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VAN SUID-AFRIKA

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ENCEPHALARTOS

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TYDSKRIF VAN DIE BROODBOOM VERENIGING VAN SUID-AFRIKA

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COVER / VOORBLAD : ***Encephalartos latifrons*: a large specimen, with a double head, in the Monte Casino gardens, Randburg, South Africa. / *Encephlartos latifrons*: 'n groot eksemplaar, met twee koppe, in die Monte Casino tuine, Randburg, Suid-Afrika.**

Photo / Foto: Derik Minnaar

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SHORT COMMUNICATIONS AND ARTICLES / KORT MEDEDELINGS EN ARTIKELS (continued / vervolg)

FROM THE PRESIDENT

We have lately decided that, in order to stay within our budget,, future issues will be not more than 36 pages long with 4 pages of colour. Yet our secretary, Guillaume Theron, has miraculously found money for this bumper year-end issue, and I thank him for his enterprise.

From January to September this year our members recruited 81 new members (page 5). Still, our membership figures have remained constant for several years, due to attrition. Why do we lose members at this rate, and what can we do to reverse this process?

On page 32 Morne Ferreira questions the taxonomy of *Encephalartos senticosus* and *E. lebomboensis.* It is indeed true that the plants at Mananga and those further south on the Lebombo range are vegetatively almost indistinguishable, but their cones are different. The cones are the reproductive structures, and it is presumed that different cone morphologies contribute to reproductive isolation which in turn is the driving force of speciation. In the *Proceedings of the third ... Conference on Cycad Biology*, pages 253—254 (1995) I explained why I consider the plants at Mananga and the Pongola valley to be the same species but different from the Lebombo plants, and also why I do not consider the Mananga plants to be a subspecies of the Lebombo plants. In the case of *E. aplanatus* the cones are identical to those of *E. villosus*, but the different foliage suggests that it is at least to some extent distinct. Here the isolating factor is thought to be neither cone nor leaf morphology, but geographical distribution. In cycad taxonomy we are not enthusiastic about subspecific ranking, because it implies a closer relationship than between species and we are not yet ready to judge such subtle relationships. See also ***ENCEPHALARTOS* 46**: 4—8 (June 1996), and ***ENCEPHALARTOS* 63**: 4—10 (September 2000).

This issue is again testimony of the enthusiasm of our members, with a wide range of interesting inputs. No contribution is too modest: for instance, a chance photograph (see *ENCEPHALARTOS* **74**: 44) taken by Wessie van der Westhuizen while on a brief visit to Honduras turned out to be more interesting than he could have imagined – see letters from Loran Whitelock and Jody Haynes on page 42 of this issue.

Finally I wish to thank my wonderful board for their unselfish input. I wish to pay special homage to Isabella and Guillaume who both worked under very trying circumstances; but I am also very grateful to Werner Diedericks who acted as auditor, to Wynand van Eeden who cared for our web page, to Diekie de Klerk who administered our pollen- and seed bank, Paul Kennedy and Willie Tang who are our overseas agents, and all our regional officers who really kept the Society alive.

Piet Vorster

Piet Vorster

VAN DIE PRESIDENT

Ons het onlangs besluit dat, ten einde binne ons begroting te bly, toekomstige uitgawes nie meer as 36 bladsye met 4 bladsye kleurfotos sal hê nie. Ten spyte hiervan het ons sekretaris, Guillaume Theron, wonderbaarlik geld gevind vir hierdie groot einde-van-die-jaar uitgawe, en ek bedank hom vir sy vindingrykheid.

Tussen Januarie en September vanjaar het ons lede 81 nuwe lede gewerf (bladsy 5). Nogtans bly ons ledetal reeds vir verskeie jare lank konstant, as gevolg van lede wat nie hulle lidmaatskap hernu nie Waarom verloor ons lede teen hierdie tempo, en wat kan ons doen om dit te keer?

Op bladsy 32 bevraagteken Morne Ferreira die taksonomie van *Encephalartos senticosus* en *E. lebomboensis.* Dit is inderdaad waar dat die plante by Mananga en dié verder suid op die Lebomboberge vegetatief feitlik eners is, maar hulle keëls is verskillend. Die keëls is die voortplantingstrukture, en ons neem aan dat verskille in die keëls bydra tot voortplantings-isolasie wat op sy beurt die belangrikste dryfveer is in die totstandkoming van nuwe soorte. In die *Proceedings of the third ... Conference on Cycad Biology*, bladsye 253—254 (1995) het ek verduidelik waarom ek die plante by Mananga en die Pongola vallei beskou as dieselfde soort maar verskillend van die Lebombo-plante, en ook waarom ek nie die Mananga-plante beskou as 'n subspecies van die Lebombo-plante nie. In die geval van *E. aplanatus* is die keëls identies aan dié van *E. villosus*, maar die blaarverskille skep die indruk dat hulle minstens tot 'n mate verskillend is. In hierdie geval is die isolerende faktor nie keël- of blaar-morfologie nie, maar geografiese verspreiding. In broodboom-taksonomie hou ons nie van subspesifieke rang nie, omdat dit 'n nouer verwanskap impliseer as tussen species en ons nog nie gereed is om die mate van verwantskappe te takseer nie. Kyk ook ***ENCEPHALARTOS* 46**: 4—8 (Junie 1996), en ***ENCEPHALARTOS* 63**: 4—10 (September 2000).

Hierdie uitgawe is weereens 'n bewys van die entoesiasme van ons lede, met 'n wye reeks interessante bydraes. Geen bydrae is te nederig nie: byvoorbeeld, 'n toevallige foto (kyk *ENCEPHALARTOS* **74**: 44) wat Wessie van der Westhuizen geneem het tydens 'n kort besoek aan Honduras het geblyk meer interessant te wees as wat hy gedink het – kyk die briewe van Loran Whitelock en Jody Haynes op bl. 42 van hierdie uitgawe.

Laastens wil ek my wonderlike bestuurspan bedank vir hulle onselfsugtige insette. In besonder wil ek vir Isabella en Guillaume uitsonder, wat albei onder baie moeilike omstandighede gewerk het; maar ek is ook baie dankbaar teenoor Werner Diedericks wat as ouditeur opgetree het, Wynand van Eeden wat ons webwerf versorg het, Diekie de Klerk wat ons stuifmeel- en saadbank bestuur het, Paul Kennedy en Willie Tang wat ons buitelandse belange behartig het, en al ons streeksverteenwoordigers wat regtig die Vereniging lewendig gehou het.

Piet Vorster

Piet Vorster

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NEW CYCAD PUBLICATIONS

BROOME, T. 2002. **Optimising cycad germination.** *NZ Palm & Cycad.* No. 86: 2–3.

[The germination requirements of the different cycad genera are briefly described.]

Author's address: The Cycad Jungle, P.O. Box 325, Polk City, FL 33868, U.S.A.

FORSTER, P.I. 2002. ***Cycas cupida*** **(Cycadaceae), a new blue-leaved species from central Queensland.** *Palms & Cycads* No 74: 3–8.

[The species which clearly belongs in *Cycas* series *Cairnsianosae* is described from a large population occurring in the Terrace Range. A dichotomous key is provided by means of which the six species in *Cycas* series *Cairnsianosae* can be distinguished from one another using the leaf characters of mature plants.]

Author's address: Queensland Herbarium, Environ-mental Protection Agency, Brisbane Botanic Gardens, Mt Coot-tha Road, Toowong, Queensland 4066, Australia.

MUNDRY, M. & STUTZEL, T. 2003. **Morphogenesis of male sporangiophores of *Zamia amblyphyllidia* D.W. Stev.** *Plant Biology* 5(3): 297–310.

[The morphology, development and anatomy of the male cones of *Zamia amblyphyllidia* was studied to amass additional information to develop a more convincing concept of the evolution of seed plants. The male sporangiophores of the cycads are usually regarded as simple sporangiophores with synangia on the abaxial side. Our developmental study of the male sporangiophores of *Zamia amblyphyllidia*, by scanning and light microscopy, suggests that the sporangiphores are pinnate, with synangia on reduced leaflets. This indicates that a significant difference between female and male sporangiophores in cycads, as previously stated, does not exist. Comparisons of male sporangiophores of cycads with those of conifers show that they are homologous. Rather, the synangia of the cycads may better be homologised with the radial synangia groups in some pteridosperm taxa. Although several authors assume that the cycad precursor displayed entire, fertile and sterile leaves, our interpretations of the male sporangiophores indicate that cycads originated from a pinnate pteridospermous ancestor with radial synangia groups. These hypotheses may point to the Medullosaceae, although this remains to be substantiated.]

First author's address: Ruhr Univ. Bochum, Lehrstuhl Spezielle Bot., NDEF 05-776, D-44780 Bochum, Germany.

OSBORNE, R. 2002. **Cycad classification concepts – A report on the Miami Symposium and Workshop.** *Palms & Cycads* No. 74: 18–19.

[The symposium was attended by 14 of the world's cycad scientists from 7 countries. One of the key decisions taken, was that for the time being, the "species" should be regarded as the smallest practical taxonomic unit and that descriptions for subspecies and varieties are not practical at this time.]

Author's address: P.O. Box 244, Burpengary, Queensland 4505, Australia.

OSBORNE, R. & GORELICK, R. 2002. **Sex change in cycads.** *Palms & Cycads* No. 76: 10–15.

[In this overview, reports of 30 incidents of sex changes involving 5 cycad genera is presented. In 16 of these cases, male-to-female changes occurred; in 13 cases female-to-male changes occurred; and the direction of one change is unrecorded. The authors propose a hypothesis which conceivably could result in sex reversals. This involves the methylation od cytosine – a constituent of DNA.]

First author's address: P.O. Box 244, Burpengary, Queensland 4505, Australia.

PRICE, J. 2002. **Cycad hunting at the palm show dinner.** *Palms & Cycads* No. 74: 22–25.

[The paper presents a digest of a talk given by Ken Hill and is richly illustrated with colour photographs of various *Cycas* species. In the past, an over-reliance on herbarium material, some of which has been quite fragmentary, severely inhibited cycad taxonomy. The many new cycad taxa that have been described in recent years are largely due to extensive field studies. So, for example, *Cycas media*, which grows in Queensland north of Rockhampton, has turned out to be not one species but at least seven!]

Author's address: 374 Tablelands Road, Cooran, Queensland 4569, Australia.

RAI, H.S., O'BRIEN, H.E., REEVES, P.A., OLMSTEAD, R.G. & GRAHAM. S.W. 2003. **Inference of higher-order relationships in the cycads from a large chloroplast data set.** *Molecular Phylogenetics and Evolution.*

[Higher-order relationships in the cycads, an ancient group of seed-bearing plants, were investigated by examining a large portion of the chloroplast genome from seven species chosen to exemplify our current understanding of taxonomic diversity in the order. The regions considered span ~13.5 kb of unaligned data per taxon, and comprise a diverse range of coding sequences, introns and intergeneric spacers dispersed throughout the plastid genome. The results provide substantial support for most of the inferred backbone of cycad phylogeny, and weak evidence that the sister-group of the cycads among living seed plants is *Ginkgo biloba*. *Cycas* (representing Cycadaceae) is the sister-group of the remaining cycads; *Dioon* is part of the next basal split. Two of the three commonly recognised families of cycads (Zamiaceae and Stangeriaceae) are not monophyletic; *Stangeria* is embedded within Zamiaceae, close to *Zamia* and *Ceratozamia*, and not closely allied to the other genus of Stangeriaceae, *Bowenia*. In contrast to the other seed plants, cycad chloroplast genomes share two features with *Ginkgo*; a reduced rate of evolution and an elevated transition:transversion ratio. The results demonstrate that the latter aspect of their molecular evolution is unlikely to have affected inference of cycad relationships in the context of seed-plant wide analyses.]

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RAIMONDO, D.C. & DONALDSON, J.S. 2003. **Response of cycads with different life histories to the impact of plant collecting: simulation models to determine important life history stages and population recovery times.** *Biological Conservation* 111: 345–358.

[Collection of plants and seeds from wild populations threatens a large number of cycad species. The authors investigated to what extent individual life history stages contribute to population growth (λ) and compared two species with major differences in life histories in the African genus *Encephalartos: Encephalartos cycadifolius*, a highly persistent grassland species that resprouts after fire, and *Encephalartos villosus*, a relatively fast growing, non-sprouting forest species. Several harvesting scenarios impacting different sized individuals were simulated to determine the sensitivity of the two functional types to harvesting. In both species λ was most sensitive to changes in abundance of adult plants. The harvesting of seeds had minimal impact on population growth rates, whereas harvesting of adult plants led to rapid population decline. This response from two very different functional types suggests that the conservation of adult plants is critical for all cycad species. Despite similar responses to adult mortality, the two species had substantially different population growth rates. This determined recovery time after harvesting of adult individuals. *Encephalartos cycadifolius* is typical of highly persistent plant species associated with low levels of recruitment and unable to recover from even small losses of adults within a reasonable conservation time frame (<100 years). The results suggest that the ability to recover from loss of individuals is an important factor that should be considered when assessing the vulnerability of wild populations to threats.]

First author's address: Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Rondebosch 7701, South Africa.

SCRAGG, M. 2002. **Cycads of New Zealand.** *NZ Palm & Cycad* No. 83: 2–7.

[The paper lists the cycads that are available or can be grown in New Zealand.]

Author's address: Unfortunately not provided.

SCRAGG, M. 2003. **Growing cycads in New Zealand.** *NZ Palm & Cycad* No. 87: 2–6.

[Practical tips are provided for growing cycads in New Zealand.]

Author's address: Unfortunately not provided.

VERSTEEGEN, S. 2003. **How I sprout my cycad seeds.** *NZ Palm & Cycad* No. 87: 7–8.

[The author shares his experience about the germination of cycad seeds in New Zealand with interested readers.]

Author's address: Unfortunately not provided.

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

FOCUS ON ...

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:

FOKUS OP ...

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 LINDSTROMII S.L. Yang, K.D. Hill & N.T. Hiêp

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DISCOVERY

During the last decade much field work and taxonomic study have been conducted in Southeast Asia on the genus *Cycas* (eg. Hill and Yang 1999, Hill in press, Tang *et al.* 1995, 1999, Wang 1996). Many new species have been identified. Among the most unusual is a dwarf species with a subterranean caudex. This plant was first noticed as a new and distinct species by Anders Lindström, currently Manager of the Botanical Collections at Nong Nooch Tropical Gardens in Thailand. He found this species being sold by the roadside in southern Vietnam in 1994 (Figure. 1), when that country was just beginning to open itself to visitors from the non-communist world.

Figure 1 Anders Lindström (left) stands next to wild plants of *Cycas lindstromii* for sale on the roadside in southern Vietnam in 1994. Photo: S.-L. Yang.

Si-Lin Yang, a Chinese botanist working for Nong Nooch Tropical Garden and Fairchild Tropical Garden, Ken Hill of The Royal Botanical Gardens, Sydney, Australia, and Nguyen T. Hiêp of the Institute of Ecology and Biological Resources in Hanoi, Vietnam, described the species as *Cycas lindstromii* in 1997. The species epithet honours Anders Lindström. A proposal placing this *Cycas* species and supposedly related species in a separate genus, *Epicycas,* was put forth by de Laubenfels and Adema (1998), but it has not been generally accepted in the cycad community and its validity has been challenged by Chen, Hill and Stevenson (2003).

DESCRIPTION

The description below is based mainly on the original description by Yang, Hill, and Hiêp (1997), but is supplemented with information from "The Cycad Pages" (Hill and Stevenson 1998).

1. STEM

The stem of *Cycas lindstromii* comprises a subterranean caudex often branched at the apex (Colour Figures 1, 2 on p. 11). It is swollen at the base, with a diameter of 13–25 cm and length of 15–23 cm. The surface is smooth and white-grey (Colour Figure. 6 on p. 11). Leaf bases are not persistent except near the apex.

2. LEAVES

Leaves number 2–12 per plant; upper surface is deep green and highly glossy (Colour Figure 7 on p. 12), the underside is yellowish green; 40–100 cm in length and strongly keeled (opposing leaflets forming a pinna-to-pinna angle of 90–130 degrees). The petiole is 6–15 cm long with spines for 50–100 % of the length in direction from the leaflets toward the stem. Leaflets number 18–60, median leaflets 100–130 mm long x 7–11 mm wide, crowded and overlapping, attached 7–12 mm apart on the rachis, leaflets are flat with flat margins and acute apices, the transition from lower leaflets to spines is abrupt and not gradual.

Cataphylls (scale leaves) are narrowly triangular, soft, 20–50 mm long x 3–7 mm wide at base, and covered with brown hair.

3. REPRODUCTIVE STRUCTURES

The cluster of female sporophylls ("female cone") is 12 cm high, 7–9 cm diameter. Female sporophylls are 8–12 cm long, with a flattened terminal blade 5.5–10 cm long x 1.8–3 cm wide, deeply pectinate along the edges with 6–13 pairs of soft lateral spines (Colour Figures. 2 and 8 on pp. 11 and 12); apical spine is distinct from the lateral spines 30 x 4–5 mm at base. Seeds are ovoid, 31–35 x 20–30 mm; fleshy layer orange at maturity, with fibrous layer present and spongy layer absent. The male cone is spindle-shaped (Figure. 2, Colour Figure 4 on p. 11), with a leathery texture, yellow, 16–20 cm long, 4–5 cm wide; stalk 3 cm long; scales 10–16 mm long x 11–15 mm wide with a sharply upturned spine at the tip 1–8 mm long.

Figure 2 Close-up view of a spent, dried male cone of *Cycas lindstromii*.

Figure 3 *Cycas lindstromii* in its sandy coastal habitat near the small coastal village of Ca Na. The South China Sea is visible in the background.

DISTRIBUTION AND HABITAT

Cycas lindstromii is known only from the eastern coastal area of southern Vietnam, in the provinces of Ba Ria and Binh Thuan. This is the hottest and driest area of Vietnam. The species appears to inhabit only coastal areas in deep sandy soils (Figures 1, 3; Colour Figures 5, 9 on pp. 11–12). The vegetation in its habitat is grassland and dry open dipterocarp woodland and forest. The climate is tropical. Plants are typically exposed to full sun or are sometimes partially shaded by nearby shrubs.

AFFINITIES AND DIAGNOSTIC FEATURES

Cycas lindstromii occurs together with another, arborescent cycad species, *C. pachypoda*. Whereas *C. lindstromii* is confined to flat sandy areas, *C. pachypoda* grows amongst granite rocks and hills within the same general habitat. Sometimes these two species will occur side by side where sand and rocky hills meet. Examination of one such location by the author suggests that hybridization does not occur between the two species and Ken Hill (personal communication) confirms this. In the original description, the authors point to a general similarity in appearance of *C. lindstromii* to *C. siamensis*, however, *C. lindstromii* differs in that it has a branching subterranean stem. In *C. siamensis* the stem rarely branches and, although the stem base is bulbous and subterranean, the stem may grow to a metre or above soil level. In *C. lindstromii* the leaves are keeled and the lower leaflets do not gradually, but abruptly reduce to spines. In *C. siamensis* the leaves are flat and basal leaflets gradually reduce to spines. The elongate terminal blades of the female sporophylls of *C. lindstromii* are also diagnostic and will distinguish it from most *Cycas* species. Within the genus *Cycas*, *C. lindstromii* is placed within the section *Indosinensis*, based on the presence of a fibrous sarcotesta (this character makes the fleshy coat of the seed difficult to cut and remove relative to the seeds of other sections of *Cycas*). According to Hill and Stevenson (1998), based on molecular and morphological analyses, the closest relative of *C. lindstromii* is *C. pranburiensis*, a dwarf coastal species which inhabits limestone cliffs and outcrops in peninsular Thailand. These two species appear to make up a distinct subgroup within the section *Indosinesis*.

