entered the cone and moved among the ovules. (Fertilized ovules develop into seeds.)

LIFE CYCLE OF CONE INSECTS

A full understanding of the pollination of a cycad species is not possible until the life cycle of the pollinator is studied. By far the most detailed studies are those for *Rhopalotria* and *Pharaxonotha* beetles by Norstog and Fawcett (1989) and Norstog *et al.* (1992). These authors beautifully illustrate how these beetles reproduce and develop in cycad cones, how they deliver pollen, and how they survive when their host plants are not in cone. These studies have been some of the most compelling evidence for insect pollination of cycads.

INSECT ATTRACTANTS

The ultimate goal of studying pollination and the behaviour of the pollinator is to understand a plant's pollination mechanism. What does the plant do to

Colour Figure 1 A large branched specimen of *Cycas tansachana* on a cliff top, with owners of the gas station who *guided* the author to the site.

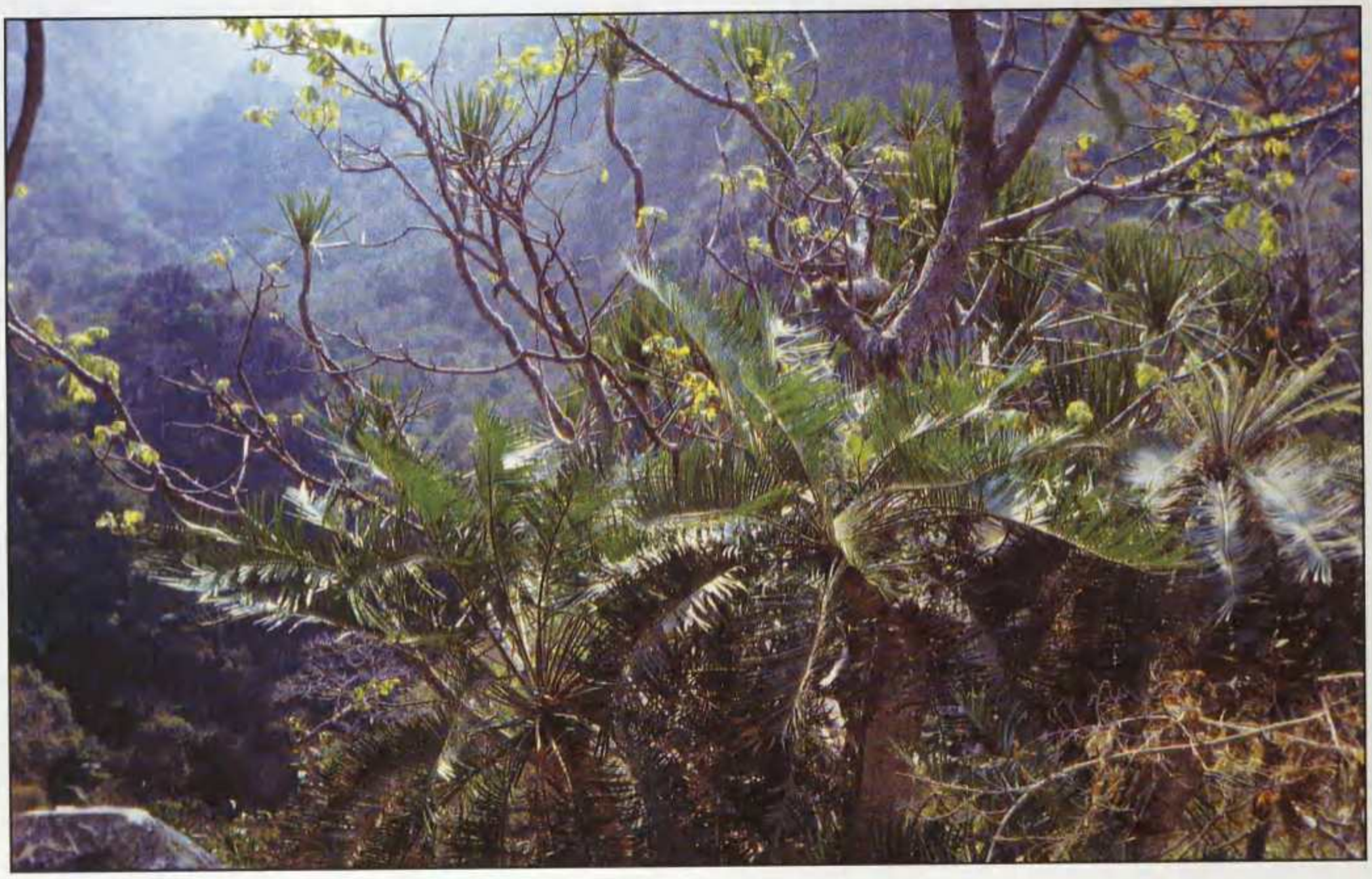
Colour Figure 2 *Cycas tansachana* often grows out of crevices on sheer cliffs.

Colour Figure 3 Female "cone" of *Cycas tansachana* in habitat. Some of the outer sporophylls have been cut away to reveal the interior. Note the dense wool covering these young female sporophylls.

Right: **Colour Figure 6** An undescribed weevil of the genus *Tychiodes* from a male cone of *Cycas pectinata* from Fang, Thailand. Length of beetle = 7 mm. Photo: W. Tang.

Colour Figure 4 Male cone of *Cycas tansachana* in habitat. Note the orange-brown wool at the stem apex below the crown.

Colour Figure 5 An undescribed species of *Xenocryptus* (Family Languriidae, tribe Xenoscelini) from a male cone of *Cycas balansae* from Yunan, China. Scale line = 1 mm. Photo: W. Tang.



Colour Figure 7 These crowns of *Cycas tansachana* reveal the keeled shape of the leaves.

Colour Figure 8 An undescribed species of *Tychiodes* from the male cone of *Cycas siamensis* from Thailand. Scale line = 1 mm. Photo: W. Tang.

Colour Figure 9 An undescribed weevil of the genus *Parallocorynys* from the male cone of *Dioon merolae* from Chiapas, Mexico. Scale = mm. Photo: W.Tang.

Colour Figure 10: (A) (*Top left*) Cut-open cone of *Zamia pumila* from Florida, revealing (B) (*Bottom left*) watery micropyle drops (magnified from A). Photo: W. Tang.

Colour Figure 11 Female cone of *Encephalartos umbeluziensis* x *E. lehmannii*. [In "*Encephalartos*" 59: 20 (Figure 15c) the wrong photograph was published for this hybrid. - Editor.]

attract its pollinator and why does the insect provide pollination service? These kinds of insights will allow us to make broad generalizations on how cycads reproduce in the wild, why their natural populations are successful or declining, how to conserve them in the wild, and why they have existed on earth for such an immense period of time.

To gain some insight into the pollination mechanism of cycads several authors have made comparisons with flowering plants, where insect pollination is best understood (Tang 1987a, Norstog & Fawcett 1989, Donaldson *et al.* 1995, Donaldson 1997). What pollination mechanisms in flowering plants may be functioning among cycads?

1) Cones as mating sites: Insects visit and congregate *on* cones to find mates. Mating cycad beetles has been documented on *Zamia* and *Encephalartos* cones by Tang (1987a), Norstog & Fawcett (1989), and Donaldson (1992). This kind of pollination appears to occur in some aroids.
2) Male cones as nursery sites: Beetles lay eggs in male cones, visit female cones by accident, and pollinate in the process. Norstog *et al.* (1986), Norstog *et al.* (1992), and Tang (1987a) have shown that the young of both xenosceline and weevil pollinators develop on male cone tissues of *Zamia*, which are packed with nutritious starch. Similar mating and reproduction has been observed on suspected pollinators of other cycads. This pollination system is similar to that of palms pollinated by derelomine weevils which lay their eggs within flowers, where the larvae develop without damaging seeds (O'Brien, pers comm.).
3) Female cones as nursery sites: Beetles lay eggs in female cones and ovules, visit male cones by accident, and pollinate in the process. This pollination is similar to that of yucca moths and fig wasps. which lay their eggs in the ovules or fruit. The developing larvae feed and destroy a portion of the ovules, while the rest develop into seeds. In some *Encephalartos*, antliarhine weevils will lay eggs inside developing ovules, possibly providing a pollination service in return.
4) Nectar-like fluids attract pollinators: Animals feeding on these fluids transfer pollen from plant to plant. Tang (1987a, 1992) has observed and analyzed micropylar fluids exuded from the ovules of female cycad cones (see Colour Figure 10, p. 10) and found that they contain sugars and amino acids, though at lower concentrations typically found in flower nectars, but higher than those in micropylar fluids of conifers, which are believed to be wind-pollinated.

In each of these pollinating mechanisms the plant is offering a resource to the animal pollinator, either in the form of nutrition, or by providing a convenient structure in which to mate, hide or breed. Do cycads use one, or a combination of these mechanisms to attract pollinators?

HEAT AND ODOUR PRODUCTION

Another clue that helps to solve this puzzle are observations that cycad cones produce heat and odours (see Figures 1, 2), particularly at night. This phenomenon has been shown to be widespread among cycads (Tang 1987b, Tang *et al.* 1987). It is also known to occur among flowering organs of palms, aroids, cyclanths, water lilies, and annonas. Many of these have been shown to be pollinated by nocturnal beetles (Beach 1984; Gottsberger & Silberbauer-Gottsberger 1988; O'Brien, pers. comm.). In darkness such beetles are guided by plumes of heat and odours, the inflorescences acting almost like lighthouse beacons. The chemicals released by cycad cones are distinctive for each species (Tang 1987b, Pellmyr *et al.* 1991) and insects specializing on cycads undoubtedly use them to find their host plants, especially in darkness. Massive heat production in pollination organs is a specialized trait that requires anatomical and biochemical adaptations (Meeuse 1975) and is not known in any wind-pollinated plants, such as conifers.

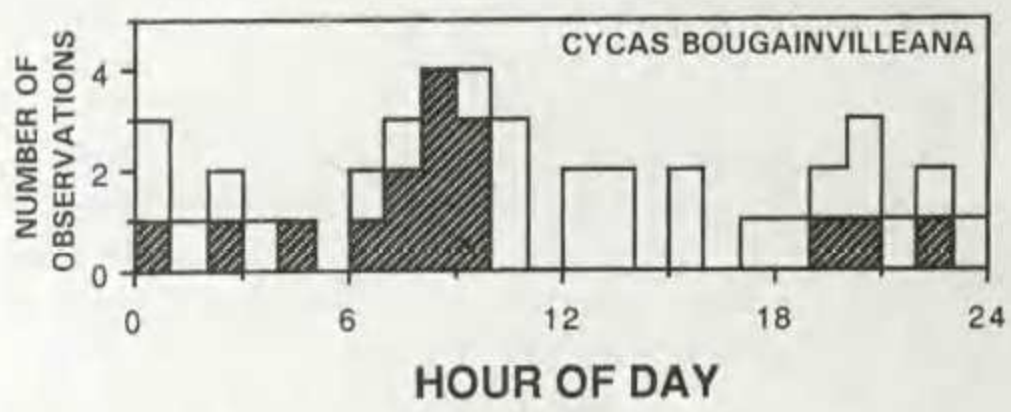


Figure 1 Observations of micropyle droplets on *Cycas bouganvilleana* at various time of day. Dark squares indicate presence of droplets and light squares indicate absence of droplets. From Tang 1993.

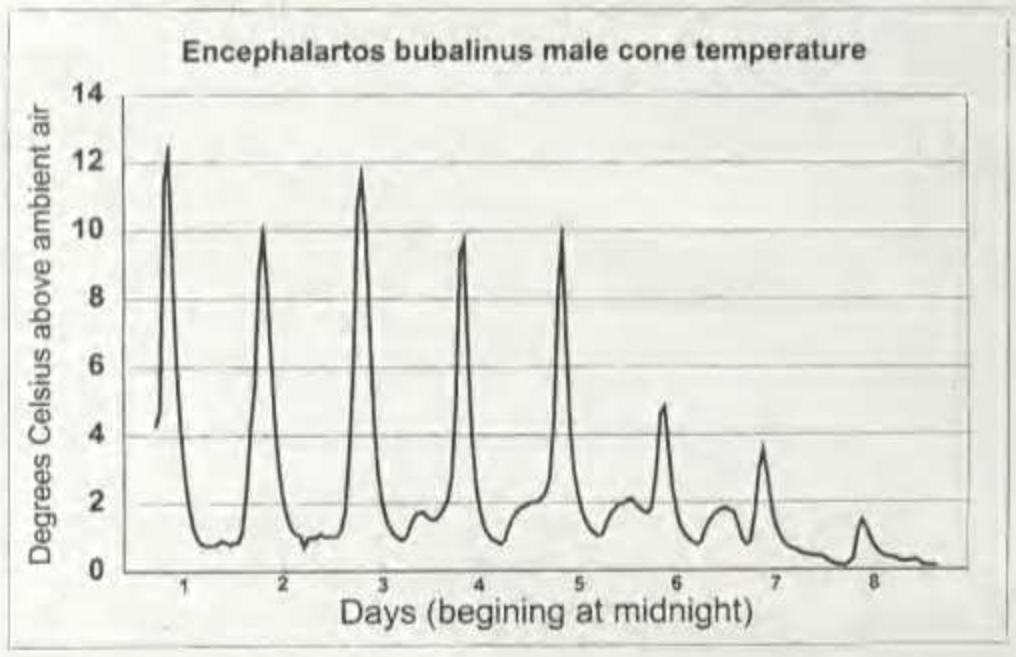


Figure 2 Surface temperature of a male cone of *Encephalartos bubalinus* (cut from the plant and brought indoors) over an 8 day period, showing the daily cycles of heating. Ambient air temperature was maintained at 24 ± 0.5°C.

ALTERNATIVE METHODS OF POLLINATION/SEED PRODUCTION

Is wind or apomixis (seed production without pollination or fertilization) important in cycad pollination and seed production? Wind and insect exclusion experiments cited above, while showing that insects are effective pollinators, do not discount a contribution by wind. Wind tunnel studies of cycad cones indicate that wind does not differentially deposit pollen onto ovules. Similar studies on conifer cones, however, show that wind-borne pollen is channelled to the ovules (Niklas 1982). Conifers also have adaptations to their cone shape and pollen shape and pollen tube growth which make wind-pollination possible (Tomlinson *et al.* 1991). These adaptations do not appear to occur in cycads. I am not aware of any studies on apomixis in cycads.