Hill and Stevenson (1998) note that *Cycas lindstromii* is remarkable in that its general appearance resembles a Florida *Zamia* more than it does a typical *Cycas*.

INSECT VISITORS TO CONES

Observations of cones in wild plants of *Cycas lindstromii* have yielded, to date, one snout weevil (family Curculionidae) tentatively placed in *Tychiodes* sp. group A (Tang *et al.* 1999). This type of weevil is found in the cones of many *Cycas* species in the section *Indosinensis* and is believed to be a pollination agent throughout this section of the genus. Based on observations of mature and partially mature female cones along roadsides and in habitat in Vietnam during the month of October, the main pollination period for this species appears to be in the spring months. However, cones of *C. lindstromii* may occur sporadically throughout the year as in *C. pachypoda*. Since hybridization does not occur between these two species in the wild, we can assume that there is a reproductive barrier between them. Either their pollinating beetles are different or there is a genetic barrier to hybridization.

CULTIVATION

This species is known to be cultivated at the Institute of Ecology and Biological Resources in Hanoi, Vietnam, Nong Nooch Tropical Garden, Thailand, and the Montgomery Botanical Center, Florida, U.S.A.. Horticultural trials suggest that this species is not as fast growing in cultivation as *Cycas rumphii* or *C. pectinata*. Relative to other cycads, its growth rate can be categorized as slow to moderate. Its habitat suggests that *C. lindstromii* would be tolerant of extreme heat, drought, and salt spray.

Figure 4 Wild-collected plants of *C. lindstromii* for sale in the central Vietnam city of Hue.

CONSERVATION STATUS

This arid coastal section of Vietnam is relatively poor, even by Vietnamese standards, and the inhabitants depend heavily on harvesting products from the wild for their livelihood: hunting, fishing, and removal of plants. The sandy terrain in which this species is found is too dry and unsuitable for agriculture. Plants of *Cycas lindstromii* are dug out regularly by locals for sale along Highway 1, the main road running north-south through the country. The sandy habitat of this species is often strewn with pits, indicating where plants have been dug out. Plants are transported and sold outside of its natural range as far north as the city of Hue (Figure 4). These practices appear to have severely impacted several known populations of this cycad and, as it continues, will threaten the future existence of this species. Currently it is listed as vulnerable by current IUCN Red List Categories (see Donaldson 2003), meaning it is facing a high risk of extinction in the wild.

ACKNOWLEDGEMENTS

Field observations in Vietnam by the author were made possible during the post-conference tour of CYCAD2002 organized by Ken Hill and Nguyen T. Hiêp. Si-Lin Yang, Roy Osborne, Ken Hill, and Terrence Walters provided valuable comments or information. Photos are by William Tang, except where indicated.

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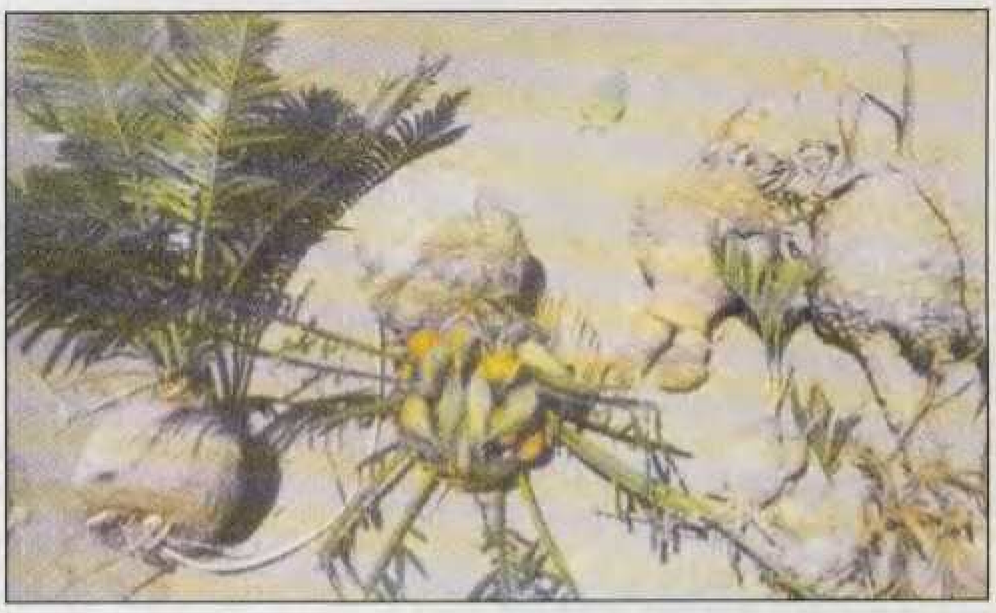
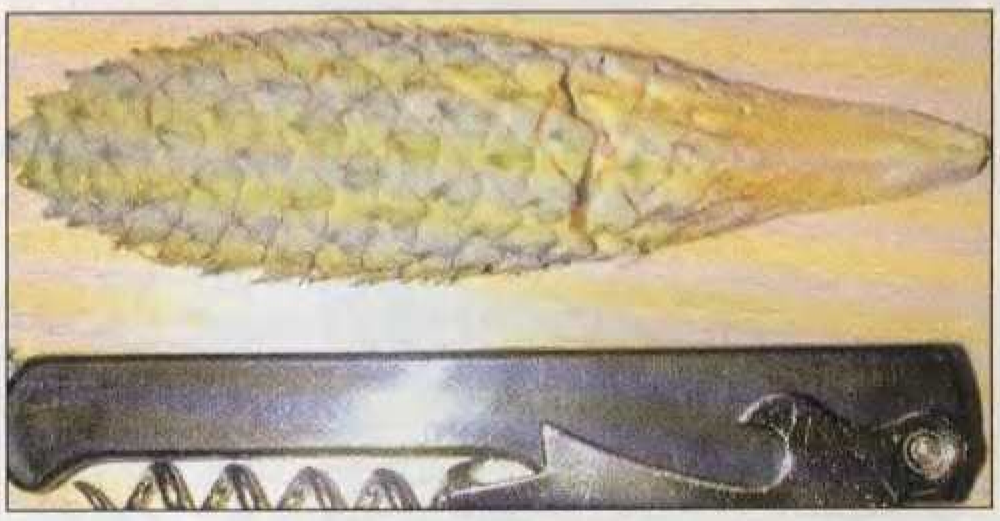
YANG, S.-L., HILL, K.D. & HIÊP, N.T. 1997. *Cycas lindstromii* (Cycadaceae), a new species from southern Vietnam. *Novon* 7: 213–215.

Colour Figure 1 The tendency to branch is evident in this stem of *Cycas lindstromii*. Photo: Willie Tang.

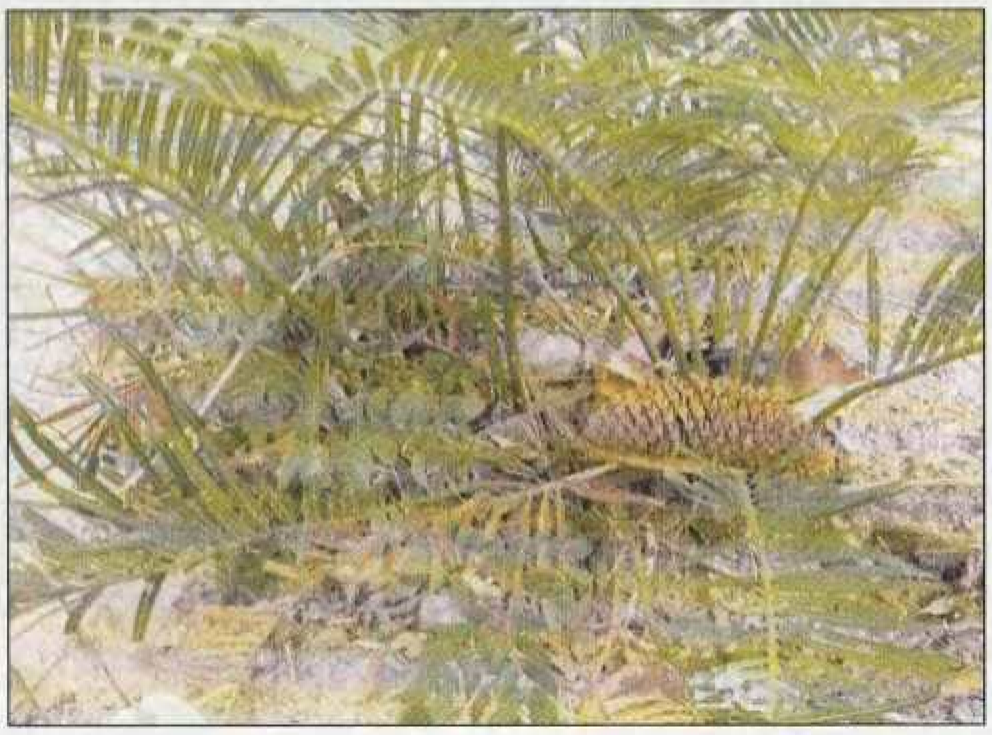


Colour Figure 2 The colour of ripe seeds and the tendency of stems to branch are evident in this photo of *C. lindstromii*. Photo: S.-L.Yang.

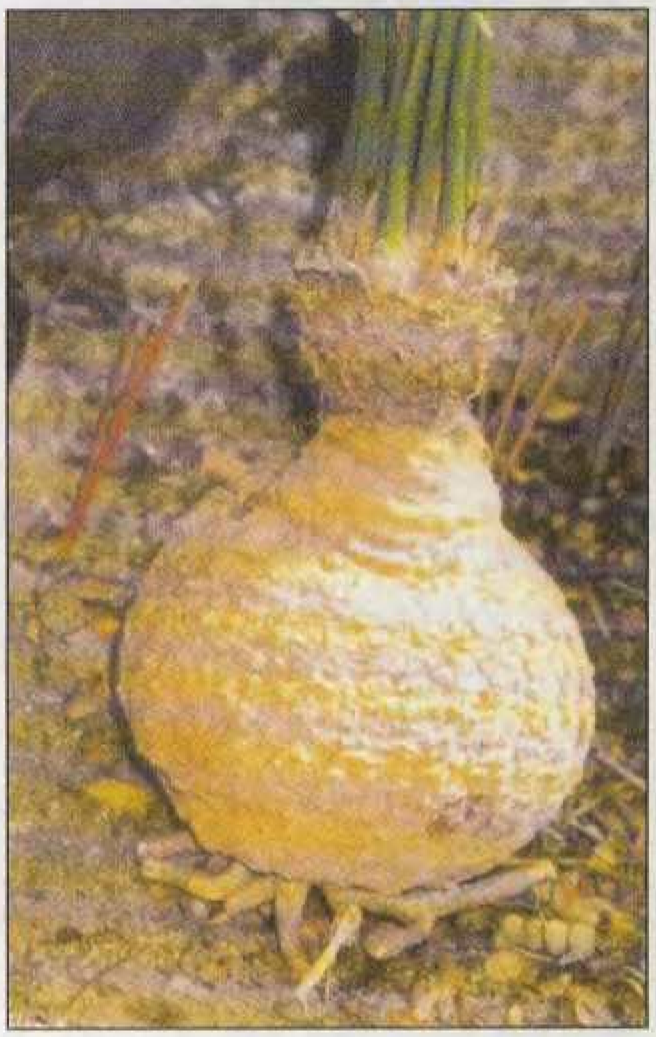
Colour Figure 3 *Cycas lindstromii* in habitat near Ca Na, with Elsa Vorster. Photo: Willie Tang.



Colour Figure 4 Immature male cone of *C. lindstromii*. Photo: Willie Tang.

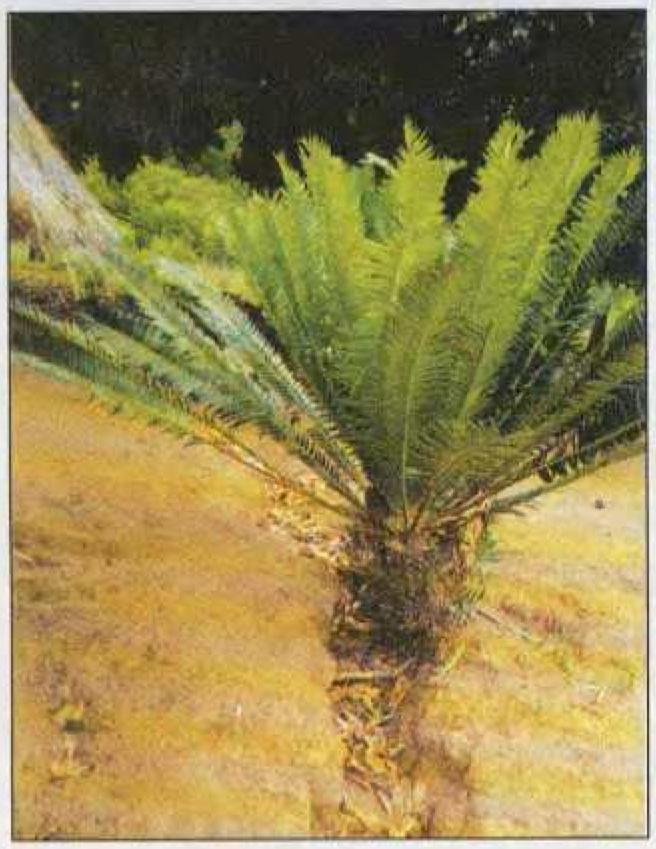


Colour Figure 5 Male plant of *C. lindstromii* in habitat near Ca Na.



Colour Figure 6 Stem colour and texture is evident in this picture of *C. lindstromii*. Photo: Willie Tang.

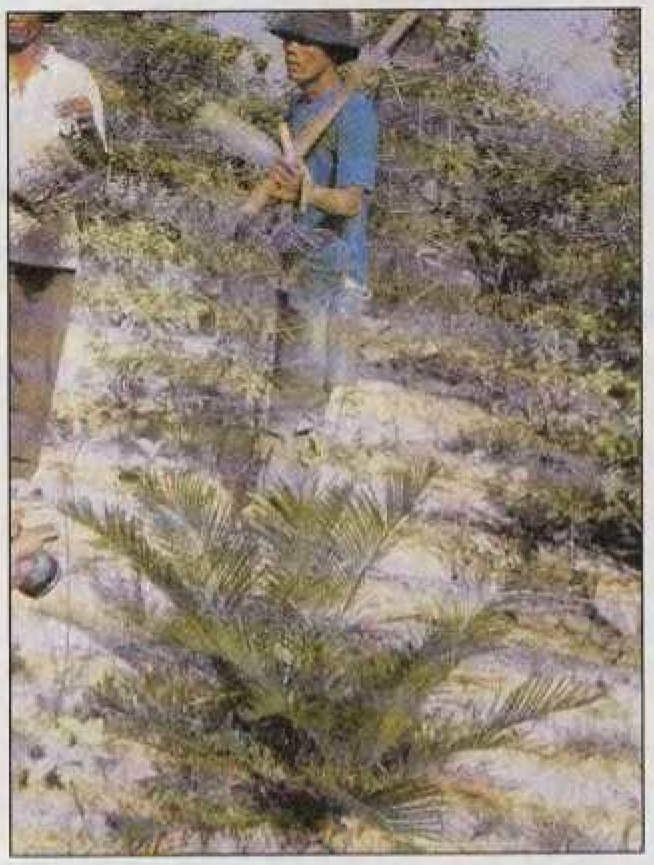
Colour Figure 7 Close-up view of the upper side of leaves of *Cycas lindstromii*. Photo: Willie Tang.



Colour Figure 8 Female sporophylls of *C. lindstromii* have a distinct elongated lamina (flattened terminal blade). Photo: S.-L. Yang.

Left: Colour Figure 10 *Encephalartos manikensis* at altitudes 500–600 m on Mount Dengalenga, Manica Province, surviving well under harsh conditions (apparently with perfect drainage!). Photo: Pedro Capela.

Left: Colour Figure 11 Female cones on a specimen of a species with affinities to *Encephalartos turneri*, found some 80 km west of Nampula in the Murrupula District of Mozambique. The cone scales are yellow-green in colour and the seeds produced by these plants are bright red. Photo: Pedro Capela.



Colour Figure 9 Local lizard hunters behind *C. lindstromii* in habitat near Ca Na. These lizards are dug out of their burrows and are eaten as food. Photo: Willie Tang.

Colour Figure 13 Jody Haynes, Cycad Biologist from Montgomery Center, Miami, Florida, USA, takes notes on a cultivated specimen of *Dioon mejiae* near La Unión, Honduras. Photo: Vince Murphy, Honduras Institute of Tourism.

Left: Colour Figure 12 An immature female cone on a specimen allied to *Encepha-lartos turneri* located about 13 km north-west of Nampula. The cone scales are pale yellow in colour and seeds produced by this population vary from yellow to orange to red. Photo: Pedro Capela.

SHORT COMMUNICATIONS AND ARTICLES
KORT MEDEDELINGS EN ARTIKELS

NOTES ON THE CYCADS OF MOZAMBIQUE

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INTRODUCTION

Situated in the southern tropics on the eastern coast of Africa, the Republic of Mozambique is second only to South Africa in its cycad diversity for the continent. This 801 590 km^2 country, with a 2 470 km coastline, hosts at least nine species of *Encephalartos*. In terms of the present "World List", three of these are endemic (*E. munchii, E. pterogonus, E. turneri*), the others being shared with South Africa and Swaziland to the south (*E. ferox, E. lebomboensis, E. umbeluziensis*), Zimbabwe to the west (*E. chimanimaniensis, E. manikensis*) and Malawi to the north (*E. gratus*) (Hill *et al.* 2003). Reports of the occurrence in Mozambique of *E. concinnus, E. hildebrandtii* and possible "new" species are discussed below. Finally, the genus *Cycas* is represented in several populations of *C. thouarsii* near the Zambezi delta (Silva 1983, Vorster & Vorster 1986).

Despite this diversity, the cycads of Mozambique are poorly known in the wild. The reasons for the limited fieldwork lie in the country's rugged terrain (sea level to 3300 m), poor road infrastructure and third-world economy; these difficulties made even more complex by decades of political strife which have made visits to cycad populations high-risk ventures for even the most intrepid explorers.

Given this scenario, the value of the work of the Portuguese botanists – Manuel Fidalgo Carvalho, Manuel Correia, Francisco Mendonça, Jorge Paiva, António Rocha da Torre, and others - in the latter part of the last century, has not been fully recognised. These workers made extensive cycad collections throughout Mozambique, with specimens filed at the herbaria of the University of Coimbra (COI) and the Instituto de Investigação Científica Tropical (LISC), both in Portugal. The work was summarised in two important monographs (Silva 1976, 1983). Of particular interest are the expeditions made by Correia, Torre and Paiva in 1964–68 to the Nampula area of northern Mozambique (see discussion under *E. turneri*).

The major English work relating the taxonomy of the cycads from the Manica Province was the publication on "*Encephalartos manikensis* and its near allies" by Robert Allen Dyer & Inez Verdoorn in 1969 (we refer later to this group of species as the *E. manikensis* complex). Their descriptions were made largely on the basis of the authors' inspection of plants growing in Raymond Münch's garden collection in Rusape, Zimbabwe, amplified by field reports from Münch, H. Basil Christian, L.C. Leach, J.A. Smit and others. Specimens relating to these descriptions are lodged at the government herbaria in Harare (SRGH) and Pretoria (PRE). Dyer and Verdoorn considered the morphology of the male cone and its microsporophylls as foremost characters in the species separations. These authors were aware of the limitations of their work, particularly in that (a) the descriptions were made largely on the basis of selected plants in cultivation in gardens and did not necessarily represent the range of variation for the taxon in the wild, and (b) cone morphology was accessed in many cases on the basis of dried specimens, in which colour and shape would have changed.

Despite the obvious value in pooling information and interchanging herbarium vouchers between the South African and the Portuguese workers, this never occurred and the past, lack of collaboration has undoubtedly inhibited progress.

In this article, we discuss the field observations of more than 100 Mozambique *Encephalartos* populations made recently by Pedro Capela, nurseryman and naturalist resident in the town of Chimoio of the Manica Province of central Mozambique. Our focus is on the points of discrepancy between these observations and the data provided in the published descriptions. Pedro Chassot and Roy Osborne assisted respectively in translation from the Portuguese and in editing of the first author's field notes.

DISCUSSION OF THE SPECIES SEEN BY CAPELA

1. *Encephalartos chimanimaniensis* R.A. Dyer & I. Verd.

This species, together with *E. concinnus, E. munchii* and *E. pterogonus,* was described as distinct within the *E. manikensis* complex by Dyer & Verdoorn in 1969. Their description was based on a very small number of plants in the Chimanimani National Park in Zimbabwe and on the adjacent side of the Chimanimani Mountain range in Mozambique.

The current IUCN/SSC cycad status survey lists *E. chimanimaniensis* as endangered, with a population size 500–1000, and under threat from over-collection and reproductive failure (Donaldson 2003). There appear only very few plants left in Zimbabwe (confined to the Chimanimani National Park) and a similarly limited number of plants in the immediately adjacent part of Mozambique exist in a few sparse groups. However, recent explorations have shown that there are at least six fairly substantial populations (each 500–1000 plants) slightly further afield, extending from the general area of Mount Binga (3 300 m, highest mountain in Mozambique) south-wards for about 65 km. These populations show a range of different cone morphologies; male cones are either long and wide (85 cm x 30 cm) or long and narrow (70–80 cm x 8–11 cm) - the latter being more consistent with the dimensions in the Dyer & Verdoorn description for *E. chimanimaniensis*. The more southern populations show some characteristics of the plants referred to loosely as "E. sp. Chipinge" and "E. sp. Elizabethvillensis". This is not suprising as the cross-border distance between the relevant sites is less than 50 kms. The more northern populations may represent intergrades between *E. chimanimaniensis* and *E. manikensis*.

2. *Encephalartos concinnus* R.A. Dyer & I. Verd.

This species was also first described as a distinct species within the *E. manikensis* complex by Dyer & Verdoorn in 1969. It was reviewed in "*Encephalartos*" by Osborne (1993a) following a field trip to Zimbabwe. Up to the present time, this species has been regarded as endemic to central-southern Zimbabwe, existing in three widely-disjunct populations of varying sizes, the type locality being that at Mberengwa (previously Belingwe). Donaldson (2003) gives an estimate of 300– 000) for the total number of plants in the wild.

A herbarium specimen (Leach & Cannell 14344, male, LISC, SRGH), collected in July 1969 from a rocky outcrop in Manica Province between Vila Pery (now Chimoio) and Vila Gouveia (now Catadandica), and labelled *E. concinnus*, has been viewed with circumspection in the past. Capela visited this area in August 2002 and found two stands, each of 500–800 plants, having "*concinnus*-like" male cones. These measure 40–50 cm in length and have a more-or-less constant diameter of 10–11 cm for their full length. These plants have deflexed leaflets (*pp* angle $>180^0$) and an irritatingly sericeous rachis. Their female cones, however, are within the normal range of variation for *E. manikensis*, populations of which are within 10–12 km of these sites.

This brings to mind the unconfirmed reports of *E. concinnus* at an undisclosed locality in the Northern Province of South Africa (Goode 1989). These observations raise the difficult issue of plant populations that have male cones characteristic of one species and female cones of another. It may be necessary to re-evaluate the taxonomic boundary between *E. concinnus* and *E. manikensis*.

3. *Encephalartos gratus* Prain

This species was first described by Prain in 1916 from plants growing on Mount Mulanje (2 400 m) in Malawi, and was reviewed by Osborne in "*Encephalartos*" in 1991. Following the original description it was found that the species extends considerably into Mozambique. In the 1960's and 1970's Torre & Correia collected specimens in the Ribáuè area in Nampula Province and at several sites in Zambésia Province (Silva 1983). Donaldson (2003) estimates the total plant number as 100 000.

Capela has found a great deal of variation in the Mozambique populations of this species, especially in cone size and colour. The latter varies from pale to very dark orange, depending somewhat on the extent of the cone pubescence. Significantly, more *E. gratus* populations have now been found within 100 km of Nampula, and the presence of at least one putative hybrid population indicates some degree of intergrading with *E. turneri*.

4. *Encephalartos hildebrandtii* A. Braun & Bouché

This species, described in 1874, is widespread along the coasts of southern Kenya and northern Tanzania. A single Mozambique collection, made in 1944 at Mugeba in the Mocuba area of Zambésia Province (Mendonça 2082, male, LISC, LMA), was labelled *E. hildebrandtii*. Capela visited Mugeba in 2001 and found scattered cycad plants on two hills in the area. These plants appeared to be within the concept of *E. gratus* and the earlier assignment of Mendonça's collection from this area, to *E. hildebrandtii*, seems erroneous from both the morphological and the geographical viewpoints.

5. *Encephalartos manikensis* (Gilliland) Gilliland (Colour Figure 10 on p. 12).

This species was first described under the name *Encephalartos gratus* var. *manikensis* by Gilliland in 1938, on the basis of plants occurring at about 1 400 m on Mount Gorongowe in Zimbabwe. Gilliland ascribed specific status to the taxon in 1939 and it was soon apparent that the species was also well represented in Mozambique. In the 1970's, Carvalho collected herbarium specimens of this species from Mount Garuso, Vanduzi and Bandula in Manica Province (Silva 1983). The species was reviewed by Osborne in "*Encephalartos*" in 1994, although the author was unaware of the work of the Portuguese botanists at that time. In a recent status report on the systematics of the genus, Vorster (2003) identifies 18 groups for the 65 species of *Encephalartos*, of which his Group 11 comprises *E. chimanimaniensis, E. concinnus, E. manikensis, E. munchii, E. pterogonus* and perhaps *E. turneri*. Donaldson (2003) gives a species number estimate for *E. manikensis* as 10 000.

At an early stage, *E. manikensis* was recognised as one of the most diverse of the African cycads, with numerous populations scattered in rugged terrain along the Zimbabwean border and extending up to 100 km eastwards into

Mozambique. Capela's field work indicates that the species may be even more fragmented, more scattered and morphologically more diverse than previously thought; there appear to be 50 or more (possibly up to 200) discreet populations in an area roughly defined as a 80 km radius circle centred about the town of Bandula. Capela's rough estimate of the total number of *E. manikensis* plants in wild populations, based on 100 populations each of 300 plants, comes to 30 000, a figure well above Donaldson's estimate - and which excludes all the additional plants in Zimbabwe. The general area for this species includes several sites from which plants have previously found their way into private collections - e.g. under the names "Bandula", "Chicamba", "Garuso", Vanduzi" etc. [It is worth noting that the *E. munchii* and *E. pterogonus* localities fall within this area, while the *E. chimanimaniensis* sites are slightly more to the south and the *E. concinnus*-like plants are slightly more to the north].

6. *Encephalartos munchii* R.A. Dyer & I. Verd.

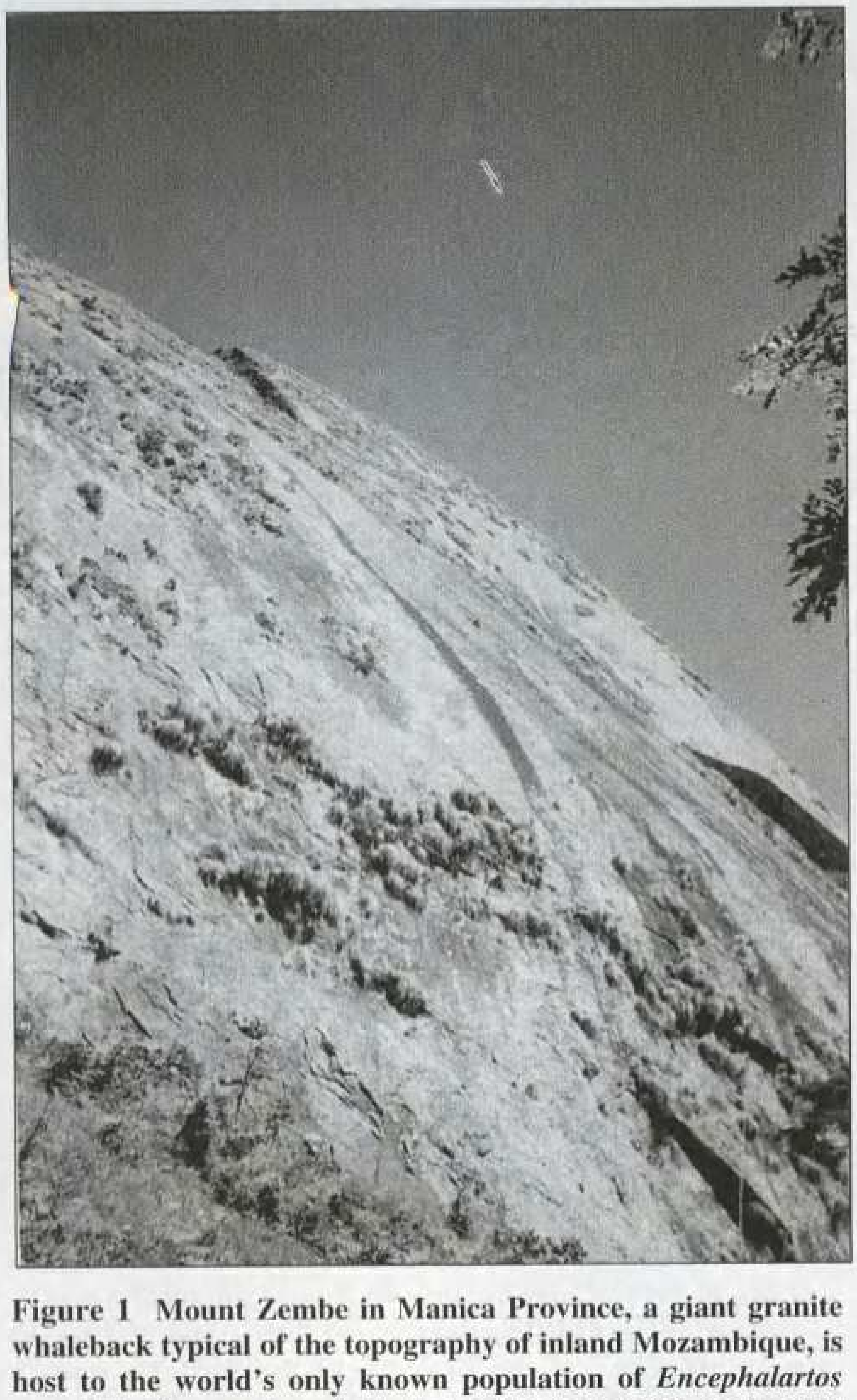

Figure 1 Mount Zembe in Manica Province, a giant granite whaleback typical of the topography of inland Mozambique, is host to the world's only known population of *Encephalartos munchii*. The number of plants is estimated at 250, and nearly all have dark green foliage – unlike the blue-grey form of this species favoured by collectors. Photo: Pedro Capela.

doorn in 1969. Carvahlo explored the single population on Mount Zembe in Manica Province in 1973 (Silva 1983) (Figure 1). The species was reviewed by Osborne (1993b) in "*Encephalartos*". *E. munchii* has become very popular among collectors, who favour it greatly for the striking blue-grey bloom to the foliage. Donaldson (2003) ranks the species as critically endangered and cites a population size of only 17 specimens.

Capela reports on seeing some 250 plants at altitudes 800–900 m on Mount Zembe. He stresses that only very few of these have the blue-grey foliage supposed typical for the species. Either the "popular" form amongst collectors was originally sourced from atypical representatives of the species, or the blue-grey foliage plants have been removed to near-extinction. The slender male cones (65 cm x 9 cm) and the jade-green colour of the cones of both sexes, said to be characteristic for *E. munchii*, are also apparent amongst *E. manikensis* populations. These two taxa may be more closely related than their specific separation implies.

7. *Encephalartos pterogonus* R.A. Dyer & I. Verd.

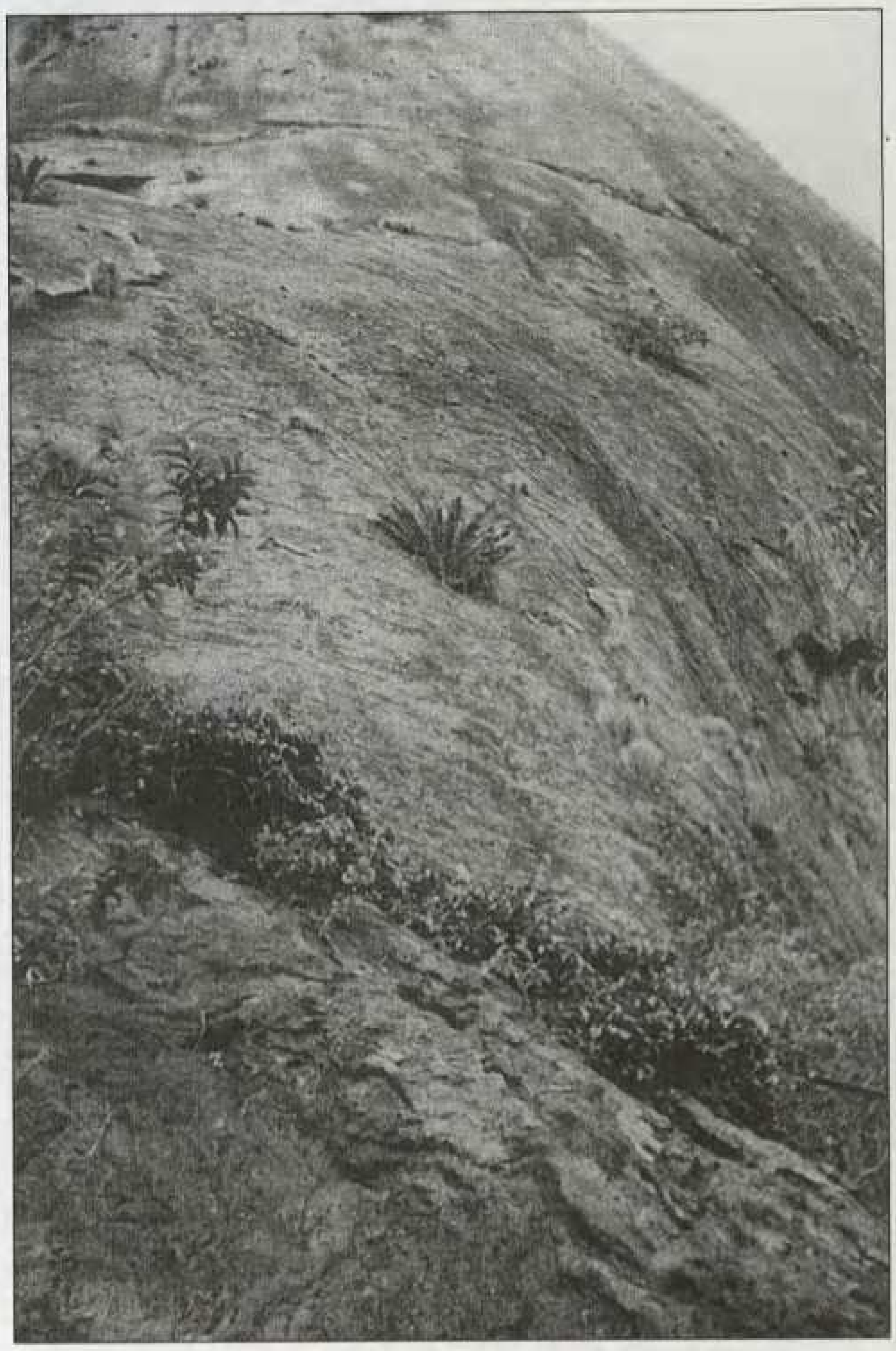

Figure 2 Mount Mwerè in Manica Province supports the only known population of *Encephalartos pterogonus*. A limited number of these plants occur in pockets on the "whaleback" sides, but several hundred are located on the summit. Photo: Pedro Capela.

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6. *Encephalartos munchii* R.A. Dyer & I. Verd.