A MODEL FOR CYCAD POLLINATION

Given the evidence above, we can begin constructing a coherent picture of how insect pollination functions in cycads. The model that follows applies specifically to *Zamia pumila*, the cycad native to south Florida. This is the best studied species and the one that I am most familiar with, but is meant to apply to cycads in general. Xenosceline beetles, perhaps one of first insects to break through the toxic defensive chemicals of cycads, were originally just herbivores feeding on cycad tissue. Some 200 million years ago, they began a mutualistic relationship with cycads, where the plant provides nutritious male cones for them to lay eggs on. The larvae crawl on and through the cone tissue they feed on. When the brood cones on which they develop begin disintegrating, the beetles, now developed to winged adults, leave to find other cones on which to mate and lay eggs. In this pollination system the male plant produces its pollinators. The larger or more numerous the male cones, the more pollinators that male plant can send out. The female cones are adapted to appear similar to male cones both in smell and texture. In some species, such as those in *Dioon*, the female cones produce heat and odour in a rhythmic pattern like male cones. Beetles searching for male cones mistakenly visit female cones, where they transfer pollen to the ovules. The tissues of female cones, unlike those of male cones, contain toxins in a form that the beetles cannot ingest (Vovides 1991b, Vovides *et al.* 1993). After sampling the female cone tissues and finding them unsuitable for depositing eggs on, they soon leave without inflicting much damage to the ovules. The micropyle droplets that are exuded from ovules during these visits may or may not be an attractant to these pollinators. They are, however, a potential source of water and nutrients to the travelling insect. Between pollination seasons, these beetles have been seen on ripening female cones, the crown of the plant, as well as the seeds that have been shed. They are reported to occur on flowers of neighbouring palms, probably feeding on pollen. These beetles thus appear to have intermediate plant hosts on which to feed until the next coning seasons of their primary host, the cycad plant.

In the Cretaceous period some 100 million years ago another beetle group, the weevils, began an explosive radiation, mainly on flowering plants, which were undergoing a rapid diversification of their own. As larvae, most weevils are legless grubs that burrow into plant tissue. A second colonization of cycads by beetles took place. Weevil groups, of different lineages on continents now separated by continental drift, were also able, independently, to break the chemical defense barriers of cycads and use the nutrient-rich tissues in cones to reproduce. In North America, a primitive weevil subfamily, Oxycoryninae, have symbiotic relationships with *Zamia* and *Dioon* cones, much as the xenoscelines do in the description above. The big difference is that instead of persisting as adults between coning periods, these weevils will go into diapause (a dormant state) as pupae in the male cone debris, a very unusual adaptation. Norstog *et al.* (1992) report that the pupae of such beetles on *Zamia* can remain in this dormant state for at least two years. O'Brien (see Tang 1997) observed one of these types of beetles emerge over a seven year period on a male *Dioon edule* cone kept in his lab! Furthermore, during this time, they emerged only during the plant's natural pollination period, without any olfactory cues, as if an internal clock regulated their development. These long diapauses probably allow these pollinators to persist during droughts, when plants seldom cone. In southern Asia and the Indo-Pacific another group of weevils, consonines in the genus *Tychiodes* (Colour Figures 6, 8, p. 9, 10), have colonized cones of the genus *Cycas*. Like the other beetles described above they also develop in the male cones. This group of weevils has not been found in the northern range of *Cycas*, in the foothills of the Himalayas of China and adjacent countries, while xenosceline beetles have, suggesting that their association with cycads is much more recent (Tang *et al.*, in press). Observations on certain *Tranes* weevils in Australia and *Porthetes* weevils and boganiid beetles in Africa (Donaldson *et al.* 1995) suggest similar and relatively recent adaptations to pollinate cycads in these continents as well.

It is important to distinguish those insects which have beneficial mutualistic relationships with cycads from those that are merely eating and performing no beneficial function for the plant. The brentid weevils *Antliarhinus* and *Platymerus* found on *Encephalartos*, for instance, have been demonstrated to be seed predators and do not appear to act as important pollinators in these cycads (Donaldson 1992, 1997; Oberprieler 1995).

CONCLUSION

During CYCAD 93, held in South Africa, after a presentation on cycad beetles, one spectator, in apparent disgust for insects, remarked why we need beetles at all to pollinate cycads. Human beings could do the job. In the garden, I can see human beings doing a reasonable job of hand-pollination. But, I cannot imagine people going out of their way to hand-pollinate cycads growing out on cliffs, in remote areas of the wild, nor could I see *them* having the dedication to do it for an entire lifetime. No, insects do a much more effective job. Their presence in cycad populations is probably one reason why cycads have persisted for some 200 million years, far longer than human beings have existed on the planet. If cycads had to depend solely on human beings for pollination, most would probably be extinct in a few generations. Research on cycad pollination has just begun to reveal a marvellous process of nature. As cycad populations are being decimated in nature, so too are their pollinators. Once their pollinators disappear, so too are the hopes for the cycad's survival. The conservation of both together is critical for the future of cycads.

ACKNOWLEDGEMENTS

Disparate fields of study have been employed to bring what is currently known about cycad pollination to light. These include plant anatomy and histology, plant physiology, biochemistry, insect behaviour, insect taxonomy, and finally evolutionary ecology to tie them all together. In my understanding of cycad pollination I personally thank Knut Norstog for his pioneering work in the field and two brillaint weevil specialists, Rolf Oberprieler, and Charlie O'Brien.

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LEAFLET ABSCISSION IN *ZAMIA, CERATOZAMIA* AND *MICROCYCAS*

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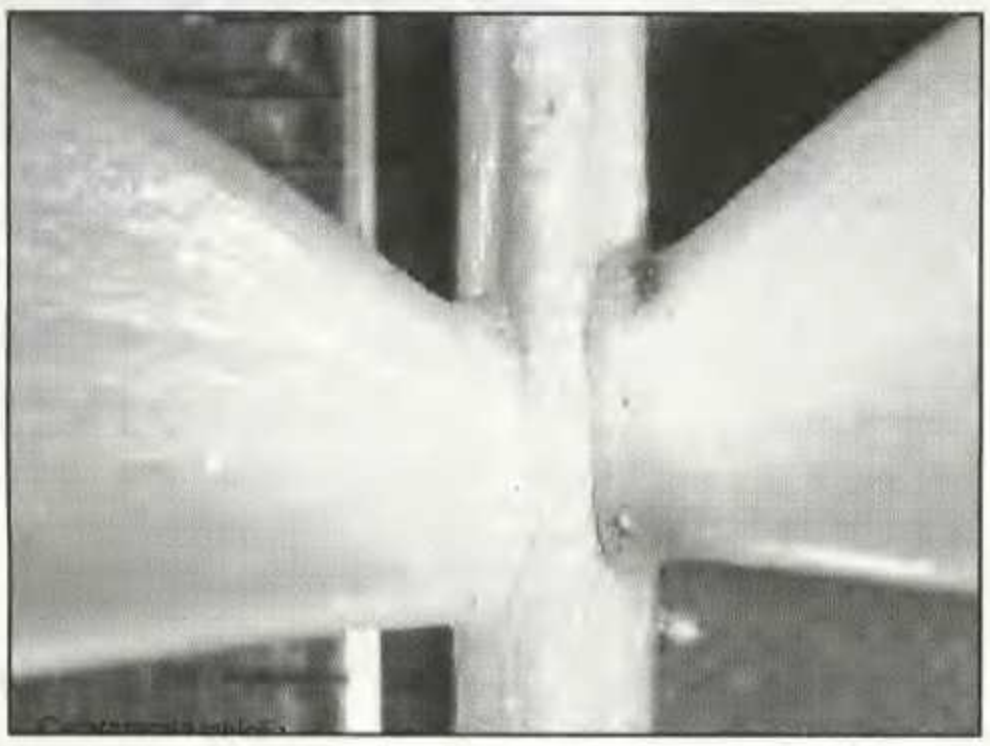

Figure 1 Close-up of a leaf of *Ceratozamia latifolia*, showing the joint, or articulation between the leaflet and rachis.

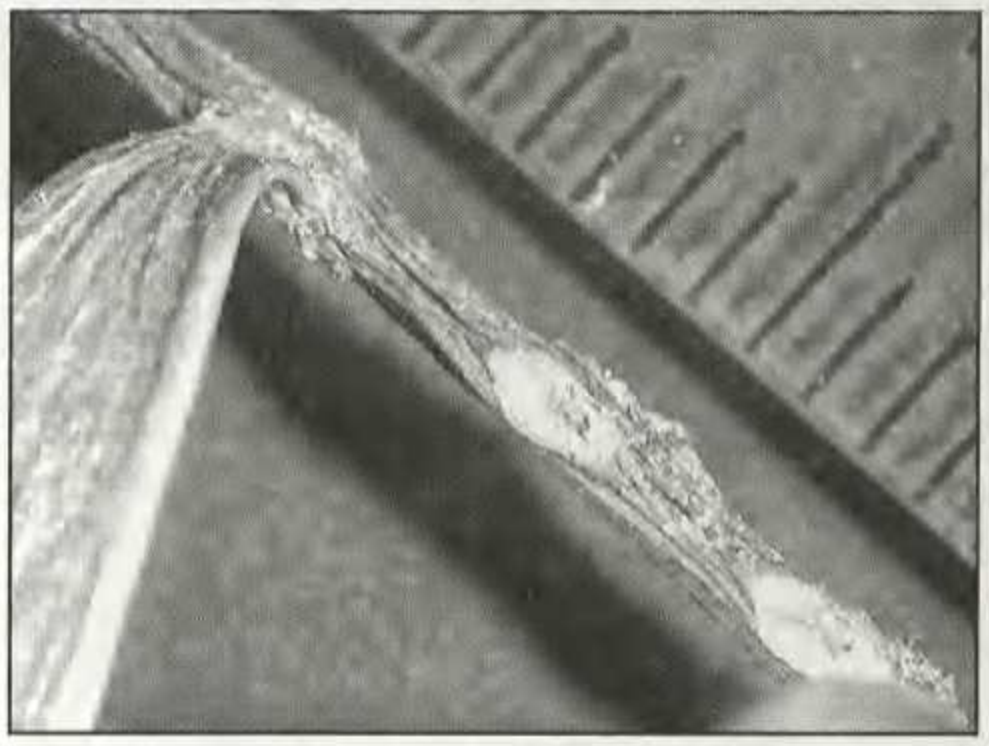

Figure 2 A leaf of a seedling *Microcycas* subjected to drought, showing how the leaflets are cleanly shed from the rachis.

Modern cycad taxonomists studying both genetics and morphology are in agreement that three New World cycad genera, *Zamia, Ceratozamia* and *Microcycas*, form a natural group, separate from the rest of the living cycads (Johnson 1959, Stevenson 1990, Norstog 1998). The foliage of these three genera are readily distinguished from that of other cycads by the presence of an articulation or "joint" between the leaflets and the rachis, where the leaflet is able to break cleanly off (see Figures 1, 2, 3). In other cycads leaflets are firmly attached to the rachis without a clear joint and remain attached even after the death of the leaf.

This leaflet joint in *Zamia, Ceratozamia* and *Microcycas* is an indication of an abscission zone, an area of natural weakness where the leaflet's cuticle, vascular strands, and

Figure 3 A close-up of the leaflet attachment of a potted *Zamia furfuracea*, denied water for one month, showing the clean abscission zone where the leaflet has been shed.

other tissues will break cleanly to leave a smooth scar. Those of us in temperate climates see abscission zones in action during the fall, when many flowering trees drop their leaves in preparation for the winter. In such plants nutrients are reabsorbed from the leaves, and abscission zones allow the trees to then cleanly shed these useless organs. Presumably the cold temperatures of winter make photosynthesis inefficient and the trees are better off producing new leaves in the spring. Abscission zones also come into play as a response to drought. Many flowering plants will shed their leaves along abscission zones after being denied water for long periods. In tropical dry forests many trees drop their leaves just before the dry season. Leaves are the main route by which water evaporates from plants, and dropping leaves allows water to be conserved.

What is the function of abscission zones in those cycads that possess them? Cycad leaves are covered with a thick layer of wax and their breathing pores (stomata) are sunken into pits. Both these characters prevent water loss and make most cycad leaves very drought tolerant. This explains why cycad leaves cut from the plant often stay green and fresh-looking for a week or more. Of those species that possess leaflets with joints, few experience cold winters or freezing temperatures. The natural habitat of *Microcycas* and the majority of *Zamia* and *Ceratozamia* species is the understorey of wet tropical forest, where warmth and humidity is high and freezing temperatures are rarely or never experienced. When do these cycads use their abscission zones? In cultivation this usually occurs on old leaves that have reached the end of their functional lives, that is leaves that have suffered mechanical damage, injury from fungal or bacterial attack, have become chlorotic from loss of nutrients or overexposure to sun, or are unable to photosynthesize due to heavy shading. The process of leaflet abscission is most noticeable in rainforest *Zamia* grown outside of their tropical forest habitats. In subtropical conditions at Fairchild Tropical Garden, when tropical *Zamia* are exposed to occasional freeze, their leaflets will shed cleanly from the leaf petiole within a few days. But, this is an unnatural situation. Long-term studies of rainforest cycad *Zamia skinneri* in Costa Rica by Clark & Clark (1992) indicate that the lifespan of leaves in the wild is 4.6 years on average and may reach 9 years. These workers concluded that the gradual growth of algae and lichens on leaflets, by shutting out light and thus shutting down photosynthesis, was the main cause of leaf death.