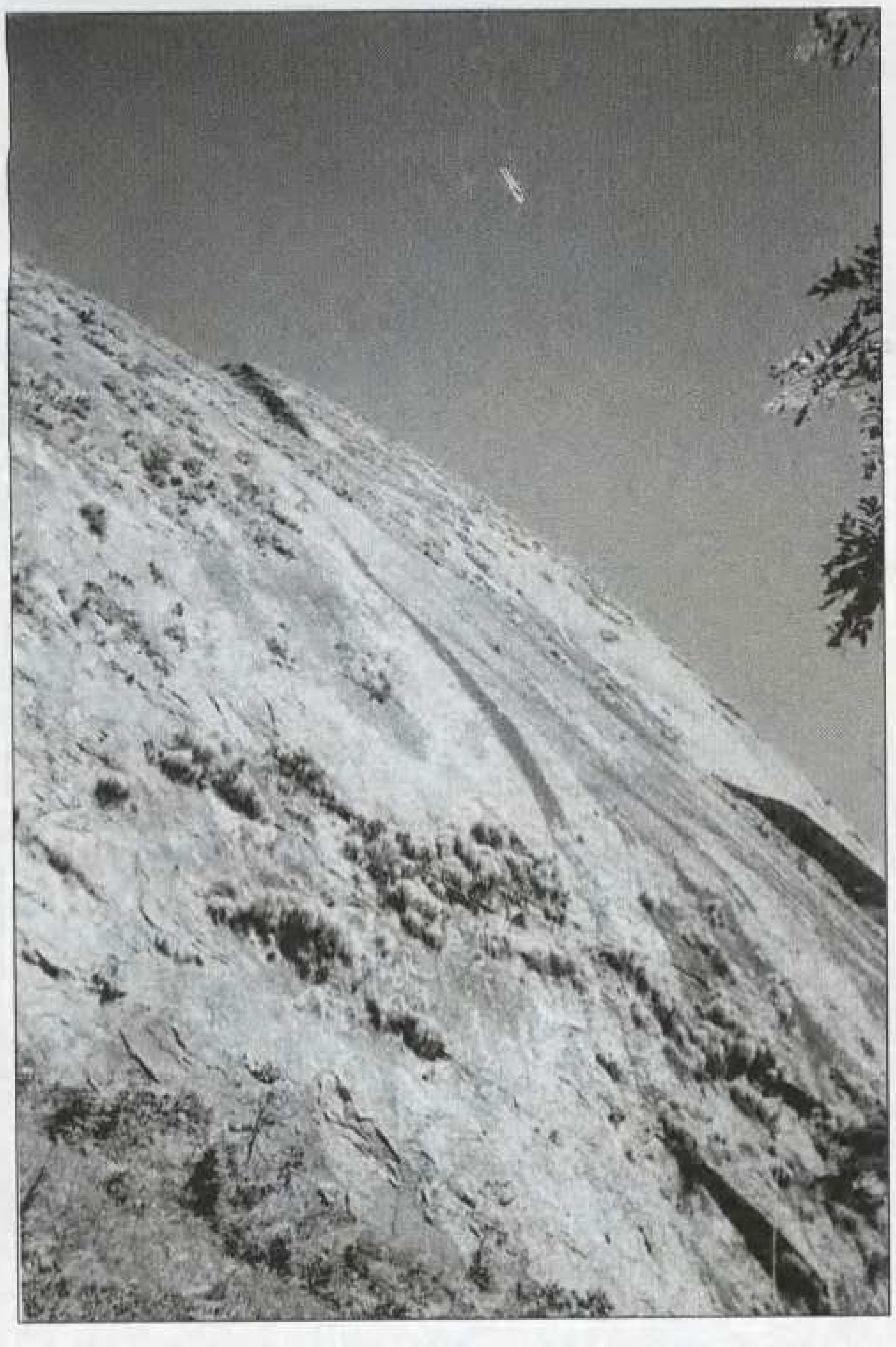

Figure 1 Mount Zembe in Manica Province, a giant granite whaleback typical of the topography of inland Mozambique, is host to the world's only known population of *Encephalartos munchii*. The number of plants is estimated at 250, and nearly all have dark green foliage – unlike the blue-grey form of this species favoured by collectors. Photo: Pedro Capela.

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7. *Encephalartos pterogonus* R.A. Dyer & I. Verd.

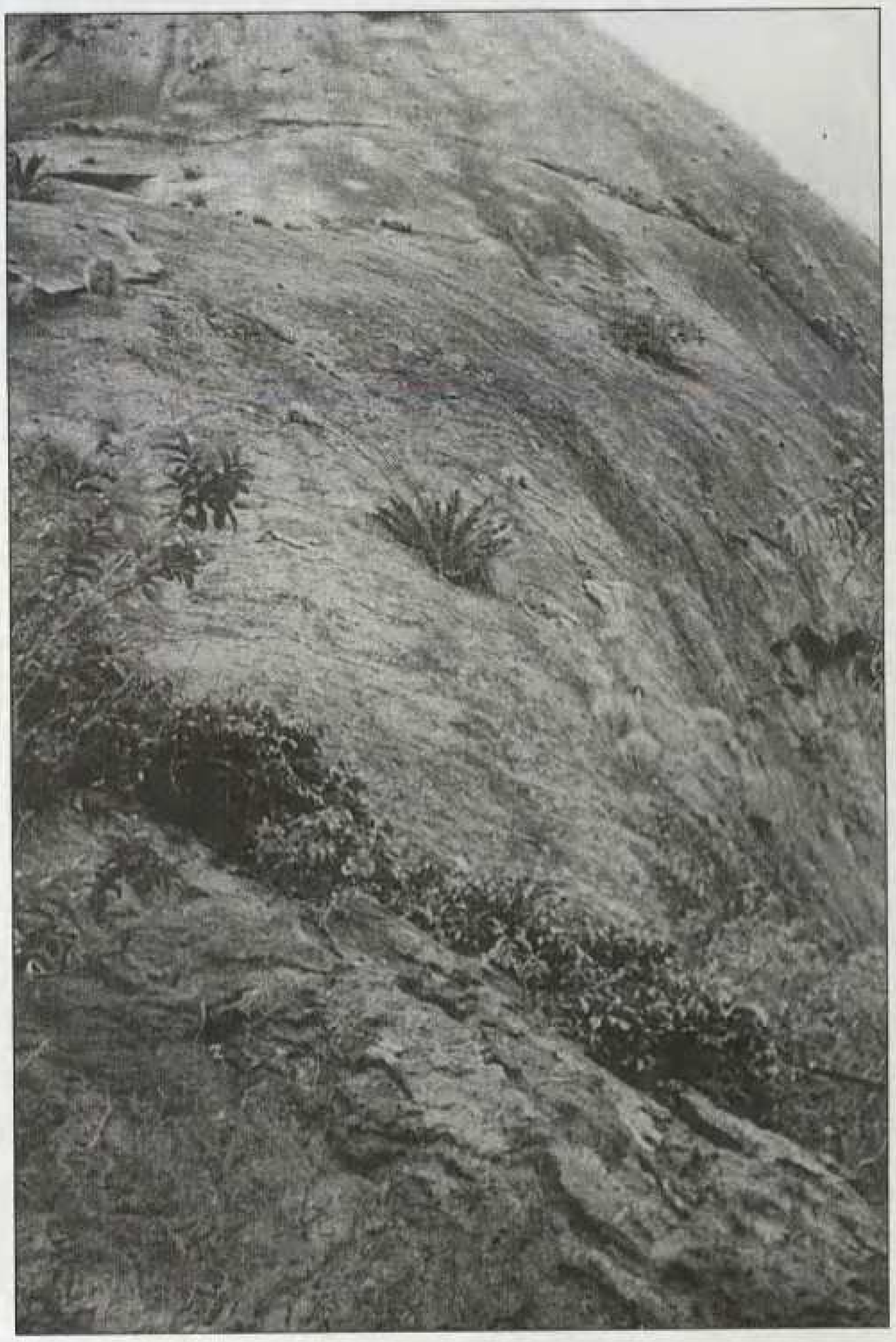

Figure 2 Mount Mwerè in Manica Province supports the only known population of *Encephalartos pterogonus*. A limited number of these plants occur in pockets on the "whaleback" sides, but several hundred are located on the summit. Photo: Pedro Capela.

species within the *E. manikensis* complex by Dyer & Verdoorn in 1969. Their description relates to a single population on Mount Mrwerè (also known locally as Luero, Ruero or Uruerè) (Figure 2, Colour Figure 14 on p. 19). This site was visited by Carvalho in 1973 (Silva 1983). Donaldson's (2003) status survey refers to this species as critically endangered, estimating the number of wild plants to only 10.

Capela now reports on seeing 300–400 plants at altitudes 600–800 m towards the summit of Mount Mrwerè. A diagnostic character in the description of this species is the yellow-coloured, wing-like, toothed ornamentation said to be prominent on the male cone scales. Capela has found that this is by no means uniform in the *E. pterogonus* population, but varies with plant age, cone maturity and seasonal conditions. Significantly, the same embellishment has now been seen on the male cones of several *E. manikensis* populations in the Vumba Mountains on the Mozambique-Zimbabwe border, while Hurter (pers. comm.) has observed it on male cones of *E. lebomboensis*. It is also apparent that several small populations of *E. manikensis* occur on hills 2–10 km of Mount Mrwerè, posing little barrier to genetic mixing. Given this information, we question whether the recognition of this single population, as a separate species, remains valid – our views being shared by Piet Vorster (pers. comm.)

8. *Encephalartos turneri* Lavranos & D.L. Goode

This Mozambican endemic was described by John Lavranos and Douglas Goode in 1985 on the basis of a specimen (holotype, Turner sub Lavranos 22553, filed at Lisbon herbarium) from a plant in cultivation in Ian Turner's garden in Zimbabwe. The description was amplified from Turner's field notes on the plant's source "on low granite hills about 22 km south-east of Nampula" in the northern central part of Mozambique. Key characters in the description of *E. turneri* were given as the distinctive pinkish bloom to the yellow-coloured cones and the hooked ends of the boat-shaped leaflets. Donaldson's (2003) status survey estimates the number of wild plants as 10 000.

It is unfortunate that the species description by Lavranos & Goode omits discussion of the 1964 and 1967 surveys of cycads in Nampula Province by Correia, Paiva and Torre. Although their morphological work was incomplete, these botanists identified three discreet taxa, referred to as *Encephalartos* "A", "B" and "C" in the *Flora de Moçambique* (Silva 1983), all on various mountains within 80 km of Nampula. Vouchers for these plants are filed in the Lisbon Herbarium. The sites are all in close proximity and the various populations are clearly related. Furthermore, the Portuguese botanists also reported the occurrence of *E. gratus* in the Nampula area.

Capela now reports even more complexity that the above scenario suggests, in that there are as many as 150 separate stands of *Encephalartos* scattered within Nampula Province, with significant inter-population variation in leaf and cone morphology. For instance, large numbers of plants, mostly akin to *E. turneri*, have been seen on mountains to the west and north-west of Nampula. Male and female cones from these populations vary considerably in size and colour. In the females, the colour ranges from yellow-green to a bright yellow (Colour Figures 11. 12 on p. 12). Capela has not observed the "pink bloom", said to be characteristic of *E. turneri* female cones, in any populations in the area. The diagnostic leaflet "hook" of *E. turneri* is present on plants near Nampula but absent on those further to the north-east. In the males cones, the colour ranges from green to orange and one form, a possible intergrade, has the russet-brown indumentum associated with *E. gratus*.

There appears to be some confusion as to the site of the "typical" *E. turneri* (*sensu* Lavranos & Goode); and we question the validity of the "22 km south-east of Nampula" locality given in the description. It seems also that those plants which have found their way into collections under that species name appear to originate from the Ribáuè area and lack the characters said to be diagnostic for the type (Piet Vorster, pers. comm.). With the discovery of so many additional populations, the boundaries of the Portuguese botanists' species "A", "B" and "C" have also become muddled. In summary, the evidence suggests three possibilities: (a) a much broader definition of *E. turneri*, (b) the concept of an "*E. turneri* complex" and/or (c) the existence of species yet to be described.

Capela is planning a more extensive survey of plants in this area, focussing particularly on the populations along the road from Nampula to Malema to Cuamba, and also visiting the hitherto unexplored vegetation of the Niassa Province.

CONCLUSIONS

Several important points emerge from Capela's fieldwork, summarised as below:

1. There are significantly more cycad plants, and significantly more cycad populations, in Mozambique, than previously thought. In particular, the single populations representing *Encephalartos munchii* and *E. pterogonus*, although small and undoubtedly vulnerable, are not in the near-extinct condition previously feared.
2. Two centres of cycad diversity are identified in Mozambique. The first is the Manica Province in the central western part of the country, with its numerous fragmented and diverse populations embracing the concepts of *E. manikensis, E. munchii* and *E. pterogonus* and their allies. The second lies some 700 km to the north-east, in an area broadly around Nampula, where *E. gratus*, *E. turneri,* various inter-grades and possible new species may be present. Apart from these "centres of diversity", cycad populations are widely dispersed throughout other parts of Mozam-bique.
3. The report of *E. hildebrandtii* occurring in Mozambique appears erroneous.

4. Species boundaries are more diffuse that the original descriptions indicate, and the present taxonomy is urgently in need of overhaul. Capela's field observations reveal that many characters given as diagnostic for the few named species are not necessary uniform within populations, nor are they exclusive to those populations. (This illustrates only too clearly that our concept of "a species" is an artificial construction. The taxonomic "lumpers" may favour embracing apparently-related populations into large single species. The taxonomic "splitters", on the other hand, would have each population given a unique name. Neither of these courses of action would be satisfactory and clearly any decisions of this nature should follow a norm applied throughout the genus.) In a more direct sense, the validity of *E. chimanimaniensis, E. concinnus* and especially *E. pterogonus*, as separate species, requires re-evaluation and the concept of *E. turneri* is much broader than indicated in the original description.

5 Morphologically, Capela's fieldwork supports the Dyer and Verdoorn concept that the male cone characters are probably the most important diagnostic elements on which to separate taxa in the *E. manikensis* complex. The variation in the male cones can be categorised as: physical dimensions (length and width) plus cone shape - pyramidical, cylindrical, ovoid, fusiform, curved or straight. Further taxonomic ranking may be based on morphology of the male cone bulla: plain, with a depressed facet, with a trapezoid centre, with a lozenge-shaped centre, etc. In addition, the degree of spininess of the reduced leaflets on the lower rachis varies - from many, or overlapping spines, to no spines at all.

As a *caveat*, we recognize that Capela's observations and our joint opinions, however useful, are simply pointers to the necessity for more comprehensive botanical fieldwork leading ultimately to a thorough revision and monograph on the Mozambique cycads. Ideally, this should be a collaborative effort between South African, Portuguese and Mozambican scientists. This is no easy undertaking; it has been said that "taxonomy is easy as long as you have insufficient material" - and this applies only too well to the status of cycad taxonomy in Mozambique.

Our planning at the present time includes a survey of possible insect species found in cycad cones in Mozambique. This would not only provide invaluable data for the growing body of evidence relating to entomophily in *Encephalartos* elsewhere in Africa, but would also be most useful in explaining the barriers to gene flow in a situation where numerous fragmented plant populations, in close proximity, appear to maintain their genetic integrity. In addition, we hope to extend the *ex-situ* cycad collection at Montgomery Botanical Center, USA, by supplying that institution with seeds from major populations of Mozambican cycads. Another objective is supplementing the cycad collection of the Mozambique National Botanical Garden so that a better *ex-situ* representation of the country's cycads is held by that garden.

ACKNOWLEDGMENTS

We are grateful to Fabiane Chassot, Maria Adélia Diniz (Centro de Botânico of the IICT, LISC Herbarium), Bernard Fischer, Piet Vorster (University of Stellenbosch) and Terrence Walters (Montgomery Botanical Center) for their kind help in the preparation of this article.

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EXCURSION TO MANANGA - *E. LEBOMBOENSIS*, 12 JULY, 2003

Pieter & Celeste van der Walt,
P.O.Box 913, 2158 Olivedale, R.S.A.

Received 6 October 2003

When the Lowveld branch of the Cycad Society, through Charles and Alice de Beer from White River, advertised in a previous edition of "*Encephalartos*", a trip to the naturally occurring *Encephalartos lebomboensis* populations near Mananga, we immediately jumped at the opportunity.

Travelling down to Nelspruit where we also visited the Lowveld Botanical Gardens – to set the scene for the next day's excursion! Little did we know at the time that this will in no way compare what awaited us at Mananga!

Saturday morning turned out to be overcast and chances for rain looked very good. A few of us met with Charles and Alice at a local garage in Nelspruit from where we embarked in a small convoy of vehicles on an almost 2 hour trip to the Swaziland border post at Mananga.

At the border post we met up with other members of the Lowveld branch, but also with members from other chapters and like-minded enthusiasts from so far as Pietersburg, Klerksdorp and Potchefstroom – even two exchange students from France joined the excursion!

Figure 1 Entrance to the Mlambo Community Cycad Nursery.

After everyone got their backpacks and hiking gear ready, the party of approximately 24 people left for the local community nursery, Mlambo Community Cycad Nursery, on the way to the Mananga village (Figure 1). Here we had a brief look at the efforts of a few local individuals that harvest the seeds (Colour Figure 15 on p. 19) on the Lebombo mountains and then cultivate it at this local nursery (Figure 2). Ultimately to make these seedlings available to the market at some ridiculously low prices, and to create some income to the local community.

Soon we left the nursery to drive on open bakkies and other 4x4 vehicles towards the foot of the Lebombo Mountains.

Figure 2 Seedlings cultivated at the Mlambo nursery.

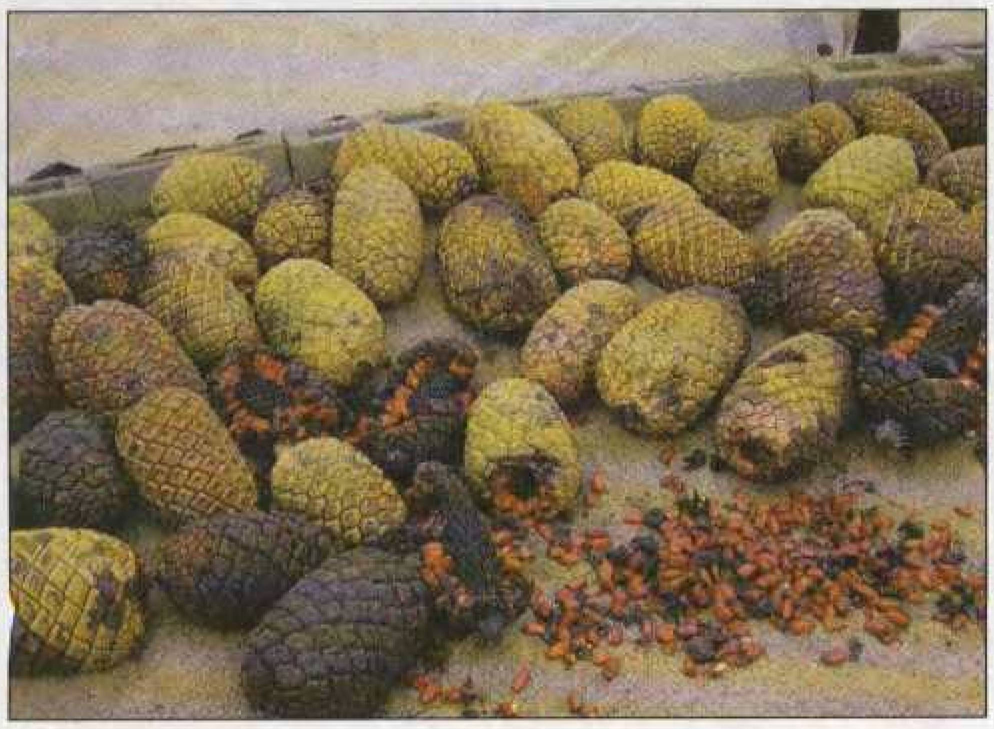
Here we met up with our guide, with rifle in hand (to guard against would be poachers!), he guided us up the mountain (Figure 3).

Figure 3 Fellow adventurers with our guide on the right.