The most primitive *Zamia* appear to be the large arborescent rainforest species such as *Zamia lindenii* of Ecuador or *Z. skinneri* of Panama. These species live in the dark understorey of tropical rainforest, which typically receive about 2–5% of full sun. In such a light-starved environment every bit of extra light that a plant can gather is essential. When plants hold more than one leaf, or even more than one leaflet, it begins to encounter problems of one leaflet shading the other. Certainly, in such a situation, if one leaflet can no longer gather light and produce food for the plant, it would be advantageous for the plant to shed that one leaflet. A single leaflet may become nonfunctional if damaged by insects or if it becomes completely coated by algae and lichens. Also leaflets may hold debris that has fallen from the rainforest canopy; by shedding, it may clear debris that is shading the rest of the leaf or plant. Thus, by cleanly shedding a single leaflet, a *Zamia* plant may be able to improve the light gathering ability of the whole plant.

Many *Encephalartos* live in exposed high-light habitats such as cliff faces, grasslands, and scrub vegetation. In such situations, the opposite might be true. A plant may benefit if its leaflets can help to shade other parts of the plant, reducing water-stress and exposure to excessive UV light, which damages the leaves' photosynthetic ability. In such habitats it may be advantageous for the plant to retain its dead leaflets to shade and protect other leaves and the trunk. Indeed, dead leaves are known to protect some species of flowering plants from extremes of temperatures (Smith 1979). There are some *Zamia* which live in such sunny habitats; these are mostly dwarf species that are generally believed to have evolved from forest-dwelling ancestors. They have retained the leaf-abscission trait of their predecessors. *Ceratozamia*, as a group, are also dwellers of the forest understorey, often growing in deep shade. Lichens and algae growth often cover their leaflets in their natural habitats as well.

One other fact should be noted. Of all cycad genera, *Zamia* displays the widest diversity of leaflet texture and shape. This includes corrugation, smooth edges, toothed edges, spotting, collars around the leaflet base, midveins (if you consider *Chigua* a *Zamia*), and the largest of all cycad leaflets measuring over 15 x 50 cm! Perhaps it is

not surprising that they have abscission zones as well, a feature which is usually considered advanced by botanists.

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CYCAD '99: A WITNESS REPORT

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Received 1 October 1999

Way back in 1987 Jean-Pierre Sclavo, a collector in France, conceived the idea to invite a number of cycad specialists and enthusiasts to France to talk cycads. The resulting meeting, known as CYCAD '87, started a chain of events from which our knowledge of cycads advanced beyond imagination. It was promptly decided to hold another meeting in three years' time, this time in Australia and again hosted privately by David and Pat Coutts. That set the trend, and since then these meetings, now formally known as international conferences, have been held every three years: CYCAD '93 in South Africa and hosted by our Society, CYCAD '96 in China and hosted by the *Cycad Society of China* and *The Chinese Acadamy of the Sciences*, and in August this year CYCAD '99 which was hosted by the Fairchild Tropical Garden in Miami, Florida.

The latest conference took place over a period of four days at the Fairchild Tropical Garden's conference centre, and a more pleasant setting can hardly be imagined (Figure 1).

For years the Fairchild Tropical Garden has been the mecca of palm-, but even more so cycad-collectors, with a wonderful collection of rare cycads from all over the world, grown to perfection in a hot humid climate.

The organization was borne by Chuck Hubbuch and Jack Fischer, both on the staff of the Fairchild Tropical Garden, with much input by Libby Besse (Colour Figure 16, p. 27) (a board Member of Fairchild Tropical Garden), and support by Terrence Walters and his staff at the Montgomery Botanical Center. Needless to say, these arrangements went very smoothly indeed.

Figure 1 The entrance to the Fairchild Tropical Garden, near the Conference Center.

This conference was more concentrated than previous meetings, being spread over four days instead of the full week allocated to previous conferences. The reader may be forgiven for thinking that by this time new information of cycads is becoming scarce. The program, divided more or less equally between horticultural and scientific topics, was very full indeed. In fact, my one regret was that the talks took up so much time that there was simply not enough time to talk to all my old friends, some from previous congresses and some known through correspondence only, not to mention all the new faces. Also, attendants tended to scatter into the garden at every free moment (Figure 2).

In order to give readers an idea of the conference, the program is given in full below. There were the usual and inevitable deviations from the program, but I will not bother the reader with these details.

Figure 2 Elsa Vorster with a fine example of *Ceratozamia robusta* in the Fairchild Tropical Garden.

CYCAD 99

August 7-10, 1999

Fairchild Tropical Garden, Miami, Florida

PROGRAM SCHEDULE

Program Schedule for Cycad 99
August 7-10, 1999

Saturday, August 7

GENERAL PRESENTATIONS

8:00 AM	Bus departs Marriott Hotel to Fairchild Tropical Garden
8:30	Registration (Registration stays open till 10:00)
9:00	**Welcome**: Louis J. Risi, Jr. (Senior Vice-President & Treasurer, Fairchild Tropical Garden); **Announcements**: Chuck Hubbuch (Director of Collections, Fairchild Tropical Garden)
	Moderator: Paul Craft (Horticulturist, Florida)
9:20	**Cycad Horticulture at Montgomery Botanical Center**: Eric Shroyer (Montgomery Botanical Center)
9:50	**Insects associated with cycads**: Bill Howard (Professor, University of Florida)
10:20	BREAK
10:50	**Fertilizing cycads to promote growth and cone production**: Tom Broome (Horticulturist, Florida)
11:20	**Variations and range of the genus *Ceratozamia***: Loran Whitelock (Horticulturist, California)
12:00	LUNCH
	Moderator: Tom Broome (Horticulturist, Florida)
1:00	***Zamias* of Panama and Costa Rica**: Russell Adams (Horticulturist, Florida);
1:30	***Encephalartos woodii*: Propagation from excised leaves**: Chris Dalzell (Durban Botanic Gardens, South Africa)
2:00	**Cycad oddities:** Stan Walkley (Horticulturist, Australia)
2:30	BREAK
2:45	Set-Up Posters: Coordinated by Jack Fisher (See last page for Poster listings)
2:45	Bus departs Fairchild to Montgomery Botanical Center
3:00 - 5:00	**Cycad Tour of Fairchild Tropical Garden** (led by Chuck Hubbuch, Director of Collections, Fairchild Tropical Garden) **Cycad Tour of Montgomery Botanical Center** (led by Eric Shroyer and Vicki Murphy, Cycad Horticulturist & Assist. Horticulturist, Montgomery Botanical Center)
5:10	Bus departs Montgomery to Fairchild and then to Marriott Hotel (Multiple trips)

Saturday evening free

Sunday, August 8

GENERAL PRESENTATIONS

8:30 AM	Bus departs Marriott Hotel for Fairchild
	Moderator: Libby Besse (Horticulturist, Florida)
9:00	**The Cycad Garden at Nong Nooch Tropical Garden**: Anders Lindstrom (Horticulturist, Thailand)
9:30	**Hand pollination of cycads**: Tom Broome (Horticulturist, Florida)
10:00	BREAK
10:30	**Germination of cycads:** Paul Craft (Horticulturist, Florida)
11:00	**Cycads of Central and East Africa: A travelogue**: Peter Heibloem (Horticulturist, Australia)
12:00	LUNCH
	Moderator: Chris Dalzell (Durban Botanic Garden, South Africa)
1:00	**Developing scientifically based collections**: Terrence Walters (Director, Montgomery Botanical Center)
1:20	***Encephalartos* conservation through cultivation**: Steve Trollip (Horticulturist, South Africa)
1:45	**A review of past cycad conferences: 1987 to 1996**: Dennis Stevenson (New York Botanical Garden)
2:15	**CITES, Cycads and Conservation: What's in it for you?** John Donaldson (South Africa); Ken Hill (Australia); Willie Tang (Florida)
3:00	BREAK
3:45	Bus departs Fairchild to Marriott Hotel (optional)
4:00	Tram tour of Fairchild (40 minutes)
5:30	Bus departs Marriott Hotel to Fairchild
6:00-8:30	**Social Hour & Banquet** (reservation required)
8:30	Keynote speaker (reservation required). **"Cycadophilia"** by Dr. Oliver Sacks, noted medical researcher and author of *Awakenings*, *The island of the colorblind* and *An anthropologist on Mars*, and the TV series *The mind traveler*.
9:45	Bus departs Fairchild to Marriott Hotel

Monday, August 9

SCIENTIFIC PRESENTATIONS

8:30 AM Bus departs Marriott Hotel to Fairchild
9:00 Welcome: Julia Kornegay (Acting Director, Fairchild Tropical Garden)
Announcements: Jack Fisher (Senior Researcher, Fairchild)

Conservation Session Moderator: Dennis Stevenson (New York Botanical Garden)

9:15 **The Cycad Pages and the World List of Cycads**: KD Hill
9:30 **Out in the cold: how well will the world's cycads fare if conservation efforts focus on biodiversity "hotspots"?:** JS Donaldson
9:45 ***Ex situ* cycad conservation at the Lowveld National Botanical Garden - a progress report**: PJH Hurter
10:00 **Cycad conservation in Australia and Asia:** KD Hill, CJ Chen & NT Hiep
10:15 **New discoveries of cycads and advancement of cycad conservation in China:** CJ Chen & N Liu

10:30 BREAK

Ecology and Tissue Culture Moderator: Peter Lindblad (Uppsala University, Sweden)

10:45 **A biotechnology strategy for long term preservation of cycads**: RE Litz, PA Moon, EM Benson, J Steart & VM Chavez
11:00 **Cycad functional response types: how can we predict cycad responses to environmental changes?:** JS Donaldson
11:15 **Spatial distribution, population structure and fecundity of *Ceratozamia matudae* (Zamiaceae) in El Triunfo Biospere Reserve, Chiapas, Mexico**: MA Pérez-Farrera, PF Quintana-Ascencio, AP Vovides & EB Salvatierra-Isaba
11:30 **Insect herbivore relationship in natural reproductive *Zamia* populations in Panama:** AS Taylor & CO Mendez Pereira
11:45 **Effect of sucrose concentration on maturation of *Zamia fischeri* Miq. somatic embryos:** I Alvarez-Rodriguez, VM Chavez, M Monroy, RE Litz & PA Moon
12:00 **Mycorrhizae are present in cycad roots**: JB Fisher & AP Vovides

12:15 LUNCH

Monday, August 9

SCIENTIFIC PRESENTATIONS
(CONTINUED)

Systematics & Taxonomy I Moderator: Piet Vorster
(University of Stellenbosch, South Africa)

1:15 **Variation in the Mexican cycad *Dioon edule***: LM Whitelock
1:30 **New discoveries in the *Cycas rumphii* complex**: AJ Lindstrom
1:45 **Morphological diversity in neotropical cycads south of the Isthmus of Panama**: DW Stevenson
2:00 **Phylogeny and biogeography of the Australian and Asian cycads**: KD Hill
2:15 **Molecular systematic studies in cycads**: DJ Bogler & J Francisco-Ortega
2:30 **The *Dioons* of Oaxaca, Mexico (Part 1):** TJ Gregory, J Chemnick & S Salas-Morales
2:45 **The *Dioons* of Oaxaca, Mexico (Part 2):** TJ Gregory, J Chemnick & S Salas-Morales

3:00 BREAK

Fossils and Reproductive Biology & Genetics Moderator: Victor Chavez (UNAM, Mexico)

3:15 **Jurassic cycadophyte leaves of exceptional anatomical preservation from Skye, NW Scotland:** BL Dower, RM Bateman & DW Stevenson
3:30 **Phytodermology of a Cenomanian fossil plant from France: significance about the presence of common features between Bennettitales and Cycadales:** M. Berthelin & D Pons
3:45 **Geneotypic variation in the *in vitro* formation of callus on the petioles of *Stangeria:*** PM Resslar
4:00 **Development of spermatozoids of cycads and *Ginkgo biloba* compared**: EM Gifford, KJ Norstog & W. Friedman
4:15 **Seed position in cones and sex determination in two species of *Zamia:*** W Tang
4:30 **Biology and conservation status of Microcycas in Cuba:** E Peña Garcia

4:45 BREAK

4:45 Bus departs Fairchild to Montgomery for Board of Directors of Cycad Society and IUCN Specialist Group.
Bus returns to Fairchild and departs Fairchild to Marriott Hotel
5:00 - 7:00 Meeting of Board of Directors, Cycad Society (at Montgomery Meeting Room)
5:00 - 7:00 Meeting of IUCN Cycad Specialist Group (at Montgomery Florida Room)

Monday evening free

Tuesday, August 10

SCIENTIFIC SESSIONS

Biochemistry & Physiology Moderator: John Donaldson
(National Botanical Institute, South Africa)

8:30 AM Bus departs Marriott Hotel to Fairchild Tropical Garden
9:00 **Leaf physiology of shade-grown *Cycas micronesica* leaves following removal from shade:** TE Marler
9:15 **Cyanobiont diversity within coralloid roots of selected cycad species:** JL Costa, P Paulsrud & P Lindblad
9:30 **Effect of shade and fertilizer on growth of *Zamia floridana*:** B Dehgan, F Almira, B Schutzman & A Dudeck
9:45 **Response of ultrastructure and function of chloroplasts from cycads to doubled-CO2 concentration:** BY Zuo, GZ Zhang, Q Zhang & CJ Chen

10:00 BREAK

Systematics & Taxonomy II Moderator: Bijan Dehgan (Professor, University of Florida)

10:30 **Phylogeny of some Eastern Cape (South Africa) *Encephalartos* species:** P Voster, HJ van der Bank, M van der Bank & M Wink
10:45 ***Encephalartos relictus* (Zamiaceae): a newly described species from southern Africa:** PJH Hurter
11:00 **Taxonomic problems and solutions in Mesoamerican *Zamia* (Zamiaceae, Cycadales)**: B. Schutzman & B Dehgan
11:15 **Developing a leaf identification key of southern African *Encephalartos* species for use by law enforcement officers**: PJH Hurter
11:30 **Preliminary study on pinnae anatomy in Zamiaceae and its systematic significance:** J Liao & Q Wu
11:45 **Cycads on Hainan Island, China:** N Liu

12:00 LUNCH

12:00-1:00 Take down Posters.
1:00 Bus from Fairchild Tropical Garden to Montgomery Botanical Center
1:15-3:15 **Tour at Montgomery Botanical Center**
(led by Terrence Walters, Executive Director, Montgomery Botanical Center)
Tour at Fairchild Tropical Garden
(led by Chuck Hubbuch, Director of Collections, Fairchild Tropical Garden)
3:30 Bus departs Montgomery to Fairchild and then to Marriott Hotel (two round trips)
4:15 Bus departs Marriott Hotel for FTG and then to Montgomery.
4:30 Last bus departs Fairchild and Garden is closed.
4:00 - 7:00 **Farewell Social** at Montgomery (reservations are NOT required. All welcome.
6:00 & 7:00 Bus departs Montgomery for Marriott Hotel

POSTERS

Classical biological control of cycad scale, *Aulacaspis yasamatsui* (Homoptera: Diaspididae) in South Florida, RM Baranowski & HB Glenn
Notes on the mating behavior of *Rhopalotria mollis* (Curculionidae): a pollinator of *Zamia furfuracea* (Zamiaceae), PF Fawcett & KJ Norstog
Cycad coning cycles in southern California, V. Hayes
Patterns of genetic variation and demography of *Cycas taitungensis* populations in Taiwan, S Huang, HT Hsieh & YC Chiang
First discovered vessel in cycads, Y Huang, H Chang & J Lin
Comparative karyotype analysis of *Ceratozamia mexicana* and *Microcycas calocoma* (Zamiaceae) using fluorchrome banding (CMA/DAPI) and fluorescence *in situ* hybridization of ribosomal DNA, G Kokubugata & K Kondo
Effect of gelling agent on growth and development of *Ceratozamia hildae* somatic embryos, PA Moon & RE Litz
Applied conservation methodology for wild dioecious species with reproductive restrictions, E Peña Garcia
***Ceratozamia mexicana* reproductive cycle with notes on seed anatomy**, Y Sanchez-Tinoco, EM Engleman & AP Vovides
Biochemical characterization of developmental stages of cycad somatic embryos, I Vargas-Luna, G Ortiz Montiel & VM Chavez

Reminder

Free shuttle bus from Marriott to Miami International Airport. Check at Hotel desk.

Cycad 99 was sponsored by
Fairchild Tropical Garden, Palm Beach Palm & Cycad Society, and Montgomery Botanical Center

Cycad 99 was organized by
Libby Besse, Paul Craft, Jack Fisher, Chuck Hubbuch and Terrence Walters.

As can be seen, several South Africans, and most of them members of our Society, attended and gave talks; including Chris Dalzell, John Donaldson, Johan Hurter of the Nelspruit Botanical Garden, Steve Trollip, and yours truly. It is also pleasing that so many attendants, including speakers, were members of our Society including Byron and Libby Besse, Tom Broome, Bane Cheek, Jeff Chemnick, Tim Gregory, Peter Heibloem, Don Kurth, Harry Luther, Michael Perry, Lou Randall, Dennis Stevenson (who will be editing the Proceedings), Willie Tang, Kampon Tansacha, Ian Turner, Stan Walkley, Terrence Walters, Loran Whitelock, and Eddie Williamson.

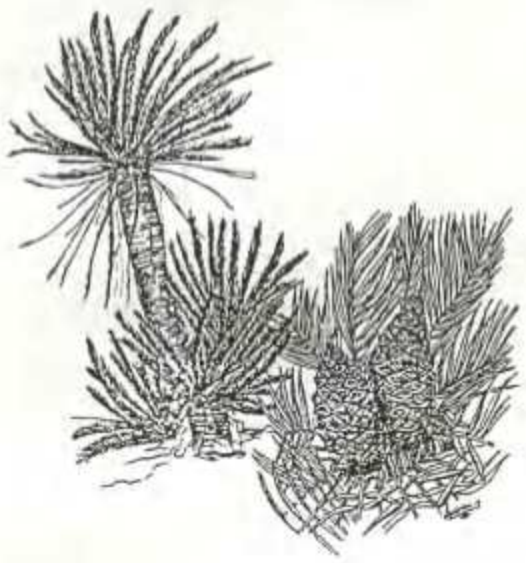
Highlights? I would hate to give offence by picking out talks which I found specially appealing, but a few certainly were of absorbing interest including "*Variation and range of the genus* Ceratozamia" by Loran Whitelock, "*Cycads of central and east Africa: a travelogue*" by Peter Heibloem (see review of his book on the same subject elsewhere in this issue), "*New discoveries of cycads ... in China*" by Chia-Jui Chen & N. Liu, "*Variation in ...* Dioon edule" by Loran Whitelock, "*New discoveries in the* Cycas rumphii *complex*" by Anders Lindstrom, and "*The* Dioons *of Oaxaca*" by Tim Gregory, Jeff Chemnick, and Sylvia Salas-Morales.

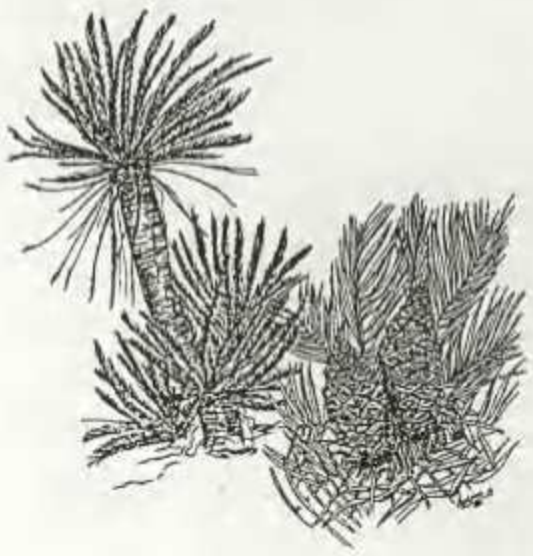
As the cycads won't be with us for long unless we practice conservation, there were also a number of interesting papers on conservation, of which the most thought provoking by far was "*A biotechnology strategy for long term preservation of cycads*" by Litz *et al.* After initial failures, some progress has been made in recent years to grow cycads through tissue regeneration in tissue culture, but we are still far from a cheap, fast, and reliable process. Litz and his colleagues suggested that, in the interim, cycad germ plasm can be maintained almost indefinitely in tissue culture until such time as plant regeneration becomes a viable option. To my mind this is a far more viable option than seed banks, and not necessarily more expensive. I would think that, even with the limited means at our disposal, our Society may be able to financially support such a venture partially or completely.

A paper of considerable importance was read by Jack Fischer and Andrew Vovides, reporting the presence of mycorhizae in *Zamia pumila* and *Z. furfuracea*, Vovides having previously (1991) reported mychorizae in *Ceratozamia mexicana* and *Dioon edule*. As yet the identity of the mycorhizae has not been determined, and it is not even certain whether they represent one or more species. It means that yet another requirement for optimal cycad growth had been discovered, others being the symbiotic cyanobacteria in the coralloid roots, and of course the intimately associated and often species specific beetles responsible for pollination.

Unlike previous conferences, there was no associated field trip this time. This gap was filled by Society member Jeff Chemnick who took Ken and Leslie Hill, Stan Walkley, Lou Randall, Ian Turner, and Elsa and myself along to Mexico for eight days. Jeff had spent half a lifetime botanising in Mexico and consequently knows the country like the back of his hand. We had a truly wonderful time, seeing plants such as one only dreams of. I will report on some aspects of that trip in the next issue. Meanwhile Jeff apparently liked it so much to show us his jealously guarded localities, that he is organizing another, even more extensive, trip for March 2000. A notice appears elsewhere in this issue.

The next conference will be in 2002 in Thailand, hosted by Kampon Tansacha and his Nong Nooch Tropical Garden. Having myself been to this garden [see articles in *Encephalartos* **54**: 19–21 (June 1998) and **58**: 21–22 (June 1999)], and having experienced the incredible Thai hospitality at first-hand, I have no doubt that this will be a meeting not to be missed. Let us start planning and saving now for that conference, and make sure that our Society is well represented. If you can give a talk, it would be greatly appreciated; but that is not a prerequisite. Many people attend just to meet other enthusiasts, exchange information, see beautiful cycads, and have a good time amongst friends.





SHORT COMMUNICATIONS / KORT MEDEDELINGS

DREAM OR FANTASY

Jack van der Merwe
P.O. Box 39, 0835 Duiwelskloof, R.S.A.

Received 26 July 1999

Would it have been a part of your daydreams to have been a landowner with a large estate, preferably thoroughly dotted with large rare cycads.

Well there is a possibility that, well scaled down, something of that nature could take place. You may well ask "How"?

Well, let us take a general view of South Africa at the present time, while staying away from the political field. The Central Government and Provincial Administrations have now a watchword. Privatization: the Railways, Harbour Services, Forestry Department, and many other Government owned institutions are up for grabs.

This being the cause, what about Government owned Nature Reserves? If enough nature lovers would band together a financial power could be created which should interest any Government Department desirous of getting rid of non profitable holdings.

Yes, I said non profitable, most Nature Reserves are running at a loss. So if a private consortium did take over a Nature Reserve, could it be transformed from a liability to an asset? In my opinion, YES. The majority of such institutions are grossly overstaffed and under present Utopian labour laws, staff cannot be reduced or fired. Furthermore today's labour ethic seems to be based on the "I'm alright Jack, and a finger to you" attitude.

A profitable undertaking would require a clean sweep of all employees and a new minimal labour force of well motivated employees. They should be employed on a contractual basis to avoid conflict with the labour unions. A further essential element is the PROMOTION of TOURISM and the sale of cycad seedlings and indigenous plants to the nursery trade and to the public.

You may well ask, "What's in it for me?" That's a very good question. Frankly, only the feeling that you are part of a private Nature Reserve, even if only a hundreth or a thousandth part of the unit, the knowledge that you have done your part to preserve our natural heritage, including our own favourite, the cycad. Depending on the facilities available at the Reserve(s) chosen, free entrance, accomodation, or at least, an annual allocation of seed as is practice at Kirstenbosch should be available to members of the consortium.

Please remember, this idea could be, not a fantasy, but another realisable dream.

NEWS FROM THE TRANSVAAL REGIONAL BRANCH OF THE SOCIETY

Derik Minnaar
302 Hiperbool Street, 0184 Meyerspark x 8, R.S.A.

Received 1 October 1999

Report on recent activities

MIDDELBURG EXCURSION

On the chilly morning of 4 September the Transvaal branch of the Cycad Society visited the "Cycad hiking-trail" at Middelburg, Mpumalanga. Seventeen people of all ages attended. They met at the registration office at 08h00. After enjoying coffee and a lunchbox breakfast they departed in various vehicles.

The first plant alongside the road was a large *E.*

middelburgensis (Colour Figure 12, p. 27). One of the frequent visitors noted that the longest stem of this plant was leaning more towards the ground than a couple of years ago. The group then moved to the Olifants River Gorge, where thousands of *E. lanatus* could be seen growing on the steep slope (Colour Figures 13, 14, p. 27). Some of the older specimens reached up to three metres in length . It was also noted that the natural pollination mechanism was so effective that virtually all of the seed were successfully pollinated and many seedlings could be seen between the rocks and surrounding mature plants. The light green leaf crowns on the even charcoaled stems left a lasting impression on the group.

Everybody then climbed down the slope to visit the famous "octopus" plant - an enormous *E. middelburgensis* with several long stems originating from a common root stock (Colour Figure 15, p. 27). This plant was declared a national monument and became one of the most famous cycads in nature. Only a few metres from this magnificent plant another large *E. middelburgensis* could be seen, with one stem completely burnt down by a veld fire. It started to regrow and will probably become a new plant.

The visitors regrouped and drove down a badly eroded dirt road to the bottom of the gorge to look up to the steep slopes at the wonderful displays of *E. lanatus* cycads.

Early during the afternoon the group moved back to the office area where the afternoon was spent enjoying a traditional South African braai. The visitors shared the latest cycad news and enjoyed a beer while the meat was sizzling on the coals. All enjoyed the trip tremendously and would recommend this visit to all members.

HELP SAVE THE ALBANY CYCAD

J. De Wet Bösenberg
National Botanical Institute, Kirstenbosch Botanical Garden, Private Bag X7, 7735 Claremont, South Africa

Received 19 October 1999

The future of one of South Africa's rarest cycads hangs in the balance following years of collecting from the wild and habitat destruction in the Eastern Cape province which have brought it to the verge of extinction.

The Albany cycad, known scientifically as *Encephalartos latifrons*, is one of South Africa's rarest cycads and conservationists estimate that only 100 to 200 plants still exist in the wild.

Now scientists at the National Botanical Institute are appealing to cycad enthusiasts and gardeners to help in their quest to boost the remaining populations.

"The sex life of these ancient plants is in dire straits. Like other cycads with low numbers, the Albany cycad populations have many more males than females, meaning that males and females may not occur in the same place and insect pollinators have a hard time finding the few remaining females. As a result, there are very few seeds," said Dr John Donaldson, cycad expert at the National Botanical Institute.

Research sponsored by the Mazda Wildlife Fund has shown that even the beetle pollinators are disappearing so that soon there may be no sex at all, leaving only sterile plants that some biologists have described as the living dead. "The future of the Albany cycad looks bleak, unless we act now to increase the number of plants and to improve natural pollination," said Donaldson.

Nature conservation agencies in the Eastern Cape have been working with farmers to protect the plants and the Mazda Wildlife Fund has provided vehicles to study ways to increase seed production and establishment. However, there are simply not enough plants left in nature to ensure the survival of the Albany cycad. As a result, scientists are looking further afield for seeds and seedlings that can be used to boost wild populations.

In contrast to the 100 or so plants left in the wild, there are estimated to be thousands of Albany cycad plants in private collections. These collections represent the best source of material for boosting wild populations. To do this, scientists need to use genetic tools to match garden plants with wild populations. Suitable plants can then be used in breeding programmes to produce seeds for reintroduction into the wild. "Cycad collectors often argue that cultivation benefits conservation and this is an excellent opportunity for everyone who has plants of the Albany cycad to participate in an effort to conserve them in the wild" said Donaldson.