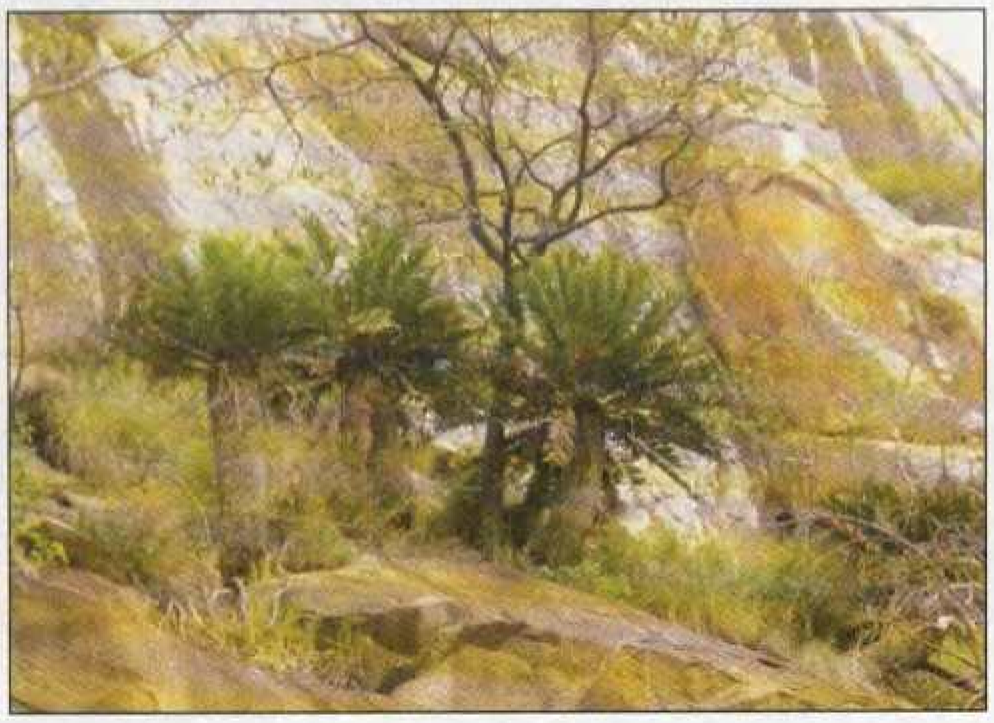
After a few hundred metres up the mountain we soon realised that this was not going to be easy. There is no paved pathways, no cable cars and to top it all it started to rain very softly, making what little pathway there was very slippery! Halfway to the top a number of *E. lebomboensis* clumps could be noticed (Colour Figure 16 on p. 19). Seedlings were also spotted sprouting in some of the cracks where they would come to rest after rolling down from the top of the mountain. After approximately one kilometre's vertical climb we reached the "summit". It was very overcast at this stage with larger droplets of rain now falling and making things a bit more miserable.

The view at the top was really breathtaking – despite the overcast weather! – with large specimens of *E. lebombo-*

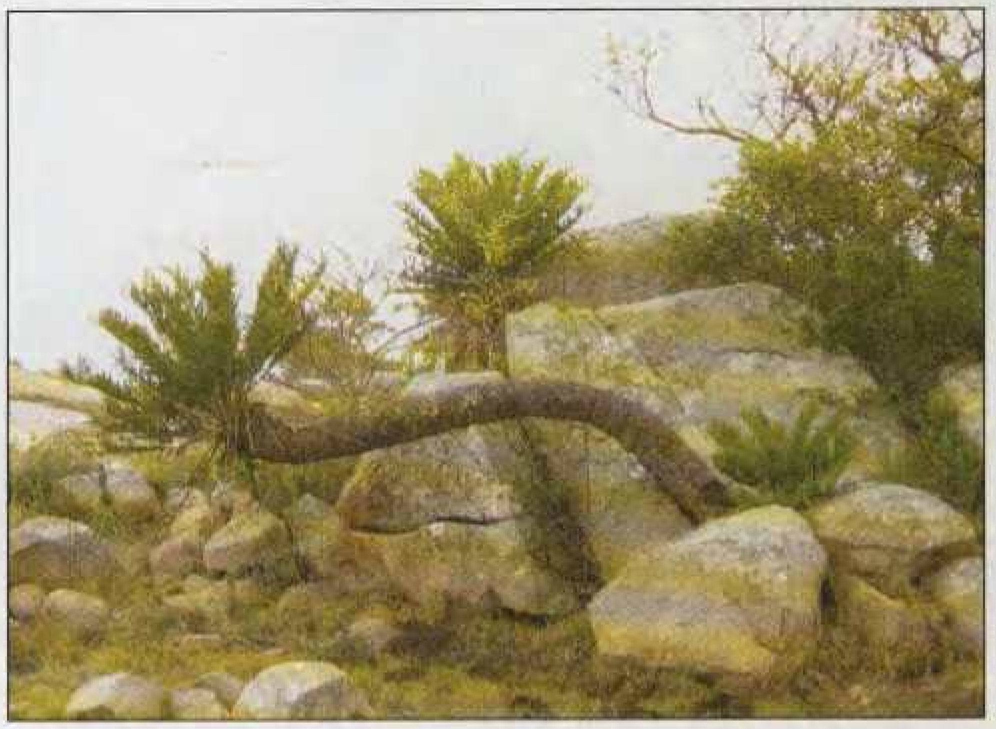
Colour Figure 14 *Encephalartos pterogonus* on Mount Mwerè showing four large male cones at various stages of maturity. Photo: Pedro Capela.



Colour Figure 15 Harvested cones of *Encephalartos lebomboensis* disintegrating at the nursery. Photo: Pieter van der Walt.



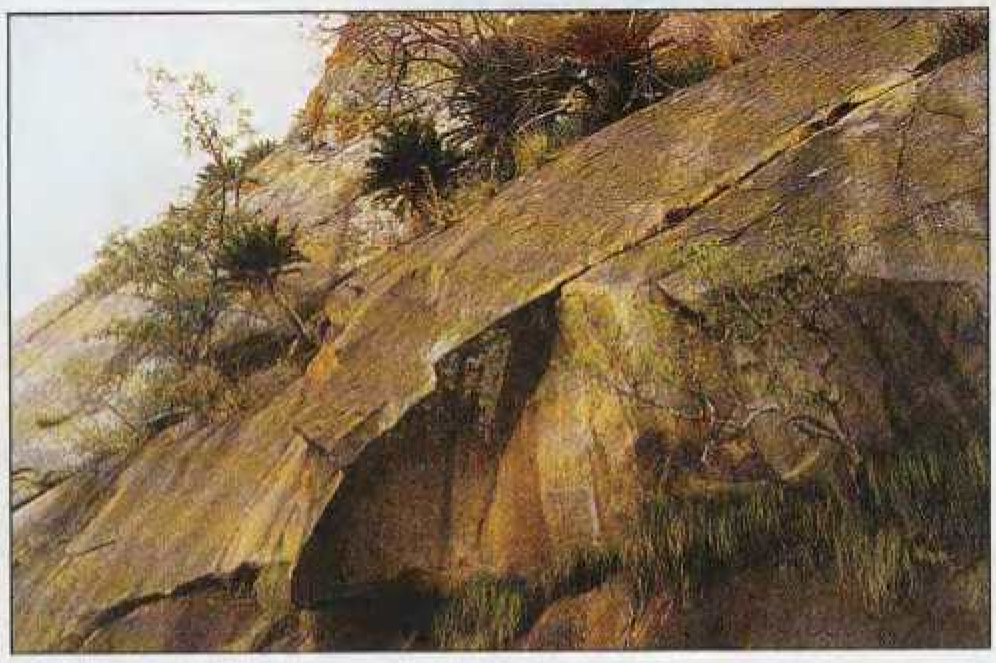
Colour Figure 16 Specimens of *E. lebomboensis* growing on the slope of the Lebombo Mountains. Photo: Pieter van der Walt.



Colour Figure 17 A magnificent curving specimen of *E. lebomboensis*. Photo: Pieter van der Walt.

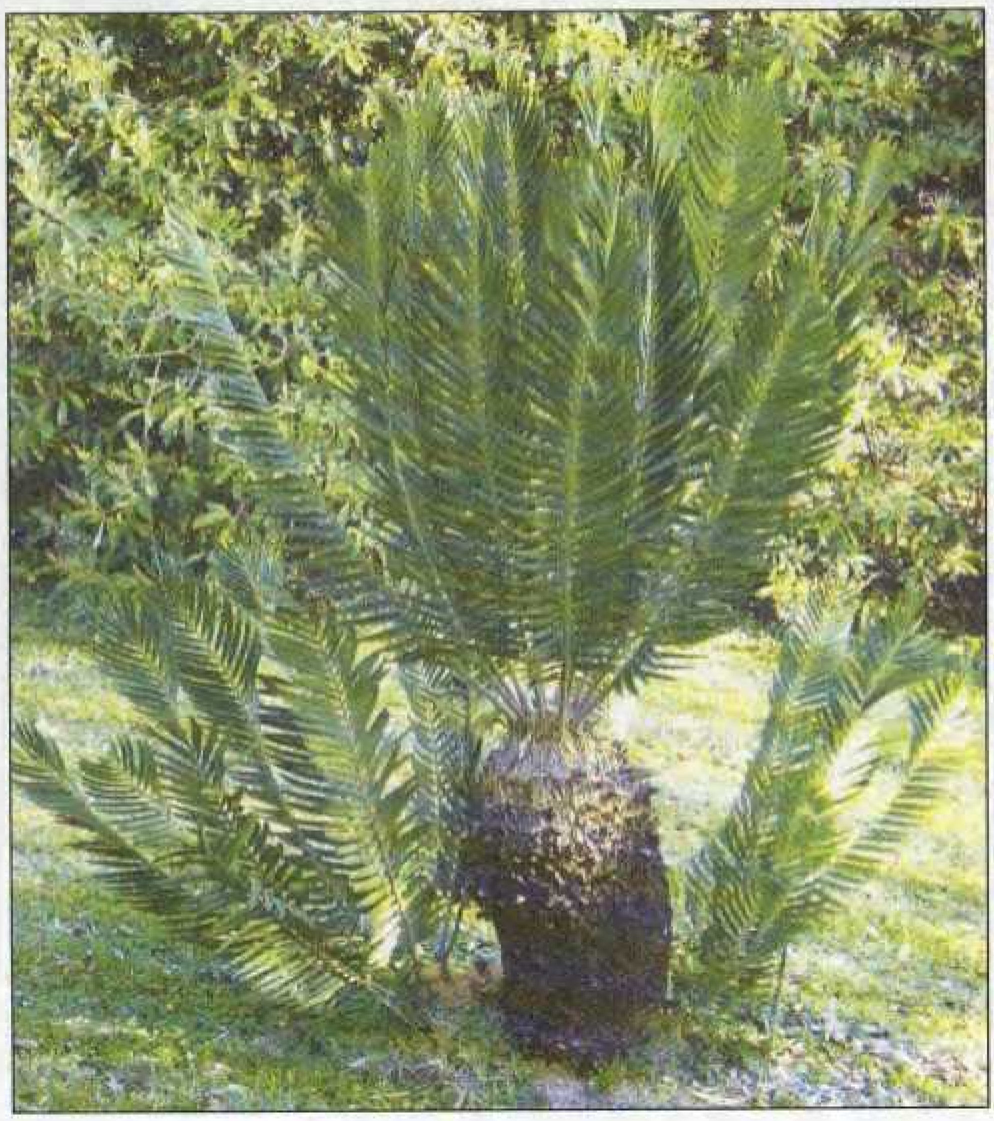
Colour Figure 18 A disintegrating female cone of *E. lebomboensis*. Photo: Pieter van der Walt.

Colour Figure 19 More tall standing specimens of *E. lebomboensis*. Photo: Pieter van der Walt.



Colour Figure 20 Cycads (*Encephalartos lebomboensis*) growing out of the rockface. Photo: Alice de Beer.

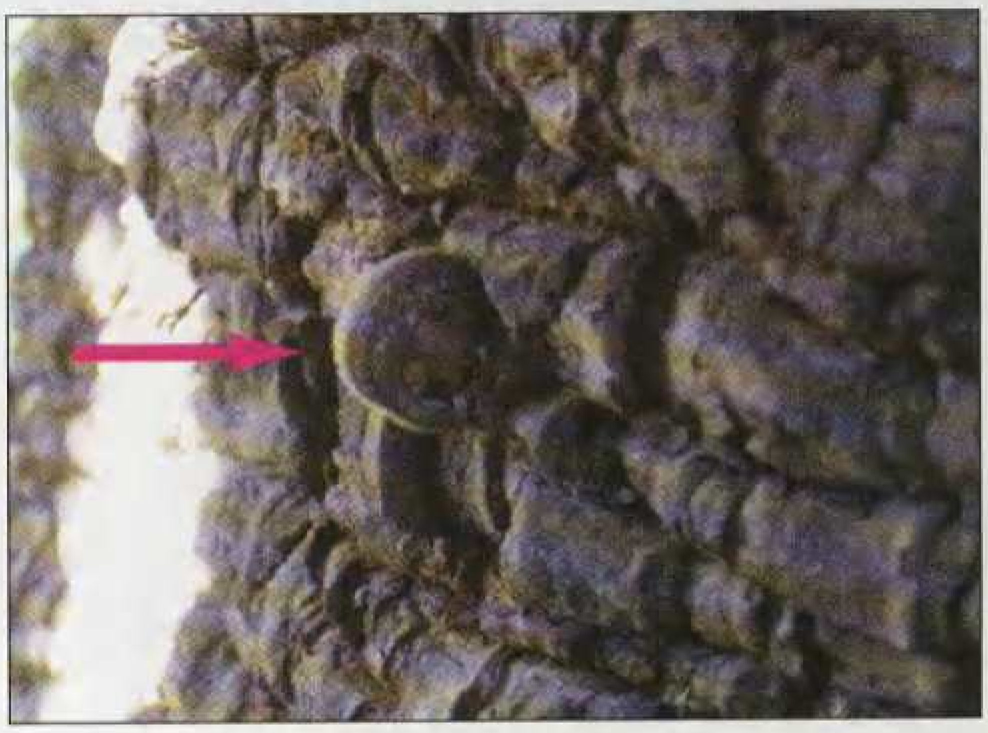
Colour Figure 22 Silhouette of *E. lebomboensis*. Photo: Alice de Beer.



Colour Figure 23 A magnificent specimen of *Encephalartos heenanii* growing in the Lowveld Botanical Gardens at Nelspruit, Mpumalanga. Photo: Pieter van der Walt.

Colour Figure 21 *E. lebomboensis*: a stem that had severe damage from fire. The cycad survived and is growing strongly. Photo: Alice de Beer.

Colour Figure 24 Rosa Heenan posing to give an idea of the actual size of the unusual *Encephalartos* growing in the Heenan's garden in Swaziland. Photo: Denis Heenan.



Colour Figure 25 A small growth on the stem of an *Encephalartos woodii* in the Durban Botanical Gardens. Photo: Pieter van der Walt.

ensis towering above the rock face. There where many plants coning with some starting to break up with characteristic bright red seeds contrasting with the yellow cones (Colour Figure 17 on p. 19). Many specimens had two cones at a time. Overall there appears to be a healthy population of specimens growing there (Colour Figures 16, 17 *ensis* towering above the rock face. There were many plants coning with some starting to break up with characteristic bright red seeds contrasting with the yellow cones (Colour Figure 18 on on p. 19). Many specimens had two cones at a time. Overall there appears to be a healthy population of specimens growing there (Colour Figures 16, 17, 19 on p. 19) and a lot of seed generation is taking place.

We were also greeted by a few local herdsmen looking after cattle, which do not seem to have any effect on the cycad population.

Sadly there was evidence of one or two larger specimens been cut down and just left there to rot!

Unfortunately due to the bad weather we had to cut the visit short at the top and descend back to where we left our vehicles. The trip down was much harder than the way up! By this time the soil and rocks were very slippery and a few of us literary saw our behinds and not very graciously – more than once!!

At the guide's camp we saw some more harvested cones meant for the nursery. We returned to the nursery where almost everyone made use of the opportunity to purchase a few seedlings to take back home as a souvenir of the visit to Mananga.

Saturday evening we met up with some of the fellow adventurers who managed to stay over for dinner at a local restaurant where we "premeditated" next year's hike to some other cycad populations in the immediate area. It was quite heartening to be able to go on an excursion arranged by another branch and to be able to see these wonderful plants in their natural habitat – a major difference from what we are used to in our carefully maintained gardens here in Gauteng!

Thanks to Charles and Alice de Beer for arranging the outing!

[See also photos by Alice de Beer on p. 20–21.]

NEWS FROM THE LOWVELD BRANCH OF THE CYCAD SOCIETY OF SOUTH AFRICA

Alice de Beer
P.O. Box 1107, 1240 White River, R.S.A.

Received 30 September 2003

Open field trip to *Encephalartos lebomboensis*

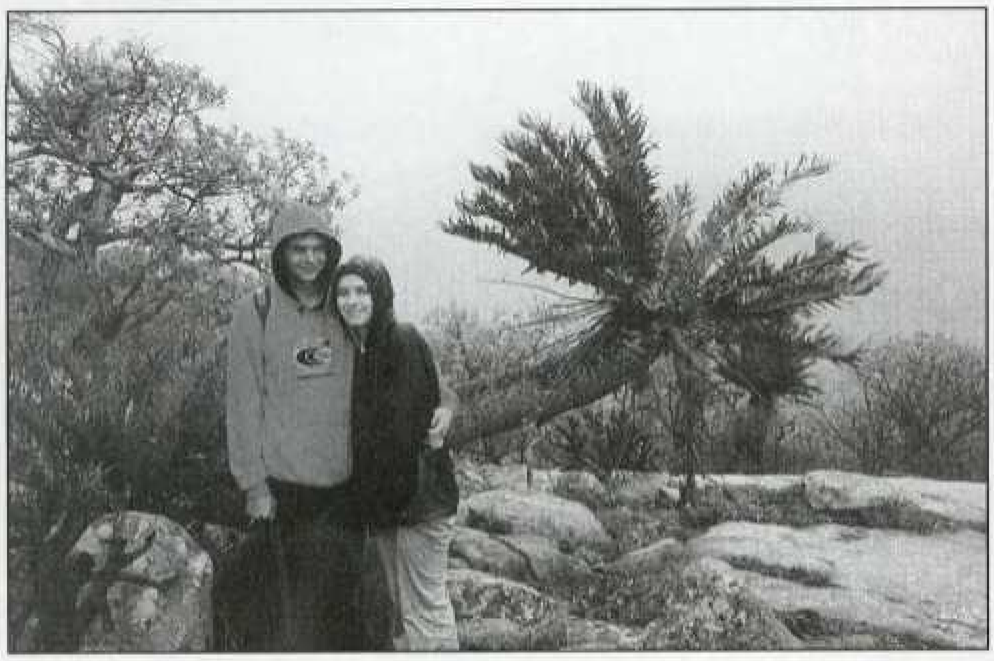


Figure 1 First time cycad enthusiasts – Adrian Hugo and Natalie Erasmus.

The Lowveld Branch of the Cycad Society of S.A. successfully held its first open walk to view the *E. lebomboensis* at Mananga. Twenty-four visitors attended the walk. Although the cycads were majestic (Colour Figures 20–22 on p. 20) and the scenery beautiful, it was overcast and rained for much of the walk. The wind and wet conditions made it extremely uncomfortable once on top of the mountain.