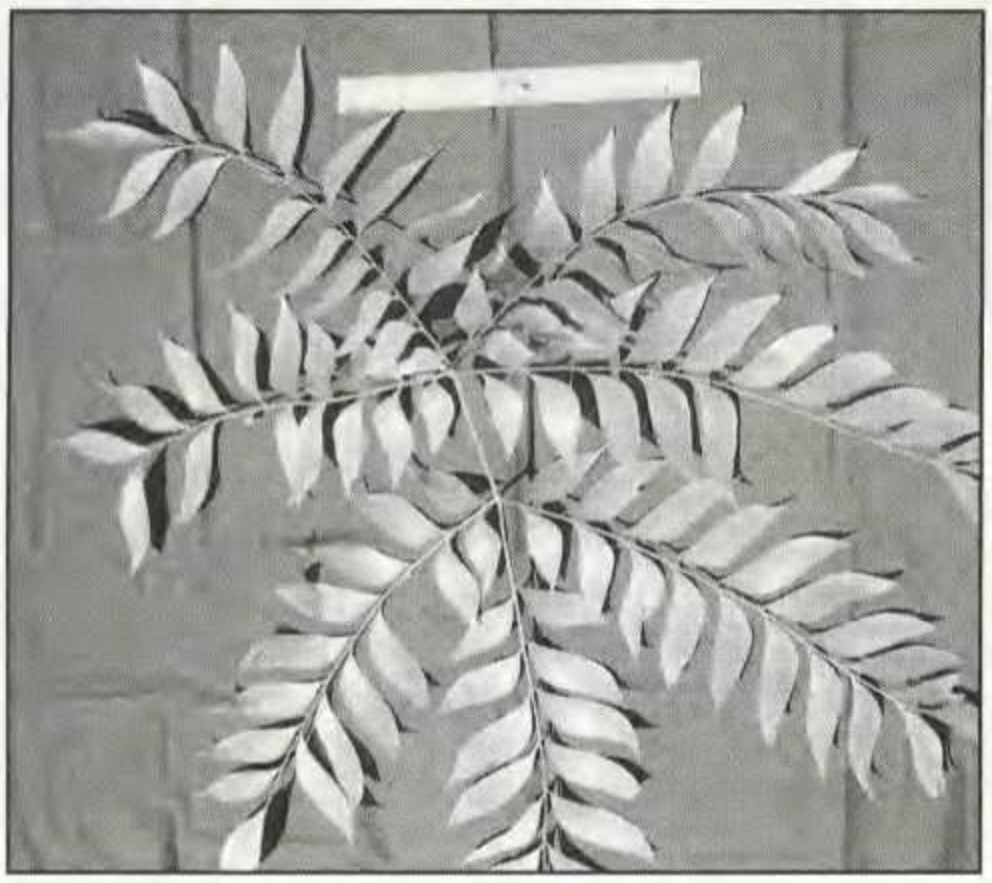
Anyone with suitable plants can contact De Wet Bösenberg at the National Botanical Institute in Cape Town, Tel: (021) 762 1166, Fax: (021) 797 6903, Private Bag X7, Claremont 7735 or by e-mail: bosenber@nbict.nbi.ac.za

BLAARSKYF VAN / LEAF BLADE OF *BOWENIA SPECTABILIS*

Nat Grobbelaar
Posbus/P.O. Box 15357, 0039 Lynn-oos/Lynn East, R.S.A.

Ontvang/Received 19 Julie/July 1999

Alhoewel die blaar in geskrifte as dubbelveervormig saamgesteld beskryf word, lyk dit hier (Figuur 1) of die primêre verdeling handvormig is. Die blare van saailinge wys egter duidelik dat die eerste en tweede pinnapare wat hier so diggedronge is, verskeie sentimeter van mekaar aan die ragis geheg is. / Although the leaf is described as being bipinnate in modern publications the primary division of the lamina here (Figure 1) appears to be palmate. In the leaves of seedlings, however, the first and second pairs of pinnae are well separated on the rachis unlike the position in this photograph.



Figuur/Figure 1 Blaar van/Leaf of *Bowenia spectabilis*

NOTE ON DIFFERENT TYPES OF *ZAMIA FURFURACEA*

Shri Dhar
20 Ballygunge Park Road, Calcutta 700 019, India

Received 26 July 1999

As I am an amateur enthusiast, keen to collect abnormal and rare plants, I have been able to collect five different types of *Zamia furfuracea*.

I am not too sure whether these *Zamia furfuracea* specimens are different species or are abnormals (Figures 1–6, and close-up views in Colour Figures 17–20 on p. 28). However, as they all appear to be different, I wrote this note so that it may interest the experts, and I would be grateful if they could identify them if the specimens represent different species.

Figure 1 *Zamia furfuracea* variegated, full view.

Figure 2 *Zamia furfuracea* cristata, full view.

Figure 3 *Zamia furfuracea* **roundish leaflets, full view.**

Figure 4 *Zamia furfuracea* **normal longish leaflets, full view.**

Figure 5 *Zamia furfuracea* **compacta, full view.**

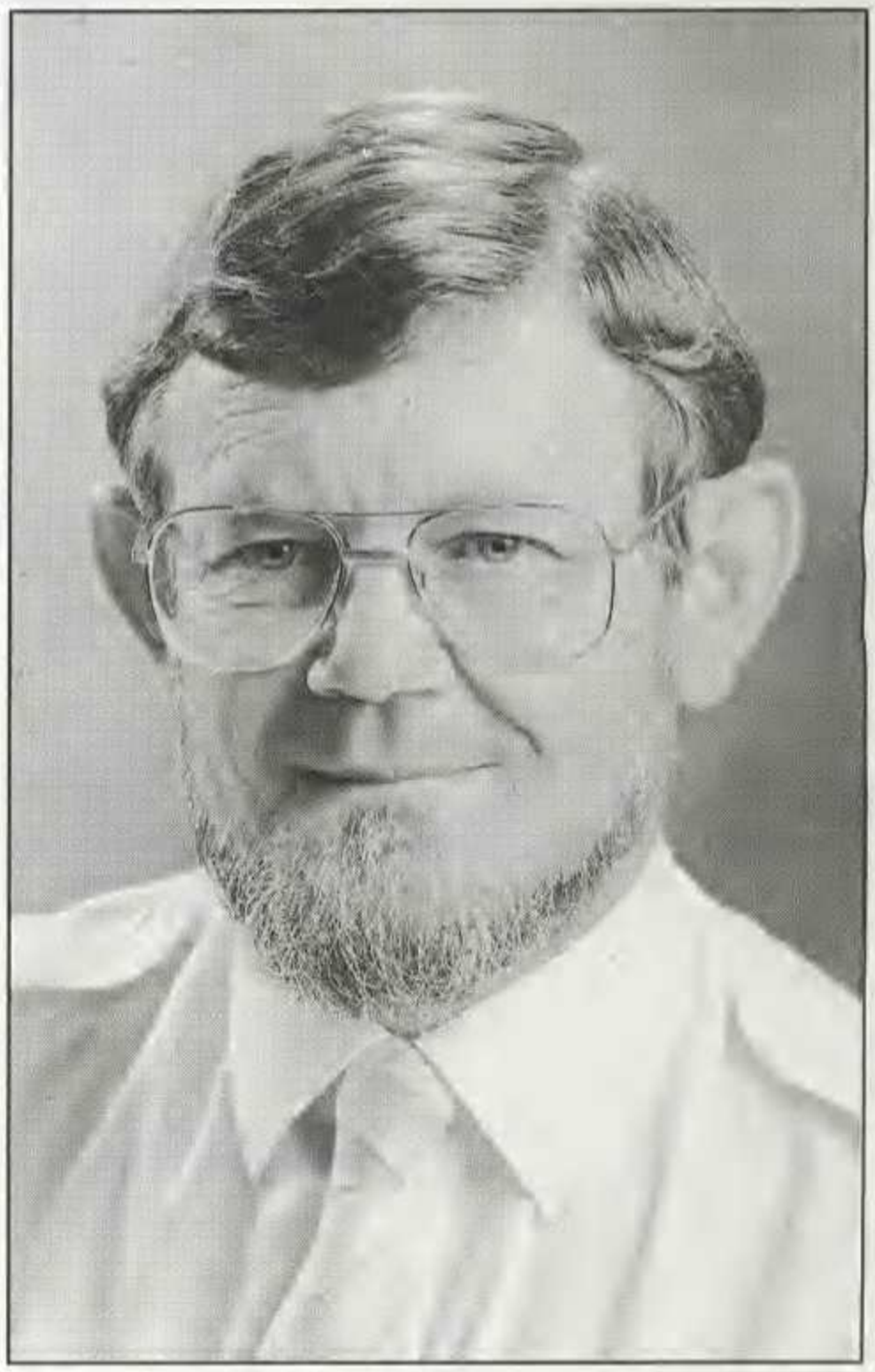
Figure 6 *Zamia furfuracea* **compacta, close-up of the leaf.**

NOTES ON *ENCEPHALARTOS UMBELUZIENSIS, E. LEHMANNII* AND THEIR ARTIFICIALLY BEGOTTEN OFFSPRING: CORRECTION

Isabella Claassen
P.O. Box 25688, 0105 Monumentpark, R.S.A.

By mistake the photo of the female cone of *Encephalartos umbeluziensis* was printed for that species (Figure 15a) as well as for the hybrid, *E. umbeluziensis* x *E. lehmannii*, (Figure 15c) in "*Encephalartos*" **59**: 20. The correct photo of the female cone of the hybrid appears on p. 10 of this issue (Colour Figure 11).

OUR NEW PRESIDENT / ONS NUWE PRESIDENT



Dr Piet Vorster was one of the founder members of the informal Palm & Cycad Society of South Africa in 1983. Piet joined the Cycad Society of Southern Africa (sic) (Member No 16) after Roy Osborne founded it in 1984. The Palm Society never forgave him for supporting the transformation of the cycad section of the Society into a full-fledged society, but he is still a member of the Palm Society, has good friends in that Society, and has some interesting palms in his collection.

For quite a number of years he is keeping an eye on the printing and despatch of "*Encephalartos*", which is being printed by the University of Stellenbosch. He therefore is to blame when your journal does not appear on time.

Piet has been collecting cycads for the past 35 years from all over the world, but his message to collectors is that it is not practical to try to grow all the species at the same locality. However, unexpected success with species such as *Encephalartos kisambo* suggests that the response of cycads to environment can be unexpected, and like most of us he cannot resist the temptation to try to cultivate new kinds. Most of his plants were propagated from seed, and some of them already have stems that are one metre in length.

Piet is a plant taxonomist at the University of Stellenbosch. His specialities are the genus *Pelargonium*, the family Amaryllidaceae and, of course, cycads, and he is the author of several new species.

Initially Piet resided in Pretoria, but for the past 20 years he is a resident of Stellenbosch. Despite the predictions of doomsayers he found that cycads grow quite well 34 degrees south of the equator, where the summers are short and frequently cool, and the winters even cooler and wet. Stellenbosch is frost-free, and thus a wide range of tropical plants can survive the winters. The main problems are regular gale force winds, as well as clayey soil. In his opinion the wet winters cause no problems, and he has lost no plants as a result of winter rain.

Piet looks forward to administer the Society in such a manner that our primary aims would be attainable for all of us, namely availability of information, liaison with fellow-enthusiasts, and availability of seed and plants. Keep an eye on future issues of "*Encephalartos*".

Dr Piet Vorster was een van die stigterslede van die informele Palm & Cycad Society of South Africa in 1983. Nadat Roy Osborne die Broodboomvereniging van Suidelike Afrika (sic) in 1984 gestig het, het Piet daarby aangesluit (lid nommer 16). Die Palm Society het hom nog nooit vergewe dat hy hom be-ywer het vir die afstigting van die Broodboomafdeling tot 'n volwaardige vereniging nie, maar hy is nog steeds lid van die Palm Society, het goeie vriende in daardie Vereniging, en hou self 'n aantal interessante palms aan.

Reeds vir baie jare hou Piet 'n ogie oor die druk en versending van "*Encephalartos*" wat gedruk word by die Universiteit van Stellenbosch. Dit is gevolglik sy skuld as u tydskrif laat is.

Piet versamel reeds vir 35 jaar lank broodbome van oor die hele wêreld, maar sy boodskap is dat dit onprakties is om alle soorte op dieselfde plek te probeer kweek. Onverwagte suksesse van soorte soos *Encephalartos kisambo* dui egter ook daarop dat broodbome soms onvoorspelbaar kan reageer, en soos meeste van ons kan hy nie die versoeking weerstaan om nuwe soorte te probeer kweek nie. Meeste van sy plante is van saad gekweek, en sommiges hiervan het al stamme van 'n meter lank.

Van beroep is Piet 'n planttaksonoom en werk vir die Universiteit van Stellenbosch waar hy plante klassifiseer. Hy spesialiseer op die genus *Pelargonium*, die familie Amaryllidaceae, en natuurlik die broodbome, en het in die proses 'n aantal nuwe soorte beskryf.

Piet het aanvanklik in Pretoria gewoon, maar woon nou reeds vir 20 jaar op Stellenbosch. Ten spyte van die doemprofete se voorspellings het hy gevind dat broodbome heel goed groei 34 grade suid van die ewenaar, waar die somers kort en dikwels koel is, en die winters nog koeler en nat. In Stellenbosch kom geen ryp voor nie, sodat 'n wye reeks tropiese plante die winters sonder probleme oorleef. Die grootste probleme is gereëlde stormwinde, asook grond wat kleierig is. Hy vind dat die nat winters nie 'n probleem is nie, en het nog nooit 'n plant as gevolg van winterreëns verloor nie.

Piet sien daarna uit om die Vereniging so te bestuur dat ons primêre doelstellings vir almal bereikbaar is, naamlik beskikbaarheid van inligting, skakeling met mede-entoesiaste, en beskikbaarheid van saad en plante. Hou toekomstige uitgawes van "*Encephalartos*" dop.

LETTERS TO THE EDITOR / BRIEWE AAN DIE REDAKTEUR

Dear Editor

ZAMIA FAIRCHILDIANA?

I have a fairly varied collection of *Zamia furfuracea* and have written a small note in this connection.

I also have another *Zamia* (Colour Figure 21, p. 28) which has been identified as *Zamia fairchildiana* by local people. Could you request the readers of your magazine to identify its correct name.

Shri Dhar, *20 Ballygunge Park Road, Calcutta 700 019, India.*

Received 26 July 1999

. . . . . .

Dear Editor

SOIL ANALYSES OF HABITATS (1)

With pleasure and satisfaction I have noticed that in recent issues of your magazine authors have added notes as to the soil which plants require. Before going into detail let me thank you for publishing my letter (*Encephalartos* **56**: 21, December 1998). Many thanks also to Dr Vorster and Prof. Grobbelaar for their statements. However, I cannot agree with what they write and should like to make some additional remarks concerning this topic. There are basically two reasons for my interest in soil analyses of habitats: Firstly, there is a tendency towards the use of supplementary fertilizers instead of universal ones in Europe. That means fertilizers used contain only the missing elements, or antagonists are added in case there is too much of one element. As for pot plants it will often be sufficient to adjust the pH values in order to block certain elements or to make others dissolve.

To make you understand the second reason for my interest let me tell you the following story: You can buy coconut palms (*Cocos nucifera*) - coconuts with 3 or 4 leaves of about one metre in length - in almost every supermarket. They are grown in peat-like soil in small pots. These poor plants have no chance to survive. Some of the ones I bought died too, the reason being that the nuts were rotten and destroyed by fungi inside. The next coconut palm I bought was subject to the following experiment: I took it out of its soil immediately and planted it into fossil shell-limestone (it is used by poultry farms to improve the quality of eggs). For watering the palm I used diluted sea water from my aquarium. I thus provided the plant with conditions similar to those at its habitat. You might find it hard to believe but the plant started producing leaves of two metres in length that were beautifully pinnated. In its 30-litre container the plant has grown to a height of about four metres and can now be visited at the "Palmenhaus", a big public greenhouse in Vienna/Schönbrunn. Some orchids from my collection are treated in the same way. For all species known to grow in coastal areas I use sea water and it works excellently. In case of some *Dioon* species I have been similarly successful.

The importance of the right soil can also be exemplified by means of some terrestrial orchids which grow in soil containing up to 200 mg manganese per one litre soil. Fertilizers with average quantities of manganese would kill the plants.

From a cacti expert I received a photocopy of a study entitled "Die Arten der Gattung *Dioon* im südlichen Mexiko" by Wolfgang Stieler and Kai Wiegerer. On page 24 it says: "Das Substrat ist lehmig-steinig mit hohem Kalkanteil. Die Population ist mit 40 adulten Pflanzen als extrem gefährdet einzustufen." Along with my own experience the article has made me absolutely certain that the existence/non-existence of lime in the soil as well as its pH value are crucial to the cultivation of any plant: Lime appears to be of the utmost importance as it makes life on earth, as we know it, possible (including *Homo sapiens*). The pH value determines the quantities of elements dissolved; without it plants could not absorb elements at all. Beside the article mentioned I have found several other studies proving my theory. If you are interested I could send you some.

In Europe farmers and gardeners, actually anybody, can have their soil chemically analyzed at horticultural schools at a price of about ATS 300 (= app. 25 US $). It could not be more convenient: You simply send in one litre of soil to be analyzed and get a complete analysis of all elements, of the pH value as well as suggestions as to which fertilizer to use. You further receive an attached chemical analysis of average soil so that you can make comparisons and see for yourself what is wrong with your soil.

***Julius Brunner**, Postfach 4, A-2326 Maria Lanzendorf, Austria.*

Received 30 July 1999

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Dear Editor

SOIL ANALYSES OF HABITATS (2)

In addition to my previous letter on soil analyses of habitats I am sending you 2 copies of soil analyses of terrestral orchids (*Die Orchidee* **49(6)**: 283, 1998; **50(1)**: 17, 1999). Habitats often seem to provide poor soil conditions, but looking more closely you will find that the soil is not as "chemically empty" as it might seem. As a matter of fact, many plants prefer growing in "chemically empty" soil (e.g. in peat). For instance, labiates grow bacteria at their roots which provide their hosts with nitrogen from the air. The leaves and roots of carnivorous plants are equipped with "traps" for insects that are converted into nourishment.

As these analyses show, there are, compared to arable soil, only little amounts of major elements, but very high quantities of minors contained in the soil examined. For most plants, this soil would be poison. Only few "specialists", like these orchids, can survive there. This appears to be the reason why orchids are to be found only in small spots scattered over the countryside.

I had big difficulties growing Zamiae until I read the following information in Jack Krempin's book "Palms and cycads around the world" (p. 256): "*Some grow in sandy coastal scrub and on rocky cliff faces near the sea, while others grow under cover with Chamaedorea palms in tree-covered areas and on rocky hillsides. Sometimes the soils are alkaline.*" Thus I tried watering them like my coconut palms - and was not really surprised any more when they started growing very well.

Soil cannot simply be judged at first glance, one must not classify it as rich or poor in nutrients by merely looking at it.

I hope I have been able to make some members of the Cycad Society of South Africa curious; maybe the next millenium will hold some interesting analyses and surprises in store.

***Julius Brunner**, Postfach 4, A-2326 Maria Lanzendorf, Austria.*

Received 17 August 1999

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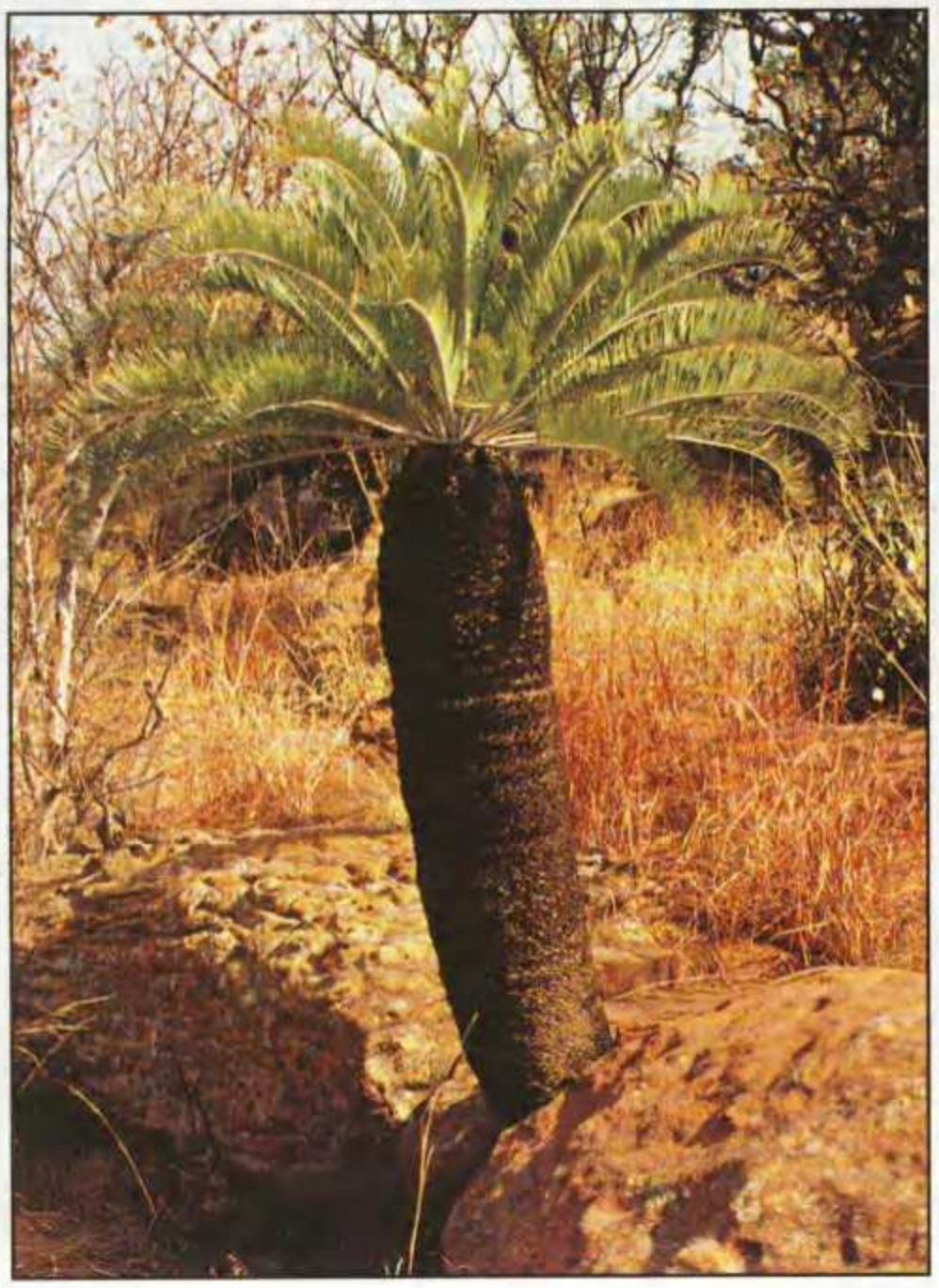
Dear Editor

CYCAD SOFTWARE

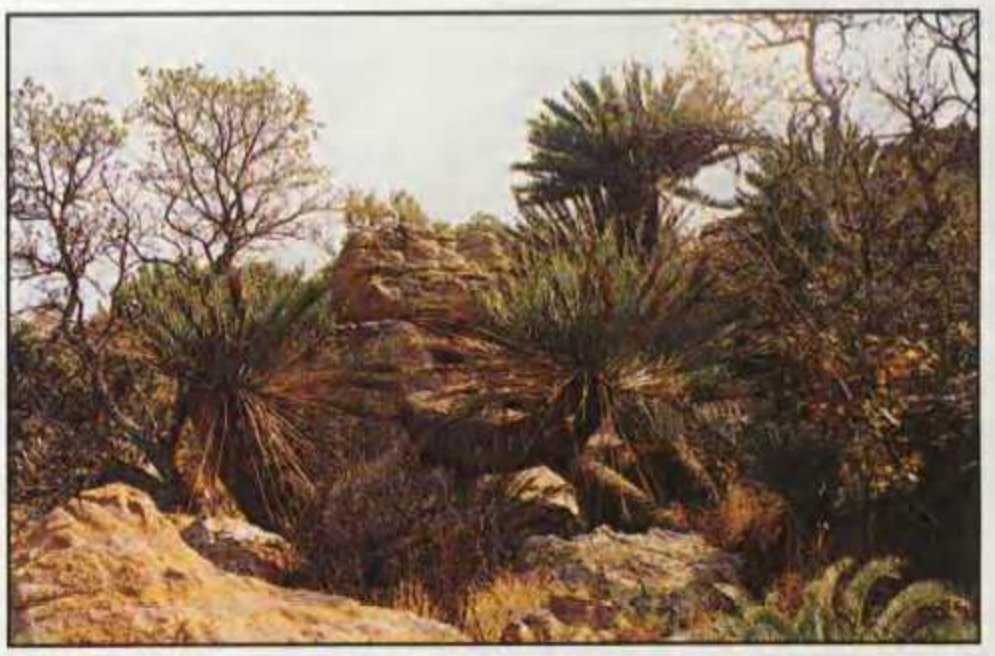
Even if cycads are ancient plants, there is no reason why we cannot use modern technology to manage our collections. I have available a simple computer program which I have found very useful to manage my cycad collection. Being a beginner, relative to most other collectors, I have a rapidly growing collection and this system helps tremendously to keep track of what is going on. My particular program has 10 fields, namely: Species, Date purchased, Purchased from, Date sold, Sold to, Permit number, Micro-chip number, Record number, Age, Sex. Information for each plant is read into the system and the plants can then be sorted under any of the fields, e.g List in order of "Date bought". Or list in order of "Record number" or "Species". At the touch of a button the program will list all your plants in the desired order. I have numbered all my plants ("Record number") and find that this is a very useful field within the program. The program is extremely simple to operate. I am selling this program to collectors and dealers for R100 + postage costs. Please take note that I can include any fields that you may desire and therefore each program can be personalised to suit your needs. If, for instance, a collector is not interested in selling plants, those fields can be replaced by other fields like "Years coned" or "Leaves per flush". Each program will be registered to the buyer and

Colour Figure 12 Multi-stemmed *E. middelburgensis* - the largest stem appears to have sagged perceptibly during the past 10 years. Photo: Derik Minnaar.



Colour Figure 13 An *E. lanatus* rooted in a rock fissure where as a seedling it was probably out of reach of the fires which periodically kills off many seedlings. Photo: Derik Minnaar.

Colour Figure 14 Lynette and Derik Minnaar amongst some splendid *E. lanatus* specimens.



Colour Figure 15 The "opctopus" *E. middelburgensis* consisting of about 4 reclining and one erect stem - several of which are about 7 m long. The plant has been declared a national monument. It is a female. Photo: Derik Minnaar.

Colour Figure 16 Libby Besse admiring the awsome *Ceratozamia euryphyllidia* in the greenhouse at Fairchild Tropical Garden. Photo: Piet Vorster.

Colour Figure 17 *Zamia furfuracea* **variegated, close-up of a leaf. Photo: Shri Dhar.**

Colour Figure 18 *Zamia furfuracea* **cristata, close-up of a leaf. Photo: Shri Dhar.**

Colour Figure 19 *Zamia furfuracea*, **roundish, close-up of the leaflets. Photo: Shri Dhar.**

Colour Figure 20 *Zamia furfuracea* **normal longish leaflets, close-up of the leaflets. Photo: Shri Dhar.**

Colour Figure 21 *Zamia fairchildiana*? **Photo: Shri Dhar.**

Colour Figure 22 Rust coloured spots on leaflets of *Encephalartos natalensis*. **Photo: Jeff Scott.**

I furthermore undertake to donate R5 to the Cycad Society of South Africa for every program sold. Any interested persons can contact me at any of the adresses or phone numbers listed below.

Andre Cilliers
Email: andre_c@ops1.agric.za
Phone: 018 2996308 (w)
018 2971602 (h)
018 2976572 (fax)
P.O. Box 351, 2520 Potchefstroom

Received 7 September 1999

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Dear Editor

EXCELLENT ISSUE OF "*ENCEPHALARTOS*"

I wanted to write and let you know how much I enjoyed the June 1999 issue of "*Encephalartos*".