It was felt that this kind of walk was a good way of meeting cycad enthusiasts (Figure 1.) from different parts of the country. We will therefore endeavour to arrange one open walk per annum.

New chairman for the Lowveld Branch of the Cycad Society of S.A.

The Lowveld Branch would like to thank Mr Leon van Rooy for his many years of dedicated service to our Society. Not only was he the founder but his keen enthusiasm together with the support and encouragement of his wife Sylvia they built a firm foundation for the branch. We wish them well with their impending move.

The new committee is: chairman – Charles de Beer, secretary – Alice de Beer, and committee members – Dirk van der Walt and Peter Payne. We have also elected a seed bank/pollen officer, Diderik Nel.

Details for Charles de Beer: P.O. Box 1107, 1240 White River; Tel/fax: 013 7500719; e-mail: **charles@lantic.net**

[See also photos by Pieter van der Walt on p 18–19.]

A CYCAD WITH A HISTORY!

Denis Heenan
P.O. Box A322, Swazi Plaza, Swaziland

Received 12 September 2003

The accompanying photos show a most unusual *Encephalartos* growing in my garden (Colour Figure 24 on p. 20; note 1. the break of about 300–400 years ago, 2. the increase in girth beyond the steel support during the "cultivation" period, 3. the more than normal twist at the end of the leaves indicative of possible mixed ancestry). This plant I have had for over 30 years. It has been at its present locality for 12 years and previously it happily survived two removals. A tough old man!

I have tried to fathom out its genealogy and came to the conclusion that it is a hybrid perhaps twice removed!! The obvious deduction when looking at it, is that this is *E. paucidentatus*. But there are two inconsistencies that hang a question mark over this. The first being the twist at the end of the leaves which can sometimes be almost absent, and, at other times most pronounced. The other inconsistency being the superabundant tomentum which forms on a coning head, becoming even heavier than shown on the photograph (Figure 1), covering the whole head. Cones appear to be similar to *E. paucidentatus*. As *E. heenanii* occur in the vicinity, it is possible that a grandparent (F2) or great-grandparent (F3) was one of these? especially when both the *E. paucidentatus* inconsistencies are common to *E. heenanii*.

Figure 1 Showing the excessive "wool" which is above normal for *E. paucidentatus*.

The caudex as can be seen (Colour Figure 24 on p. 20), divides into 3 parts. The first growth is approximately 1.4 m long to where it was cut off at full diameter. It is therefore impossible to estimate its age at that time. Girth is 1.1 m on this section and it is interesting to note that I have measured this species with similar girth but up to 6 m in length! There is no clue as to what caused the break but, as it seems clean it looks as if it was done by a sharp instrument such as a saw. Estimating the remaining growth at 300–400 years the question arises: "Were there any saws in this part of the world at that time? and for what purpose? If for food (broodboom) why leave a good chunk behind?" The mystery deepens. The second section of the caudex is more curved. It is 1.5 m long and circumference drops to 0.9 m. The last or top section is the growth "in captivity". I do not use the word "cultivation", as, apart from careful planting and periodic removal of weeds around the base this cycad has been left entirely "to do its own thing"! However, in this 30 years, growth has been exceptional with another 0.7 m added to its length and girth has increased to 1.2 m. This is possibly due to better soils conditions. Rainfall is consistent with the original locality from whence it came.

Now comes the interesting part!! This plant has always suckered quite freely and I have removed 3 or 4 over the past few years. Recently 3 suckers have become predominant and this year have each produced a healthy male cone with large quantities of "wool" which can be seen in the photo (Figure 1). The main stem normally pushes 2–3 cones at a time.

I have often been asked the age of this plant but because of the amputated section, this is impossible. I have known of a cut section producing a "bud" in one year and others, remaining completely sound, but showing no "buds" for over 30 years. Also it is not known what the length of the amputated section was. I can only say "probably over 700 years old".

At this point I would like to commend my good friend, Loran Whitelock from Los Angeles, for his book "The Cycads", a masterpiece of diligent study, wonderful photography, and damn hard work. I did, however, take him to task at the cycad symposium in Thailand last year for referring to me as "….the late Denis Heenan, formerly of Pigg's Peak, Swaziland". He has now written in my book "Dear Dennis. Sorry for what I said in the acknowledgements – I specify that you are indeed ALIVE"!!! He is forgiven and I have thanked him for the magnificent cover photograph of *E. heenanii*. His wonderful book is a "must" for any botanist, cycad collector, or enthusiast.

LEAFLET TERMINOLOGY

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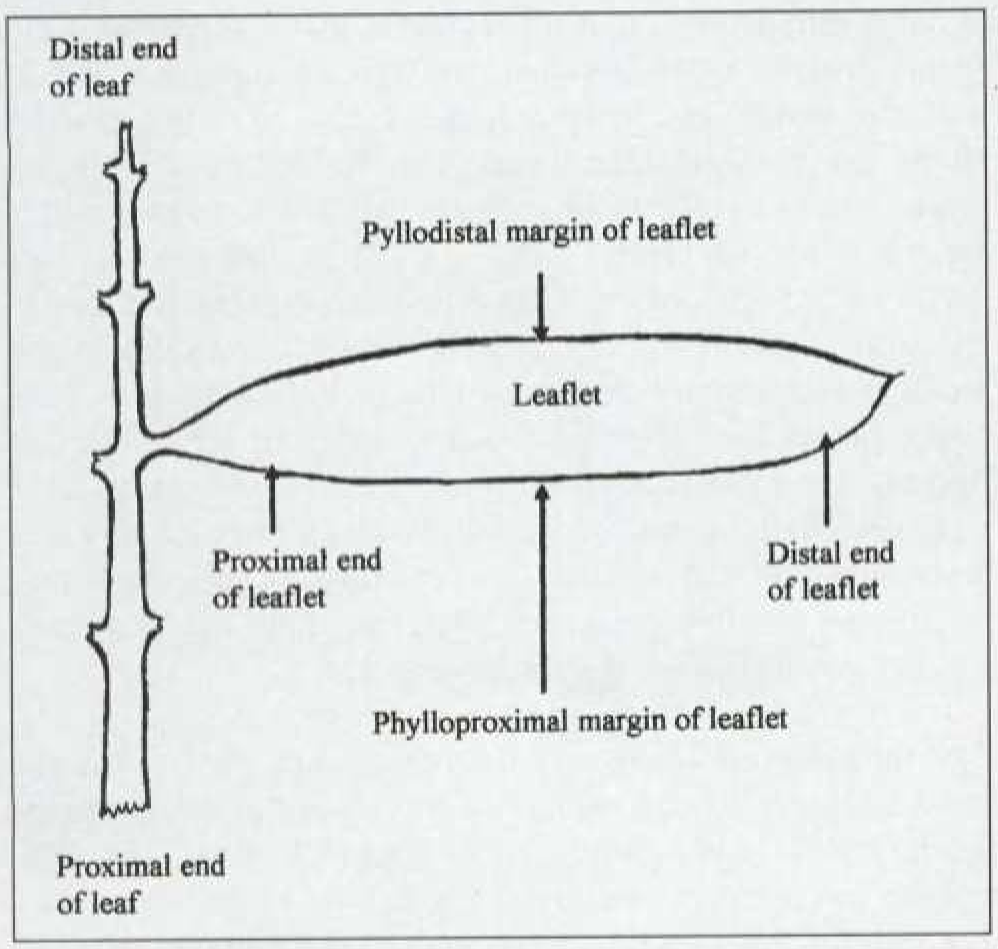

Because of a lack of suitable terms, authors usually distinguish between the two margins of a leaflet by calling them either the upper or distal margin and the lower or proximal margin. The use of "upper" and "lower" is confusing because the same margin can be the upper margin under one set of conditions and the lower margin under a different set of conditions or stages of leaf development. The use of "distal" and "proximal" is simply incorrect. The distal part of an organ is the part that is farthest away from the point at which the organ is attached to the remainder of the plant whilst the "proximal" part of an organ is the part of the organ closest to its point of attachment to the remainder of the plant (see Figure). The distal part of the leaflet therefore is its apical part whilst the proximal part of the leaflet is the basal part of the leaflet.

It is therefore clear that there is a definite need for terms that can be used to refer to the two margins of a leaflet. I would like to propose that the terms "phyllodistal" and "phylloproximal" be used for these margins. The **"phyllodistal"** margin (see Figure) being the leaflet margin that, in the untwisted leaflet, is directed towards the distal (apical) part of the leaf and the **"phylloproximal"** margin being the margin that, in the untwisted leaflet, is directed towards the proximal (basal) part of the leaf.

GROWTHS ON *ENCEPHALARTOS WOODII* CAUDEX

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Received 6 October 2003

Recently I had the privilege of visiting the Durban Botanical Gardens where I noticed that on the stems of some of the larger *Encephalartos woodii* specimens there are small nodules/growths growing on the caudex, approximately 1 to 1.5 m from the base of the specimen, appearing to be a new leaf (Colour Figure 25 on p. 20). On each of the two different specimens I could only find a singular growth on the whole caudex.

My question is will or could these growths develop into fully fledged "branches" or will they eventually just die off? I did, however, notice that most of the branching does occur at the top of the stem which in these cases were another 1 to 1.5 metres higher up (Figure 1).

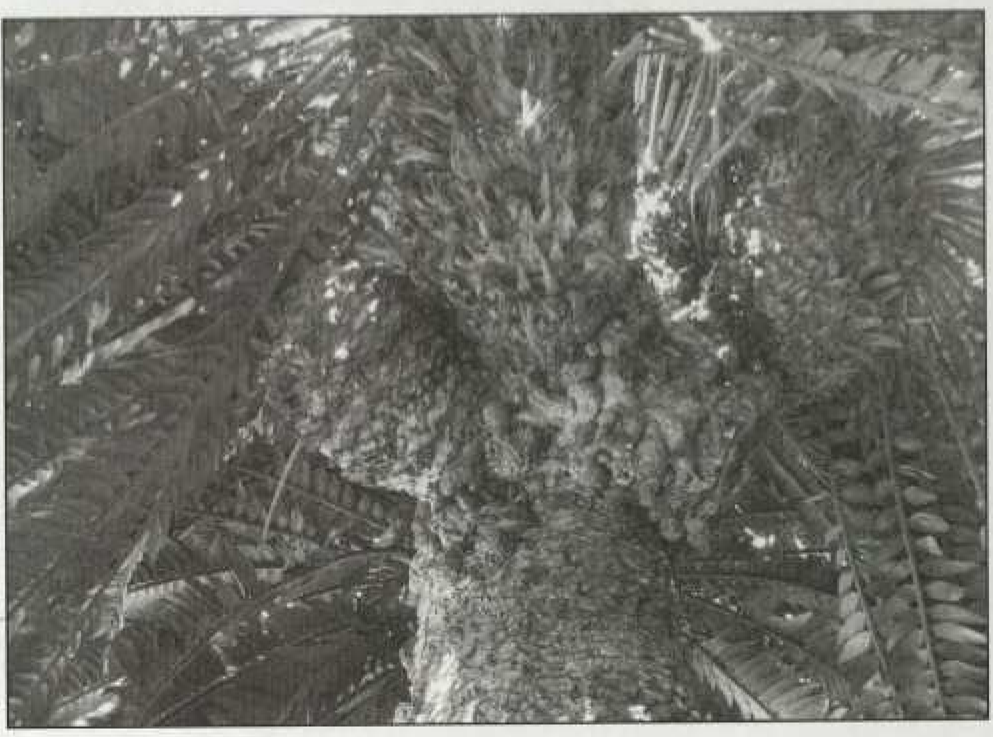

Figure 1 Branching of *Encephalartos woodii*.

ENCEPHALARTOS FEROX OCCURRING IN MOZAMBIQUE

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When people think of the area north of Xai-Xai in Mozambique, they mostly think of fishing and palm trees, but underneath the shrubs on the dunes (Colour Figure 26 on p. 25) grows one of the most interesting species of cycad namely *Encephalartos ferox*. Most people believe that cycads grow in soil that has more than enough nutrients for a plant to grow in. Not in all cases.

Figure 1 Plants at Chidenguele growing in close proximity to each other.

The *E. ferox* grows less than 100 m from the sea in dune and sand that is almost totally devoid of any nutrients, but yet reach stem heights of up to 70–80 cm (Colour Figure 27 on p. 25). The colony near Chidenguele has about 250 mature plants of both sexes growin in close proximity to each other (Figure 1). Active regeneration through seedlings is observed, but it seems as if only a few of them reach maturity.

What is interesting about this cycad is that it seems as if the location of the plant (shadow, full sun, etc.) plays a part in how the leaves and leaflets look. Plants growing in deep shade are a more dark green and the leaves are longer, while leaves of plants in full sun are much shorter and a lighter shade of green. The leaflets in the colony vary greatly from each other. Some leaflets, especially those in the sun, are more curved and short, while the ones in the shade are longer and straighter (Colour Figure 28 on p. 25). Some plants have the traditional quantity of teeth that one normally associates with *E. ferox* while some plants have only one tooth on some leaflets. What I have also noted in some plants is that when a new leaf flush occurs the leaves emerge as an olive green and then later hard off to a more normal green (Colour Figure 29 on p 25).

The female cones also vary in colour. The dark red is the most common colour, orange is only found in a few plants, while yellow is very rare (Colour Figure 30 on p. 25). The colours aren't very specific to a habitat or location, as I have found a plant with a red female cone growing about 10 m from a plant with an orange female cone. It would be interesting to note in future if the male cones also display such a variation in colour.

The local population, especially east of Inhambane at Barra and Tofu, is growing more aware of the worth of the cycads. The plants are being sold at the roadside (Colour Figure 31 on p. 25), and you rarely see a lodge without there being an *E. ferox* growing in the garden. It is sad to see that colonies higher up the coast are being cleared to make way for new houses, and one can only hope that the people realize that they should protect the plants' habitat so that it can be saved for future generations.

THREE NEW PLANT SPECIES FOUND

Newsitem from "La Tribuna", Edition No. 2285, Honduras, 5 September 2003

Source : http://tribuna.icomstec.com/news/index.php?id=18428&mode=2

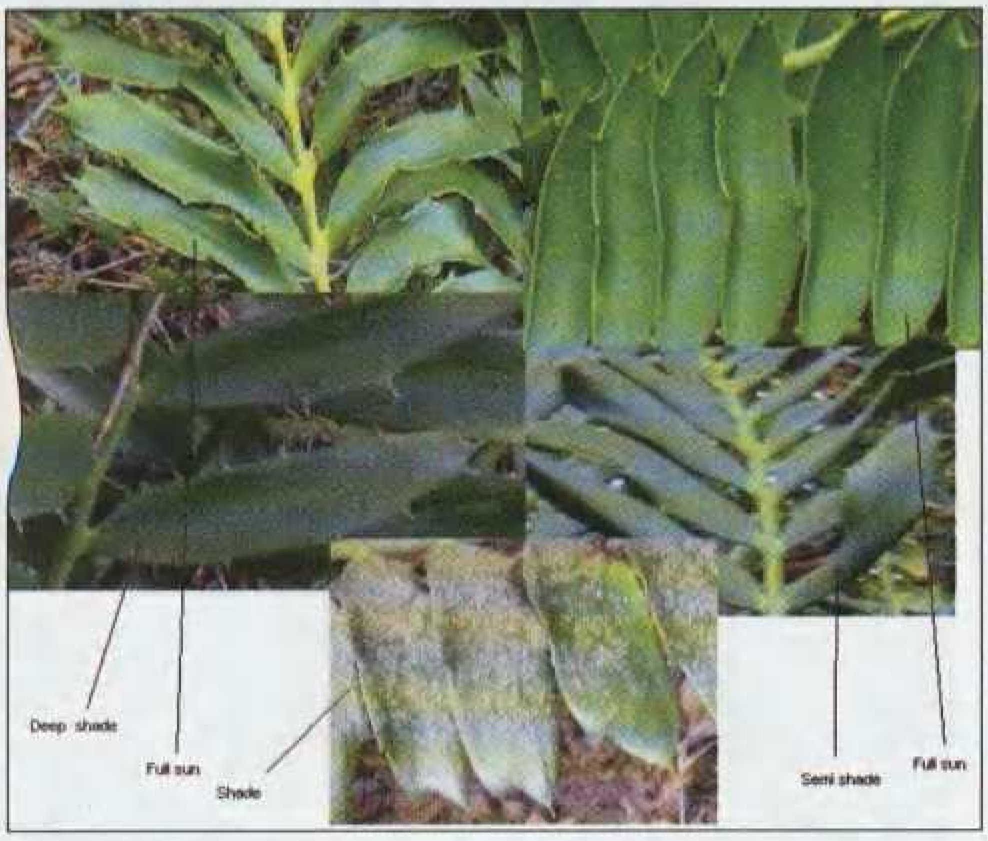
(*Translation from Spanish by Roy Osborne*)

Received 15 September 2003

An American scientific expedition, which recently explored the Olancho, Yoro, Atlántida and Cortés departments [provinces] in search of unusual plants known as cycads, has shown the existence of three species in danger of extinction, new to science and endemic to Honduras. The expedition took place from 9 July to 7 August this year under the direction of Montgomery Botanical Center, Miami, Florida, a botanical garden which specialises in the

Colour Figure 26 *Encephalartos ferox* growing on the dunes near Tofu. Photo: Diderik Nel.

Colour Figure 27 Example of a mature *E. ferox* with a stem of ± 80 cm. Photo: Diderik Nel.



Colour Figure 28 Variation in leaflets of different plants. Photo: Diderik Nel.

Colour Figure 29 The new leaf flush is olive-green but later hards off to green. Photo: Diderik Nel.

Colour Figure 30 Difference in *E. ferox* female cones. Photo: Diderik Nel.