The addition of colour really adds to the look of the journal. And the articles were very professional and informative. I enjoyed it immensely cover to cover!

***Robert Buckley,** 32005 Pleasant Glen Road, Trabuco Canyon, CA 92679-3228 U.S.A.*

Received 9 August 1999

[Thank you for writing to let us know how much you enjoyed the colour issue of our journal. **- Editor.**]

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Dear Editor

WHAT IS "*ENCEPHALARTOS*"?

ENCEPHALARTOS initially was a society newsletter, created for members to report their experiences, ask questions, obtain information, and contact likeminded people. Over the years it took on the appearance of a magazine, but basically it never lost its function as a newsletter.

Perhaps because of its appearance, but probably because of the high information content of the informative items, it became regularly quoted in the *Kew Record of Taxanomic Literature*. This re-enforced the perception that it is a periodical of scientific status, and in recent times we have received several pure scientific contributions. My question is: is it wise to send such contributions to ***ENCEPHALARTOS***?

Because ***ENCEPHALARTOS*** belongs to the members of the Society, it is not our policy to refuse any contribution unless it is offensive. On the other hand, because we wish to publish contributions as rapidly as possible, because of the "newsletter" nature of the magazine, and because our Editor does not always have experts in all disciplines available to review contributions, we cannot be responsible for the correctness of articles. That is the responsibility of the author.

I am of the opinion that purely scientific articles should not be sent to ***ENCEPHALARTOS***. If you do have such a serious item to publish, send it to a recognised scientific journal where it will be peer-reviewed for correctness, and then send an "easy read" version to ***ENCEPHALARTOS***. A case in point is David De Laubenfels' article in ***ENCEPHALARTOS* 59**, which contravenes the *International Code of Botanical Nomenclature*, through no fault to the Editor.

If you do not agree with something written by a fellow member, you are free to write in and correct him, as long as it is done in a friendly spirit. Right now some members are furious with others, and with the Editor as well, for publishing something which they consider to be of poor quality. I implore you not to distance yourself from the Society in such instances, but to write in, in a friendly tone, and correct the wrongs. One has, however, to be very careful not to alienate fellow members: a while ago a member published something which in my experience was wrong, and I wrote a friendly refutation in view of my experience. Unknowingly this member was so upset that he withheld further interesting (albeit probably incorrect!) communications.

***Piet Vorster,** Botany Department, University of Stellenbosch, Private Bag X1, 7602 Matieland, R.S.A.*

Received 1 October 1999

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Dear Editor

SULKING CYCADS

I think all too many of the members of this Society, as well as other cycad collectors, are familiar with the fact that cycads, especially certain species, have a tendency to "sulk". This is particularly true after being transplanted. Many collectors, I'm sure, have a specimen or two which are "sulking". By this I mean that the plant has been dormant for some time (often for years), and now refuses to make new leaves, yet the firm trunk indicates that the plant is still alive and well. Consequently one has to be satisfied to look at a leafless trunk year after year and hope that next season something will happen.

This situation is particularly true with species such as *Encephalartos lanatus, E. friderici-guilielmi* and other slow growers. I hope that the following suggestion will help remedy this situation for fellow collectors.

I found that regularly spraying with a mixture of Seagro (5ml/l) and Trelmix (5ml/l) increases the growth rate of my plants markedly. I spray the trunks or stems dripping wet with this mixture every two weeks in summer and every month in winter. Because cycads are capable of taking up nutrients through the stem, spraying of the leaves is not necessary. In fact, because of the waxy layer on the leaflets of most species, I believe that absorption through the stem will be more effective. This treatment could become rather costly for collectores with large collections of mature plants, and I therefore suggest that only "sulking" or transplanted plants be treated. I have also noted an increase in the number of leaves per flush in some of my adult plants with this treatment. Below are a few examples (see Table 1). Please note, however, that the increase in number of leaves was only observed over two seasons.

Seagro is a natural product and cannot burn or damage your plants. It contains nitrogen which is the element which stimulates the leaf growth. Trelmix is a trace element mix which I add to ensure that my plants do not lack any nutrients. This is often the case with potted plants where nutrients have been lost through watering over a long period of time. I believe that any other trace element formulation will do as well. I encourage other collectors to try this treatment this season. I hope that we can revive sulking plants this way.

***André Cilliers**, P.O. Box 351, 2520 Potchefstroom, R.S.A.*

Received 7 September 1999

Table 1 Number of leaves per flush

Species	Number of leaves '97/98	Number of leaves '98/99
E. horridus	9	14
E. friderici-guilielmi	9	16
E. eugene-maraisii	8	19
E. natalensis	12	17

Dear Editor

DIVIDING FEMALE CONE OF *ENCEPHALARTOS PRINCEPS*

I was very interested to see the photographs on page 32 of the June 1999 issue of "*Encephalartos*" of the two-apexed cone.

I enclose a photograph of my *E. princeps* female cone (Figure 1) which, when first forming, was a perfectly normal looking cone, but which with time became divided through the middle although the apex was still single.

Is this a frequent occurrence?

***Barrie Rivron**, 4, Shiri Road, Greendale, Harare, Zimbabwe.*

Received 4 October 1999

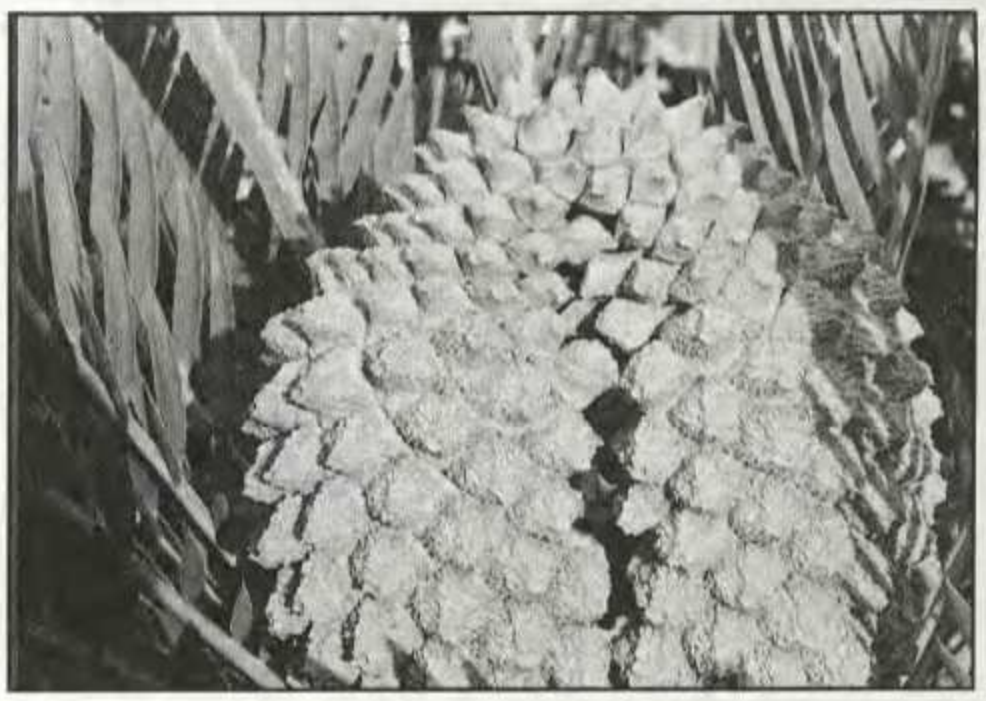

Figure 1 ***Encephalartos princeps*, divided female cone.**

[This phenomenon is rare but has been observed several times for other species such as *E. paucidentatus. E. lanatus*, and others. The spontaneous disintegration of the female cone is the result of several physiological processes (see paper in the *South African Journal of Botany* **55**: 581–585) and in your case a hormonal

imbalance precluded the abscission of the cone scales and this caused the rupture of the cone axis when the seeds enlarged. - **Nat Grobbelaar.]**

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Dear Editor

DISEASE DIAGNOSIS ON *ENCEPHALARTOS NATALENSIS*

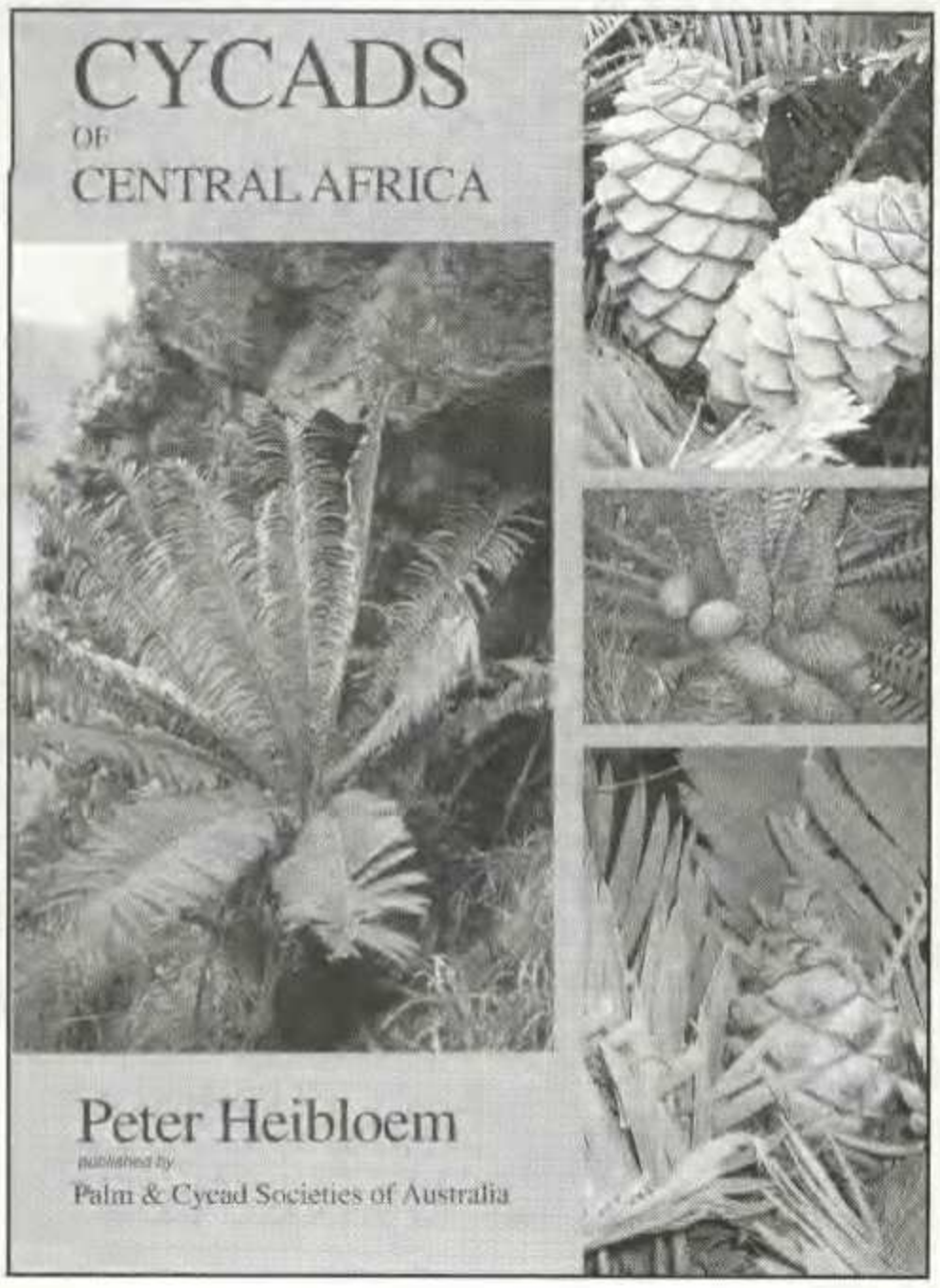
Four years ago I purchased this 7 year old cycad and planted it in my Randburg garden. The soil is ouklip and the plant is watered twice a month during winter, and seldom in summer when it rains. About 3 months ago I noticed red (rust coloured) spots appearing on about 60% of the leaflets (Colour Figure 22, p. 28), and mostly on the younger leaves. The leaflets also showed signs of leaf curl towards their apices. I would be most grateful if someone could identify the problem in this cycad, and possibly recommend a solution for treatment. I have several other species in the garden and none show signs of this phenomenon.

Jeff Scott, P.O. Box 3441, 2115 Northcliff [Tel: (011) 802-5821 (w), Cell: 0832532904, e-mail: jeff@giuricich.co.za

Received 20 September 1999

[If any of our readers can identify this problem, please contact Jeff Scott. - **Editor.]**

BOOK REVIEW / BOEKBESPREKING



HEIBLOEM, Peter. ***Cycads of central Africa.***
BRISBANE: Palm & Cycad Societies of Australia, 1999.

117 pages, numerous colour photographs. Available from the Palm & Cycad Societies of Australia, P.O. Box 1134, Milton, Queensland 4064, Australia, at A$60 (hard cover, available only to pre-publication subscribers), or A$30 (soft cover), plus postage; or from Megan Carr Promotions, P.O. Box 30171, 7966 Tokai, South Africa, phone/fax. (021) 788 3564, E-mail mcarr@pixie.co.za at R175 or US$30 (softcover, including postage).

In *Encephalartos* **58**: 25 (June 1998) an announcement appeared of a special issue of *Palms & Cycads*, the periodical of the Palm & Cycad Societies of Australia, which was devoted in its entirety to a preview of Peter Heibloem's book *Cycads of central Africa*. This book has now appeared and is available from the sources cited above.

At that stage the Palm & Cycad Societies of Australia replied to my enquiry that the special issue would only be available to members of those Societies, but that the forthcoming book would be generally for sale. However, the author had purchased a number of copies of the special issue, and these were offered for sale to South African readers in an advertisement in *Encephalartos* **59**, at R95 or US$14 per copy. The question which readers may well ask, is whether they should buy the magazine, or pay twice as much for the book.

A comparison shows that the book has almost twice as many pages as the magazine, and twice as many pictures. It also reveals that the first part of the book, the travelogue (see below), is entirely new. However, it also shows that the second part of the book, comprising the

treatments of individual species, is ***exactly*** the same as the magazine, even to pagination. Therefore one can choose whether you want the species treatments only, or pay double the price for the species treatments plus the travelogue.

Author Peter Heibloem is a member of our Society. Over a period of four years he has travelled eight times to central Africa in pursuit of cycads, and this book is a documentation of these travels.

In recent years seed of central Afican *Encephalartos* species have become available due to the exertions of a number of intrepid collectors. This was almost certainly in contravention of CITES regulations; but without condoning illegal activities, I pose the question: were these actions harmful or beneficial? Due to the nature of the terrain, the difficult logistics, and the problems of transporting material over international borders, the amount of material could not have been great. One of the persons involved (never ask me to divulge his name!) told me that he considered the total demand throughout the world to amount to no more than 5000 seeds per species, which would translate to about ten cones. In my opinion this amount of seed, taken once only, would be unlikely to harm these remote populations. I submit that such activities firstly satisfy a legitimate demand after which few collectors would be interested in undertaking hazardous and expensive expeditions such as described by Heibloem in order to collect material, secondly that they make germplasm/propagative material available throughout the world, and thirdly that habitat destruction poses a far more serious threat to these remote populations than do collectors. In fact, it is probably prudent that material is collected before it is too late, ***and placed in scientific collections such as those of the National Botanical Institute in South Africa, and the Montgomery Foundation in the U.S.A.*** I implore those involved in enforcing restrictions on the movement of plant material to consider these points.

The book consists of two parts:

The first part is a travelogue in which Heibloem describes each of his journeys individually. In each chapter he vividly describes the immense difficulties faced in travelling in central Africa, recounting a number of hair-raising adventures. Also in each chapter he describes the actual visits to individual species, including their habitat. This travelogue makes absorbing reading, but it is also most valuable for providing information on the habitat. For most growers the main problem is how to treat their plants which they have never seen in habitat, and in this respect these chapters provide vital information. There are colour photographs on almost every page, showing not only general views of the country through which the author travelled and persons whom he met, but also views of plants in habitat.

In the second part the species are treated individually. The author's stated aim is to provide "a layman's guide and photographic record" while shunning "technical botanical descriptions". As a professional botanist I salute the wisdom of this decision, though on occasion I regretted the omission of information which would have been of value to me as a scientist. Here it should be stated that not all cycad countries north of South Africa were visited, and consequently not all species are treated. Apart from a number of still undescribed species which were wisely omitted, notable omissions are *Encephalartos barteri* from west Africa, and *E. gratus* from Malawi. *E. septentrionalis* remains a mystery, as the plants illustrated under that name grow in Uganda, several hundred kilometres from the type locality in Sudan, and has apparently not been visited since Schweinfurth's discovery of the plants almost 140 years ago. In two cases undescribed species were however included, namely the "blue Sudan" plants from the Didinga Hills, and the plants from Bunia in the Congo which Heibloem asserts to be distinct from *E. ituriensis*. Also included are photographs of, and notes on, species which Heibloem hadn't personally visited, namely *E. poggei*, *E. laurentianus*, and *E. macrostrobilis*.

The second section commences with a listing of treated species by country. Here are two maps: a not really useful vegetation map, and a political map showing the distribution of individual species in countries. On the latter the symbol "19" appears twice, once for the "blue Sudan" and again in a position where it probably represents the regrettably omitted *E. gratus*. One of the interesting things of this map is that it shows *Encephalartos* to extend much further south of the equator than to the north, probably because the Sahara to the north is too dry for cycads.

The individual species are also treated country by country. To my mind this is a pity. While in many instances geographical distribution provides at least an indirect clue to evolutionary relationships, in this treatment it does not. Thus the species of the *E. poggei* group are treated in three different places, the three species suspected of being in the *E. septentrionalis* group are treated in two places, and the Bunia plants which are claimed to be close but different from *E. ituriensis* is treated four species later. As for the treatment of individual species, the text consists of a short account of the geographical ***distribution*** and habitat; a shortish description under the subheadings *stem*, *leaves*, and *cones*; ***observations*** on local environmental conditions and regeneration; and ***cultivation***. The latter is based on the author's experience in Queensland, which is more tropical than most parts of South Africa, and therefore not necessarily applying elsewhere. The photographs are small but adequate, and in most cases show plants in habitat and/or cultivation, a close-up view of a leaf, and male and female cones.

By any standard this is a slim volume in physical appearance, but it is worth its weight in gold for the wealth of illustrations, in many instances the first photographs ever to be published. Indeed, the illustrations, which are on almost every page, comprise the crowning glory of this book. Cycads are very difficult to photograph in nature, yet Heibloem's photos are almost without exception good. Not only do these provide a good idea of the plants in nature, but also of their habitats. For the latter reason alone the book gave me enormous pleasure, and it should enable growers to assess the requirements of these tropical species.

The book is printed on the same fairly thin, semiglossy paper as *Palms & Cycads*, and it is sturdily sewn-bound. The end-papers (of the hard-cover edition) show attractive but not particularly useful silhouettes of leaflets. The pagination is quaint, in that the two sections of the book each has individual page numbering starting at 1.

Certainly this is not the last word on tropical *Encephalartos*. There are still undocumented, undescribed, and undiscovered species out there, we still don't know all about their distribution and woefully little about their pollinators, and scientists still have a difficult task ahead to determine evolutionary relationships between the species. Yet this is a very important contribution to our knowledge of these species, showing what important work non-scientists can do.

I am very pleased to have this compilation on my bookshelf, and shall consult it often. I also unhesitatingly recommend it to anyone interested in tropical *Encephalartos*, and suggest that those readers procure a copy before the edition is sold out.

Piet Vorster
Botany Department, University of Stellenbosch, Private Bag X1, 7602 Matieland, R.S.A.

[Correction: author citation (Heibloem p. 24 and 26 of The Species section). Please note that Johan Hurter is the sole author of the names of the species *Encephalartos equatorialis* and *E. whitelockii*, with Hugh Glen and myself only being co-author(s) of the two "Focus on ... " articles in "*Encephalartos*" **44**: 4–9, **48**: 4–9. **- Isabella Claassen.**]

NEW CYCAD PUBLICATIONS

LUMAGA, M.R.B., MORETTI, A. & DE LUCA , P. 1999. **Morphological aspects of stomata, cuticle and chloroplasts in *Ceratozamia kuesteriana* Regel (Zamiaceae).** *Plant Biosystems* 133(1): 47–53.

[Light and scanning electron microscopy were utilised to study stomata and cuticle morphology whereas transmission electron microscopy was used to observe plastid ultrastructure in *Ceratozamia kuesteriana* Regel (Zamiaceae). Results show that in *C. kuesteriana* a diperigenous-type stoma (or a derivation of a diperigenous type) occurs and that protein crystalloids and prolamellar bodies are simultaneously present in the chloroplast.]

First author's address: Orto Botanico, Facolta di Scienze, Universita degli Studi di Napoli "Frederico II" Via Foria 223, Italy.

PACINI, E., FRANCHI, G.G. & RIPACCIOLI, M. 1999. **Ripe pollen structure and histochemistry of some gymnosperms.** *Plant Systematics and Evolution* 217(1–2): 81–99.

[Some aspects of pollen cytology at dispersal were studied in 12 species of gymnosperms which included *Encephalartos horridus*. The pollen grains differed in: 1. volume and cell number; 2. polarization of external structure and internal cell components; 3. wall thickness, especially of the intine, and the resulting percentage of cell volume with respect to total pollen grain volume; 4. stratification and chemical nature of the various intine layers; 5. nature and location of polysaccharide reserves; 6. morphological differences between the dry and hydrated states and phenomena related to hydration; 7. presence and site of orbicles. The various characters are compared and discussed in relation to the length of the reproductive cycle and the relations between the male gametophyte and its female counterpart.]

First author's address: Department of Environmental Biology, Botany Section, University of Siena, Via Mattioli 4, I-5310, Italy.

SEAWRIGHT, A., OELRICHS, P.B., N.G., J.C., SANI, Y. & NOLAN, C.C. **The toxicity of the Australian cycad *Bowenia serrulata* to cattle.** In *Toxic plants and other natural toxicants*. Edited by T.T. Garland and A.C. Barr, p. 447–452. Published by CAB

International, Wallingford Oxon OX10 8DE, England, UK.

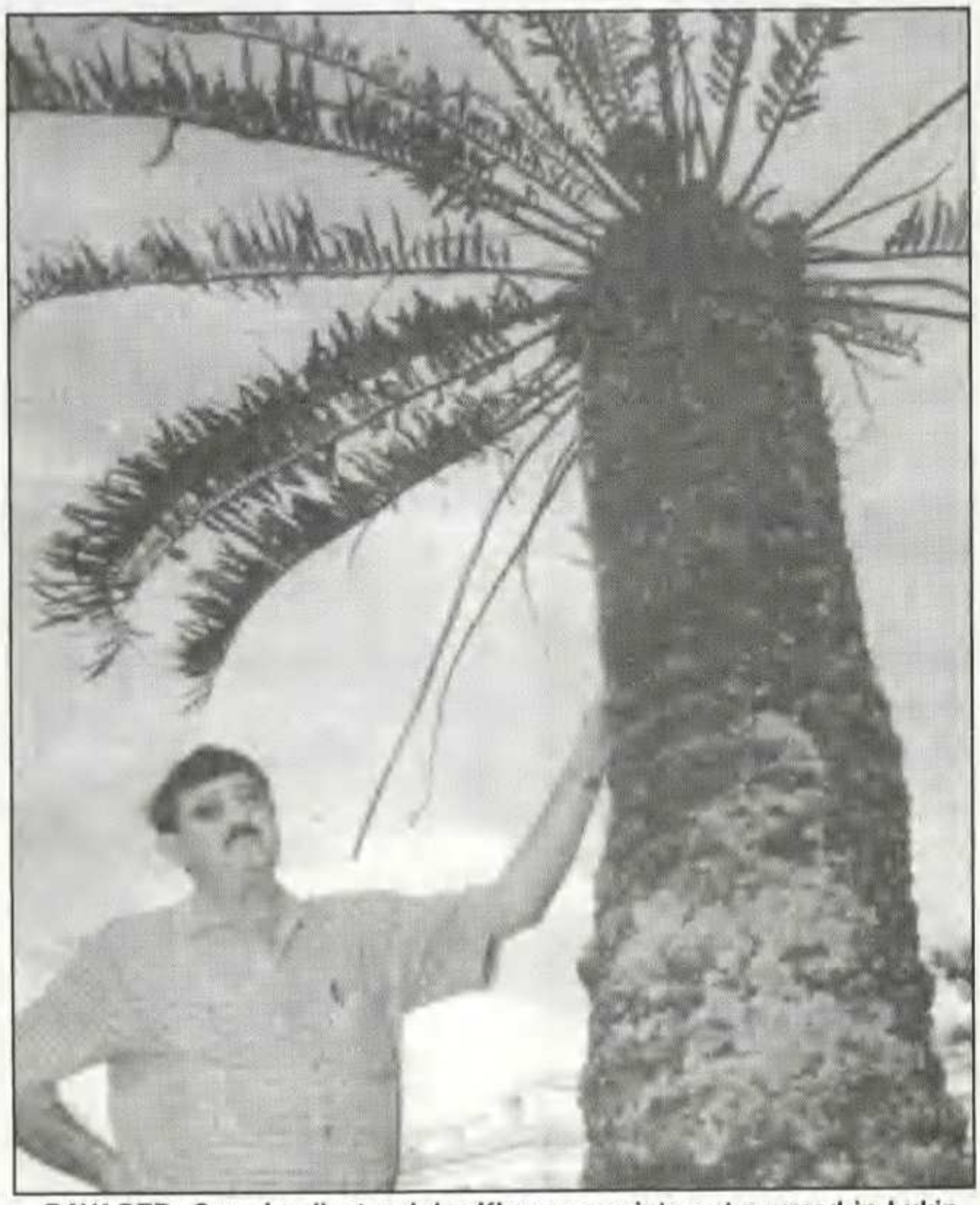
[Summary unfortunately not available.]

First author's address: National Research Centre for Environmental Toxicology, 39 Kessels Road, Coopers Plains, Queensland, Australia.

Compiled by ***Nat Grobbelaar****, P.O. Box 15357, 0039 Lynn East, South Africa.*

NEWSPAPER CLIPPING / KOERANTUITKNIPSEL

Daily Dispatch, Saturday, July 10, 1999 — 7



RAVAGED: Cycad collector John Kloppers points out a cycad in Lukin Road, East London, that has not been watered, fertilised or sprayed. These rare plants are worth thousands. Kloppers believes it would not cost the city council much to care for them better. Picture by ALAN EASON

Priceless plants dying in former 'cycad city'

By Nick Wilson

EAST LONDON — This city, once hailed as the "cycad city of the world", could regain its title if the municipality starts looking after its cycads, says cycad collector John Kloppers.

Kloppers, who hails from Groblersdal in Mpumalanga and has collected about 2 000 of the rare plants, visited East London this week and said he was horrified at the state of the priceless plants.

"I've visited here for the last 30 years, but this is the worst I've ever seen them."

Kloppers showed the Saturday Dispatch the condition of the cycads in Lukin Road.

Some have been ravaged by insects, particularly the dreaded Leopard Moth, and have not been watered or been given fertiliser for years.

He pointed out a cycad, which was leafless, and said it was about 400 years old and nearly dead.

Kloppers said the city council should create a little "dam" around each cycad to allow them access to adequate water. They should be fertilised once a year.

He said the leaves should be sprayed with insecticide.

Kloppers was of the opinion that it would not cost the municipality much to care for the plants.

"If they start looking after them, it (East London) will become a cycad city again."

Kloppers said the cycads on the museum's premises were well-looked after and were given sufficient water and fertiliser.

The municipality's director of community services, Bongani Noruka,, said he was not aware that the cycads were in bad condition. "The first I heard of it was from you."

He intends to investigate the matter.

Noruka said he was not a horticulturalist, but horticulturalists in his directorate had informed him that cycads do not need much water.

He said the municipality did spray them with insecticide once a year. The cycads in Queen's Park were treated the same way and they "looked fine".