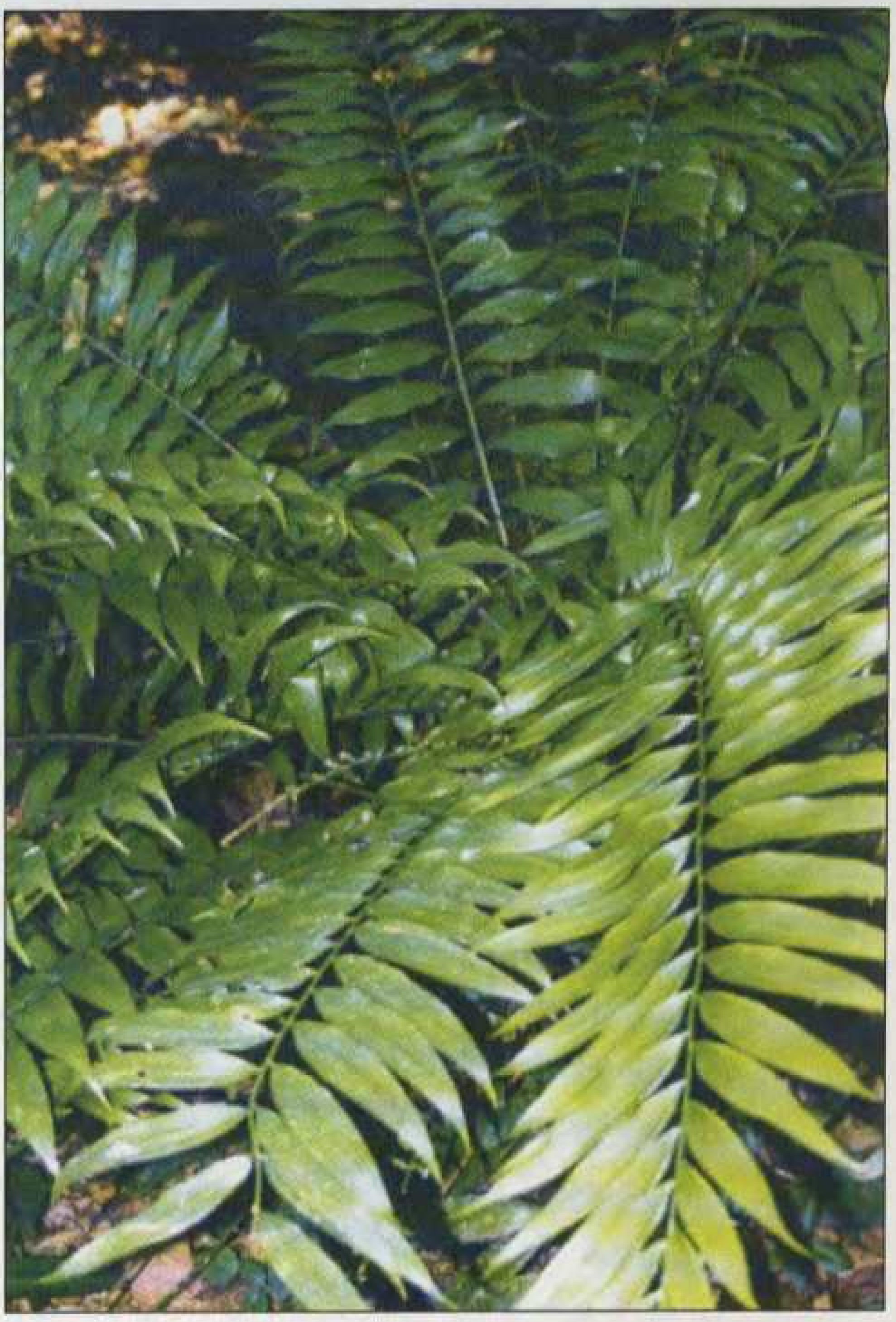
Colour Figure 31 *Encephalartos ferox* being sold at the roadside. Photo: Diderik Nel.

Colour Figure 32 Mr Roelf van Wyk and Lynette Minnaar amongst the cycads at Monte Casino. Photo: Derik Minnaar.

Colour Figure 34 Some members of the Cycad Society discussing the *Encephalartos latifrons* examples at the Monte Casino Gardens. Photo: Derik Minnaar.

Colour Figure 35 *Zamia* sp. in Honduras, with Loran Whitelock on the right. (See letters by Loran Whitelock and Jody Haynes elsewhere in this issue.)

Colour Figure 33 Some *Encephalartos heenanii* specimens on the left and the large 5 m snake-like *E. middelburgensis* at the back on the right. Photo: Derik Minnaar.



Colour Figure 36 *Zamia* sp. photographed in a garden in Honduras by Wessie van der Westhuizen of Stellenbosch. (This photo was printed in "*Encephalartos*" **74:** 44 of June 2003. See also letters by Loran Whitelock and Jody Haynes elsewhere in this issue.)

study and conservation of palms and cycads (Colour Figure 13 on p. 12).

Members of the expedition included technicians from the National Herbarium of the National Autonomous University of Honduras (UNAH), the Department of Protected Areas and Wildlife (AFE-COHDEFOR) and the Honduras Institute for Tourism, the latter providing backing and logistical support as part of an initiative encouraging scientific visits to the country. Honduras represents a special interest to MBC, both in the description of the species, and in their traditional use in rural villages.

Dr Mark Bonta, of Delta State University, is documenting the cultural history of the species *Dioon mejiae*, known in Olancho and Yoro as *teocinte*. *Teocinte* physically resembles a palm but produces a cone with seeds that are used to make *tortillas*, *tamales* and *atol*.

An important consequence of this expedition has been the identification of populations of three different cycads hitherto unknown to science, and the collection of specimen material to allow the official description and naming of these species. Another important factor has been the awareness of the cycads, and their conservation needs, to the organizations responsible for management of protected areas like the Pico Bonito National Park and the Lancetilla and El Merendón Reserves.

[*Editorial note* – Jody Haynes of MBC tells us that two of the new species are *Zamia* and one is a *Ceratozamia.*]

NEWS OF THE TRANSVAAL/GAUTENG REGIONAL BRANCH OF THE CYCAD SOCIETY OF SOUTH AFRICA

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The Transvaal/Gauteng branch of the Cycad Society visited the famous Monte Casino gardens on 6 September 2003. The casino is located comfortably in Randburg (Johannesburg), and made quite a name with the unique indoor city. The magnificent collection of cycads (Front Cover and Colour Figures 32–34 on p. 26) belonged to the well-known Jan van Vuuren, who sold it to the casino some four years ago.

Derik welcomed the group and started the visit with an informal stroll through the garden. The Transvaal branch of the Cycad Society sponsored the entrance fee. The few hectare gardens are combined with many water features with exotic birds and reptiles. There is also an amphitheatre where bird shows are presented. The cycads dominated the display. Many species were planted in groups along a steep slope. Amongst the group of "Transvaal blue" cycads, an ancient five metre *E. middelburgensis* can be seen (Colour Figure 33 on p. 26). The garden is definitely worth a visit on a lazy Sunday.

FLOOD DAMAGE TO CYCADS

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INTRODUCTION

Anyone who grows cycads in pots knows how sensitive these plants are to over watering. Waterlogged pots have undoubtedly caused the deaths of thousands of cycads in cultivation. It is thus generally understood among cycad growers that these plants are not very resistant to flooding. Very few careful observations, however, have been published on the effects of flooding on cycads. Harmon (1977, 1978) reported on potted plants flooded for over 24 hours due to hurricane in Louisiana. Because much of the soil had floated out of their pots, all these plants were repotted afterward. Emerging leaves went "limp and brown" after submergence and thin leaves like those of *Zamia fischeri* (prob. *Z. vasquezii*) suffered most. *Zamia furfuracea* leaves suffered least. All *Dioon, Zamia* and *Ceratozamia* eventually recovered, but no *Encephalartos* or *Macrozamia* survived.

I live in southeast Florida, where the moist subtropical climate is excellent for growing most cycads. The drawback with this area is that it is flat, with an elevation averaging only 3 metres above sea level. Southeast Florida was once part of the Everglades ecosystem and is still prone to flooding in the wet season. In the early 20th century, the U.S. Army Corp. of Engineers dug extensive canals to drain this part of Florida to make more land available for habitation, but during hurricanes and torrential rains these drainage canals may be overwhelmed and much of the land will revert back to swamp.

About half of the urban area in Miami-Dade County, where I live, is classified as being prone to one flood every 100 years. In other words, this means that every year there is a one percent chance of a flood. In October 1999 and again in October 2000 over 38 cm (15 inches) of rain fell in 24 hours in Miami and my area of the city suffered two such 100-year floods back to back. My property is located on the edge of a lake that was without drainage to a canal. The property flooded and sections remained flooded for 1–7 days (Colour Figure 37 on p. 33). Soil may have remained saturated for longer. Below I report on the effects of these floods on cycads planted in the ground.

MEASURING FLOOD EXPOSURE AND DAMAGE TO CYCAD PLANTS

Flood exposure can be categorized into three types, root flooding, stem flooding, and leaf flooding, in which all or a portion of these sections of the plant are immersed in water. A cycad may show high flood tolerance in one of these organs, but not another. Flood tolerance is easily measured in leaves – dead leaf tissue will turn brown within days and is easy to see as it occurs (Figure 1, Colour Figure 38 on p. 33). Damage to stems is much more difficult to assess. Often the stem apex dies and can be pulled out readily, but in most cases any stem lesions caused by flooding will be hard to detect, until months later, especially if it occurs beneath soil level. Root systems cannot be surveyed for damage unless the plant is partly or completely dug up. Dead and dying roots can be easily recognized by their brown colour and because they decay quickly upon death. Those plants which showed leaf flushes within 1–2 months after flood or showed normal leaf flushing next spring were considered relatively undamaged by their flood experience. Plants which showed weak or stunted leaf growth next spring, or skipped leaf growth altogether were considered to have suffered extensive stem/root damage.

Figure 1 The stem and lower leaves of this *Encephalartos ferox* specimen were submerged for two days; the lower leaves are brown. The plant continued normal growth next spring. Photo taken less than one month after flood.

The plants exposed to flood were mostly seedlings or young plants grown from seed and had been in the ground for five years or less. Most species involved were represented by only one to a few individuals and the growing conditions were not uniform: some were on mounds while others were in low spots. The soil is composed of fine sand with varying amounts of oolitic limestone and organic matter. Some of this organic matter is peat moss, which aids in aeration, but organic matter around some plants was composed largely of everglades muck, the main type of organic matter available locally. Because of small sample size and non-uniformity in plant size, elevation, and soil conditions the results of this flood cannot be viewed as the result of an experiment, but only as preliminary observations on flood tolerance in cycads. Extrapolation of these results to plants in different soil types and locations must be done with caution.

RESULTS

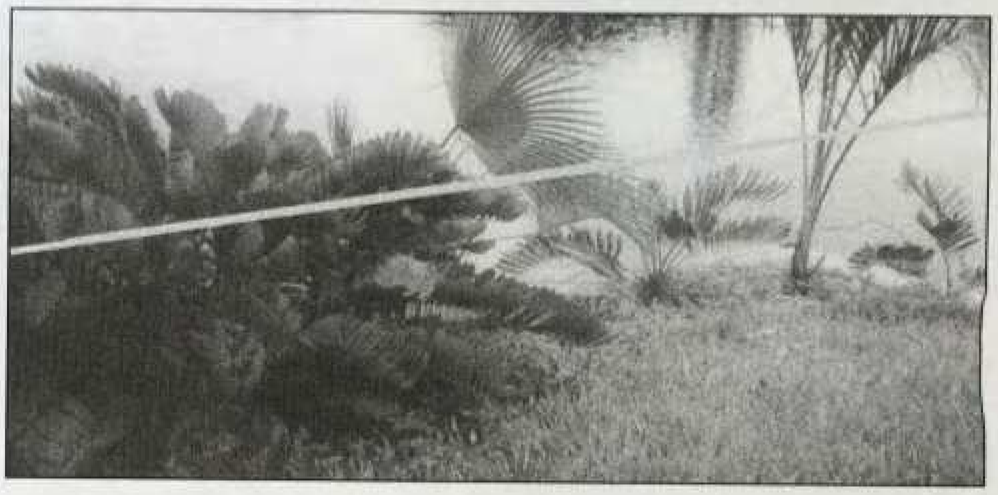

Figure 2 Two forms of *Zamia furfuracea* exposed to flood. The leaves of the coastal form (left) were undamaged after up to 5 days of submergence. The inland form (right) was defoliated and appeared to have suffered root damage, but eventually recovered. Line indicates the maximum height of the flood.

In general, leaves of cycads will begin to show damage after 24 hours of submergence. Newly emerging leaves and those not fully hardened are especially vulnerable. In some species the mature leaves are more tolerant and 2 days or more submergence is required before damage sets in. Damage is localized in leaf tissue that is submerged, however, partial submergence of the petiole may cause damage that results in the death of the entire leaf. *Zamia furfuracea* (wide leaflet, coastal form) displayed the greatest leaf flood tolerance of all species tested. Leaves of this species, even on new seedlings, that were submerged 5 days showed no sign of damage (Figure 2)! In general, roots and stems had greater flood tolerance than leaves. Surprisingly, days of flood and saturated soil had little effect on the roots and stems of some plants; *Encephalartos laurentianus*, a specimen of *E. bubalinus* (Colour Figure 40 on p. 33), and *Ceratozamia kuesteriana* flushed vigorous new leaves about 1 month after flood. After 4–5 months many plants continued their normal growth cycle, suggesting that no major damage had occurred to roots and stems. In most instances, it was clear that root systems had suffered at least minor damage. For instance, newly emerging leaves of *Zamia vasquezii,* where only petioles were submerged, but whose roots and stem were flooded, became wilted and remained so for long periods or stopped growing and died, indicating that absorptive areas of the roots, namely root hairs, had either died or were not functioning to take up water and nutrients. Some plants were dug up in the months after flood and in some cases it was clear that all roots had died even if a leaf remained green and alive (Colour Figure 39 on p. 33), while in others the stem and at least some roots remained alive. Stem damage was the most difficult to assess. Unless the stem meristem died, many months passed before indications of damage became apparent. Merisitem damage sometimes became apparent where the apex shrunk and the topmost leaves were pulled inward and together (Colour Figure 41 on p. 33). In the next growing season, if no leaves flushed this was also interpreted as a sign of stem damage. In one instance the sides of the stem began decaying months after the flood; the meristem, which escaped prolonged inundation remained intact (Colour Figure 42 on p. 33). In general, severe root and stem damage begins to set in after 2 days of flooding. Very few plants seem able to tolerate more than 4 days with roots and stems submerged. There are exceptions and these will be discussed below.

Stems that were actively flushing new leaves, especially those in early stages of flushing, were highly vulnerable to flood damage. For instance, two specimens of *Encephalartos bubalinus*, a relatively flood resistant species, which were flooded as they were beginning to push new leaves appear to have suffered meristem injury. Production of new leaves next spring was either delayed, stunted, or both. Unusually vigorous specimens were more prone to death and damage due to flood than less vigorous specimens. Inactive plants appear to be less prone to flood injury. For instance, a plant of *E. aemulans*, with a 5 cm wide stem, that was carrying no leaves (all leaves had been loss due to wind and snail damage) and was dormant, was immersed for 7 days. I removed this plant from the ground, slicing through the taproot accidentally with a shovel. Too my surprise, not only did it survive, but it flushed two new leaves within 2 months of replanting! It appears that actively growing plants require oxygen to fuel the metabolism of root and meristem cells which are dividing and transporting nutrients. When deprived of oxygen during immersion in floods these cells die readily. Cells in a dormant plant, in contrast, are not actively metabolizing and require much less oxygen. They appear to tolerate flooding much longer.

Seedling plants, with their small stems, appear less able to recover from flood damage than larger, better established plants. Small plants deprived of leaves may not have enough food reserves to survive until next spring or to replace roots and leaves destroyed by flood. For example, a seedling of *Encephalartos cerinus*, with a stem width of less than 3 cm, produced a small leaf after losing its leaves in two days of submergence. After several months it eventually died, probably because it was unable to regenerate enough roots. A larger plant, in contrast, recovered without problems.

Because of these variations in plant size, stage in growth cycle, growing condition, etc., rather than list flood results for each individual plant, I have attempted to categorized flood tolerance for each species that was tested as high, moderate, and low based on overall observations and note exceptional tolerance in particular species (Table 1).

Table 1: Species are ranked in the order of their tolerance for flooding: A) those most resistant to flood, B) those with moderate flood resistance, C) those with low flood resistance, and D) those with uncertain flood resistance. Size and number of plants tested is indicated in the right hand column: S = seedling (stem width <3cm), I = immature plant, A = adult plant

A) High Flood Tolerance (3 days or greater with only minor damage)	
Species	# plants observed
Zamia furfuracea (coastal form; 5 days stem submergence)	20S, 1A
Z. variegata	4I
Z. roezlii	1I
Z. angustifolia	4A
Cycas micholitzii (C. Vietnam)	12A
C. tropophylla (4 days stem submergence)	2I
Encephalartos laurentianus	1I
Macrozamia lucida (5 days submergence- leaves die, but recovers twice)	1S
Z. vasquezii	11I
Z. lindenii (Ecuador)	2I
Z. verschaffeltii (= *Z. splendens*)	3I, 1A
Z. pumila (Dominican Republic)	6A
Dioon spinulosum	2A
D. rzedowskii	1I
Ceratozamia microstrobila	2I
*E. gratus**	*
E. gratus x *hildebrandtii* hybrid	1A
E. hildebrandtii	1A
E. ferox	2A

- based on nursery trials at Nong Nooch Tropical Garden and in landscapes in Bangkok, Thailand (Kampon Tansacha personal communication)

B) Moderate Flood Tolerance (2-3 days with minor or moderate damage)

Species	# plants observed
Ceratozamia robusta (Belize)	1A
Ceratozamia kuesteriana	1A
C. latifolia (?origin and species uncertain)	4I
Dioon holmgrenii	1S
Cycas guizhouensis (locality unknown)	3I
Stangeria eriopus	5S, 3I
Encephalartos lebomboensis (Swaziland)	1I
E. bubalinus	4I
Ceratozamia hildae	9A
Cycas diannanensis	2I
Cycas panzhihuaensis	2I
Cycas pectinata (Kanchanaburi)	2I
Lepidozamia hopei	2I
L. perroffskyana	1I
Macrozamia miquelii (5 days submerged)	1S
E. lehmanii x *horridus* (natural hybrid)	6S
E. cerinus	1S, 1I
E. villosus (Kranskloof Gorge)	3I
Zamia standleyi	3I
Z. floridana (Miami)	22A
Z. umbrosa (NE Florida)	6I
Z. furfuracea (inland form; 5 days stem submergence – severe root and leaf damage, but recover)	3A
Z. furfuracea (inland form) x *spartea* hybrid	1A

C) Low Flood Tolerance (less than 3 days – with major damage or death)

Species	Flood exposure	# plants observed
Bowenia spectabilis	2 days stem submergence - fatal	3S
Ceratozamia sabatoi	1 day stem submergence – fatal or moderate damage	2S
Cycas hainanensis (Baishui mtn.)	3 days stem submergence – plant declining 3 yrs latter	1A
C. pruinosa	1 day stem submergence -fatal	1S
C. tanqingii	2 days stem submergence -fatal	1A
C. dolichophylla	2 days stem submergence -fatal	1I
Dioon "Jacala"	2 days stem submergence – no leaf growth for 2 years	1I
D. edule var. *angustifolum*	2 days stem submergence - severe root damage, no leaf growth for 1 year	1A
D. edule var. *edule* (Chavarillo)	2 days stem submergence – no leaf growth for 2 years	2I
D. mejiae	2 days stem submergence – no growth for 3 years	1I
D. merolae	2 days stem submergence - fatal	1I
Encephalartos arenarius (blue form)	1 day of stem submergence during new leaf flush -fatal	1I
E. horridus	2 days stem submergence - recovers, 3 days - fatal	1S, 1I
Macrozamia glaucophylla	3 days stem submergence - fatal	3S
M. macdonnellii	3 days stem submergence – fatal	1S

D) Flood Tolerance uncertain: data reveals some upper and lower tolerances for flooding

Species	Flood exposure	# plants observed
Bowenia serrulata	4 days stem submergence - fatal	5S
Ceratozamia miqueliana	1 day stem submergence - no damage	2I
C. "El Mirador"	1 day stem submergence - no damage	2I
C. "Molongo -wide leaf redback"	1 day stem submergence - no damage	2I
Cycas macrocarpa var. "Brevidens"	7 days stem submergence - fatal	1I
C. pectinata (Fang, Thailand)	5 days stem submergence - fatal	1I
E. dolomiticus	1 day stem submergence - no damage	1I
E. lehmannii	1 day stem submergence - no damage	1S

E. mackenziei	1 day stem submergence - no damage	1S
E. natalensis	4 days stem submergence - fatal	1I
E. transvenosus	1 day stem submergence - no damage	1I
E. turneri	1 day stem submergence - no damage	1S
Macrozamia communis	5 days stem submergence - fatal	1S
M. fearnsidei	5 days stem submergence - fatal	1S

TREATMENT OF PLANTS AFTER FLOOD

After damage to roots, a plant with intact leaves is prone to dehydration. Hot sun or drying winds will put severe stress on such a plant trying to recover. Proper shading and protection from wind is essential. If you suspect damage to roots, do not cut off all leaves – I did this to one specimen of *Cycas diannanensis* and the stem died (fortunately side suckers later formed).

Warmth and adequate moisture is necessary to encourage growth of new roots. The floods which struck my garden occurred in the fall and unfortunately cool weather that ensued in the coming months prevented adequate recovery of many injured plants and probably led to their deaths. In such a case it may be best to remove the plant from the ground and place it in a warm, moist, and shaded sand bed; treatment with fungicides and rooting hormones should also help. After the second flood I tested a growth stimulant, "Superthrive" (see Tang 2001), on some flood damaged plants in the ground. This product contains Vitamin B12 and other plant hormones. This was mixed with water and poured into the saturated soil around the roots about 1 week after waters receded. The reaction to this treatment was mixed and therefore the effect was unclear and hard to interpret. Some treated plants died, some flushed new leaves, and some recovered by next growing season. Since there were so few plants treated and no controls (similar plants left untreated), there was no clear way to determine if this grow stimulant had a positive, neutral, or negative impact.

PREDICTING FLOOD RESISTANCE

Many of the species listed above as having high flood tolerance are native to habitats that are exposed to periodic flooding. For instance, *Zamia roezlii* grows in the upper zones of mangrove swamps (Norstog 1976), *Z. variegata* is found naturally in swampy conditions in Guatemala (M. Perry pers. comm..). In my garden emerging leaves of *Z. variegata* continued to grow and expand after the stem was submerged – it was the only species observed to do so. Others are streamside species. Streams will rise after heavy rains, even if rains occur in mountains far away, and may stay flooded for days. It is interesting to note that *Macrozamia lucida* is often found alongside streams (Osborne 1998). The one seedling that I have was submerged for 5 days in two successive floods. Although the leaves were killed, I was amazed that this small plant was able to recover twice. Other species that are found in wet conditions by streams, however, such as *Cycas hainanensis* (Tang 1998), are not so resistant. Other resistant species, such as *Encephalartos laurentianus*, *Z. lindenii*, and *Z. verschafeltii* are rainforest species, in which torrential rain and local flooding may be common. A third habitat that is prone to flooding is coastlines in hurricane zones. Tidal surges associated with hurricanes may reach over 4 metres and extend for hundreds of metres inland. The duration of these tidal surges depend on the speed of a hurricane and the lay of the land. A slow moving hurricane in a flat area may cause floods lasting days. It is interesting that the cycad with perhaps the greatest flood tolerance, *Z. furfuracea*, is a coastal species. Plants from an inland population of this species were much less tolerant of flooding.

Several cycads tested are fire adapted species. For example, *Stangeria eriopus* is an inhabitant of fire-prone savannah and the Miami form of *Zamia floridana* lives in pine woodlands that burn about once every seven years. These species were defoliated when submerged and suffered severe stem/root damage as a result of flooding, but showed remarkable ability to recover, much as plants in fire-prone areas can recover from severe fire wounds. One specimen of *Stangeria* produced leaves 1½ years after flood, long after I had given it up for dead.

Some highly flood tolerant species do not, at first glance, appear to occur in a flood habitat. For instance, *Encephalartos gratus* is an inland species occurring on granite mountains. It is hard to explain or predict why such a species would have any flood tolerance at all. If we take a more in-depth look at its habitat, however, we find that many plants located on the plains below the mountain are often subjected to summer flooding due to runoff from the mountain itself (Osborne 1991). These plants at the mountain base are probably the source for most plants in cultivation. Plants from higher up the mountain may not have such high flood tolerance. Another example is *Cycas tropophylla*, a dweller on seacliffs. Instead of looking at current topography or climate, perhaps we should look at the topography or climate over hundreds of thousands of years. In the geologic past, ocean levels were tens of metres higher than now, and the seacliff habitats we see now may have been flood prone. Although no floods have been recorded in any human records, devastating floods might occur once every 1,000 years in a particular location and the cycad populations we see in such habitats may be the survivors of these rare events and carry genes that allow them to survive floods. The reverse is also true, that cycads may be absent from otherwise suitable habitat because of rare flood events that are not apparent to humans.

PREVENTING FLOOD DAMAGE

If you are in an area where flooding is possible or even if it is only a rare occurrence (as in my case!) you should make preparation to minimize flood damage. If a rare flood occurs, despite 50 years without floods, it could destroy a lifetime of work in your cycad garden. In a flood every centimetre of elevation is important. Depending on how quickly water level recedes, each centimetre may represent many hours of exposure to flood. In my garden, a plant on a mound was flooded, on average, for less than half the time of a plant in a depression. Water drainage in my neighbourhood depended on mechanical pumps. When water receded far enough for lawns to be exposed, pumping stopped. Unfortunately, some plants in low spots remained submerged for days afterward and died while others just a few centimetres higher survived.

After two successive floods I lobbied the mayor and local council members of my city for flood relief. A storm drainage system connected to the nearby canal was installed. While this will not eliminate torrential downpours it will allow rapid drainage of water previously impounded by the neighborhood lake. Rapid drainage means the duration of flooding is shortened; it is the duration of flooding that causes damage to cycads. Most cycads will be unharmed by floods lasting less than a day. In response to a public outcry in the county at large, enormous pumps have been installed along the county's major drainage canals to remove water quickly. These improvements may have solved the flood threat in my garden. The solution to flood problems may not be horti-cultural, but political, at city hall or in the county government.

ACKNOWLEDGEMENTS

I thank Michael Perry for reviewing a draft of this paper and for sharing his extensive experience with cycad horticulture.

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ENCEPHALARTOS LEBOMBOENSIS (MANANGA VARIANT) – RELATION TO *E. SENTICOSUS*

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My recent visit to Swaziland once again afforded me the opportunity to have a close look at two cycad species in their natural habitat namely *E. senticosus* and *E. lebomboensis* (Mananga population).

While inspecting plants growing on the Lebombo mountains (*E. senticosus*), I compared my observations with the information given in "Focus on *E. senticosus*" in *Encephalartos* **63**, September 2000. The result of this comparison supports the view by Piet Vorster that the specimen originally described by Inez Verdoorn as *E. lebomboensis*, most likely did not come from that area. I nevertheless find it sad that the plants found on the Lebombo mountains ended up being called *E. senticosus* instead of *E. lebomboensis* as originally named. I realize that the rules of taxonomy must have been followed when naming the new species, but does it really make common sense?.

My outing also took me to the top of the Mananga mountain for the first time, where a variant population of *E. lebomboensis* is found. I was very excited to find most of the plants in cone (Colour Figures 44, 45 on p. 34). Mananga is not a huge mountain range as I expected, but rather a single fairly small mountain although it is quite high. This habitat is truly a beautiful site with many large plants (Colour Figure 43 on p. 34). I came to the conclusion that this mountain habitat differed from the Lebombo mountain habitat in many aspects especially as far as plant species, growth and climate is concerned. The cycads growing here very closely resembles *E. senticosus* except for a slightly more defined leaflet arrangement along the rachis, perhaps a smaller number of prickles on the petiole and then of course the cone differences.

Although only the opinion of an amateur, I personally would have grouped the Mananga cycads as a subspecies (or variant) of *E. senticosus* and not as a subspecies (or variant) of *E. lebomboensis.* My reasoning behind this is because of the close resemblance (plant structure) to *E.*

Colour Figure 37 2000 flood in the backyard of my Miami home. Water was almost knee deep in most places. The plant in the centre is a *Dioon spinulosum* with a ripening female cone. Three days of partial submergence did not harm cone or seed development. Photo: Willie Tang.

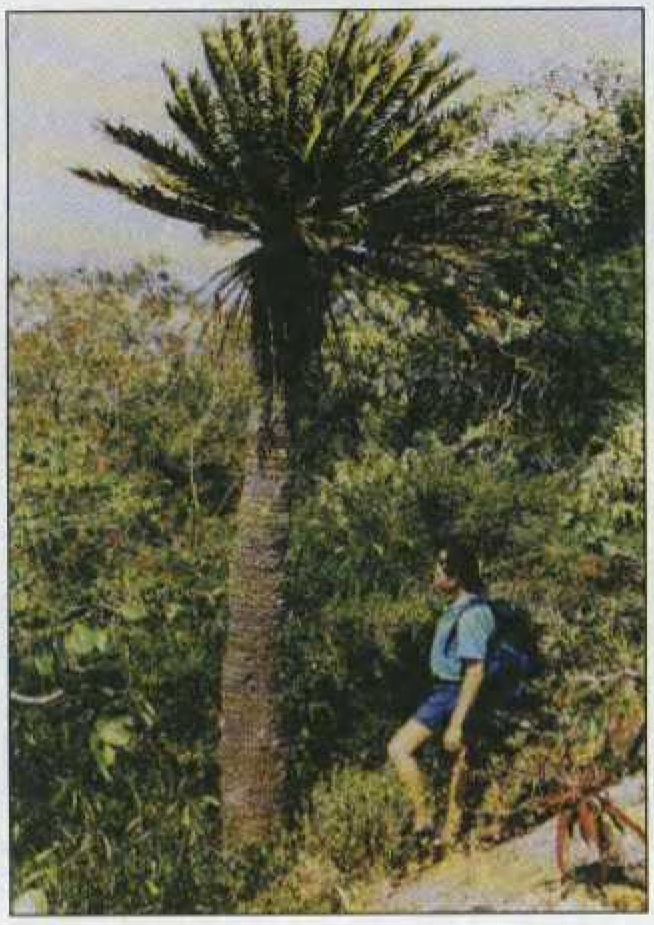
Colour Figure 38 Petioles of *Encephalartos lebomboensis* "Piet Retief" showning signs of browing after 1½ days of flood. Photo taken 1 month after flood. Photo: Willie Tang.

Colour Figure 39 Young stem of *Lepidozamia peroffskyana* sending out new roots months after 5 days of submergence. The stem eventually died, presumably from lesions that did not fully heal. Photo: Willie Tang.

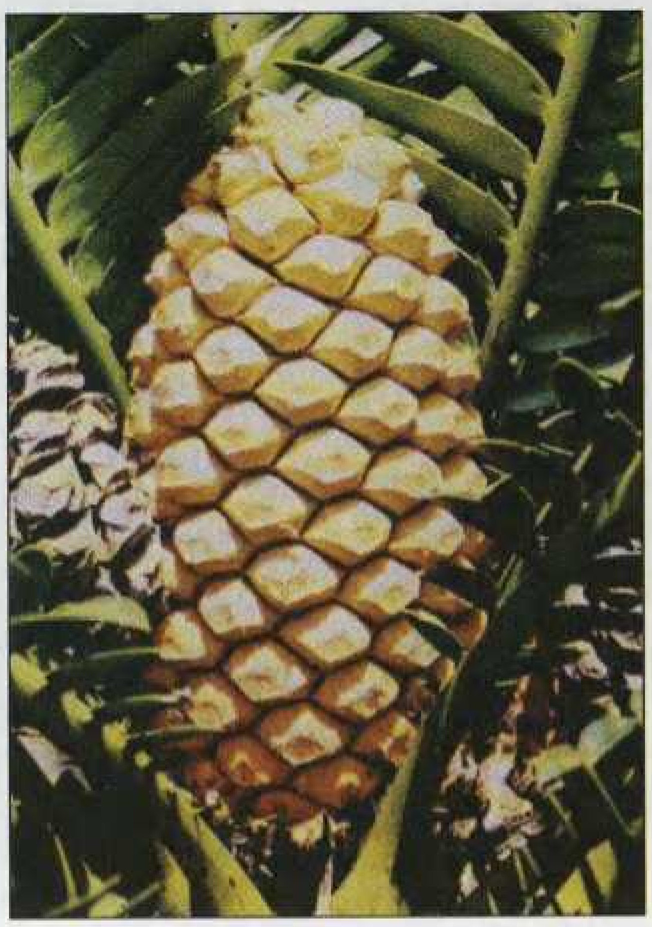
Colour Figure 40 *Encephalartos bubalinus* flushing a new set of leaves one month after the second flood. Photo: Willie Tang.

Colour Figure 42 This *Cycas tanqingii* stem was exposed to flood for 2 days. Several months after flooding, the outer layer of stem tissue is decaying. Roots appeared uninjured when the plant was dug up. Photo: Willie Tang.

Left: Colour Figure 41 *Encephalartos bubalinus* with leaves at three stages of recovery: 1) large leaves that matured before flood - pulled together months after the flood when the meristem died and shrunk, 2) small shrivelled leaves formed two years after the flood, and 3) strong healthy leaves are emerging three years after the flood. Photo: Willie Tang.



Colour Figure 43 Allen Tate admiring a very tall *Encephalartos lebomboensis* (Mananga). Photo: Morné Ferreira.

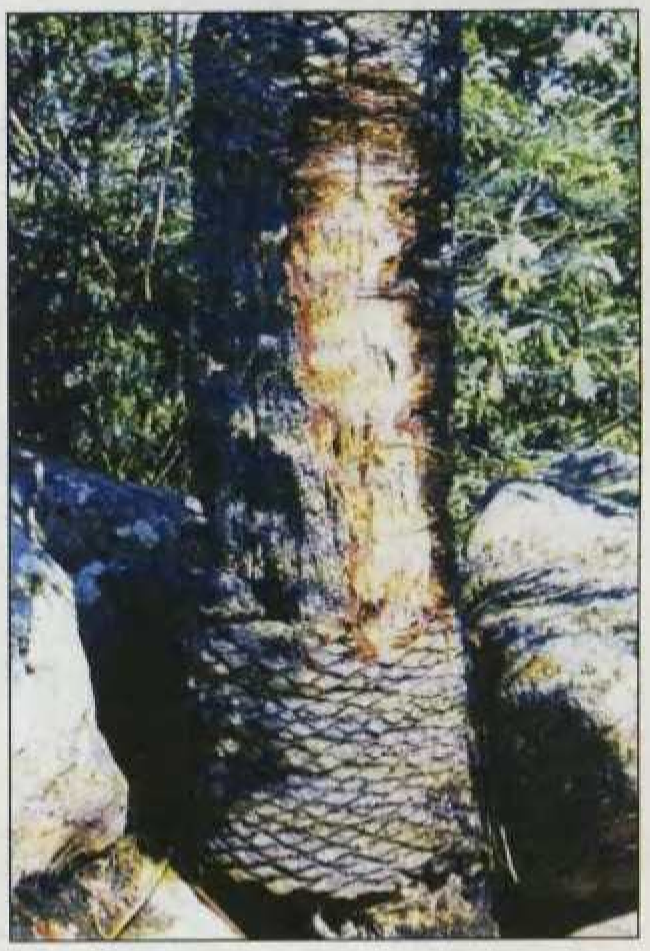


Colour Figure 44 Male cone of *E. lebomboensis* (Mananga), note the leaflets which closely resemble *E. senticosus*. Photo: Morné Ferreira.

Colour Figure 45 Female cone of *E. lebomboensis* (Mananga). Photo: Morné Ferreira.

Colour Figure 46 Orchid (*Polystachia* sp.) with ferns on *E. lebomboensis* (Mananga). Photo: Morné Ferreira.

Colour Figure 47 Serious Muthi damage to an *E. lebomboensis* (Mananga) stem. The stem has been cut more than halfway through. Photo: Morné Ferreira.



Colour Figure 48 Large fresh Muthi scar made to an *E. lebomboensis* (Mananga) stem. Photo: Morné Ferreira.

senticosus and its close proximity to the *E. senticosus* habitat (within 20km). The typical species *E. lebomboensis* (Piet Retiefii) grows probably more than a 100 km from its Mananga variant. Did cone similarities weigh heavier in this instance than plant structure similarities and proximity? (Although this was not the case in differentiating *E. villosus* and *E. aplanatus* where plant structure seems to have weighed heavier). Perhaps a study and comparison of pollinating insects from the Lebombo, Mananga and Piet Retief habitats could reveal some very interesting facts as well.

As a matter of interest I share with you my observations regarding the climatic conditions and plant growth at the Lebombo and Mananga habitats (although only 15-20 km apart). Mananga has a more frequent mist cover than the Lebombo habitat as well as a seasonally wetter and cooler climate. At Mananga ferns, orchids, moss and lichens grow on most of the cycad trunks but you seldom, if ever, find this at the Lebombo habitat (Colour Figure 46 on p. 34). *Agapanthus* sp., Cape honeysuckle (*Tecomaria capensis*), *Littonia modesta* is abundant at Mananga yet I did not see any of these at the Lebombo habitats. Mananga has *Aloe arborescens* whereas the Lebombo habitat has *Aloe marlothii* and a very lovely spotted variant of *Huernia zebrina*.

I think it may be very possible that the two mountains were connected in the distant past. This poses a few interesting questions regarding the evolutionary adaptation by plants to different climatic conditions. Would a windy wetter environment change the appearance of a cone? Would pollinating insects adapt themselves to different environments?

On another note, there is a serious degree of Muthi-harvesting evident at Mananga. I noticed at least two large plants, which seems to have rotted and fallen over perhaps as a result of such harvesting. But on the other hand I saw many large plants that has Muthi scars, which were probably made over many years (Colour Figures 47, 48 on p. 34). I wonder if any study has been made to determine the effect of such harvesting on populations.

"CYCAD HOTEL": A MODEL FOR UNDERSTANDING INSECT POLLINATION IN CYCADS

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INTRODUCTION

Twenty years ago it was widely believed that all cycads were wind pollinated. Field and laboratory studies since then have drastically altered our understanding of pollination in cycads. It is now generally believed that cycads are insect pollinated (Norstog and Nicholls 1997, Tang 1999, 2003). Presently there is a need for a unifying concept in this field. Observations have been made on different species of cycad and these are like pieces of a jigsaw puzzle. What is needed is a synthesis to bring together these various observations to produce one clear picture. A unifying theme will allow us to look past individual differences in cycad species and pollinating insects so that we may view the fundamentals of how insect pollination works in cycads and how it may have evolved. A successfully pieced together picture will point researchers in the most fruitful directions for future research and make apparent what the next important questions in cycad pollination are that need to be answered.

One of the most effective approaches to understanding a poorly known phenomenon, like insect pollination in cycads, is to compare it with an analogy that is familiar and easily grasped – if the analogy matches, the phenomenon then becomes clear to us.

"CYCAD HOTEL"

Before I begin this analogy I'd like to point out a delightful photograph by Bryan Laughland published in "*Encephalartos*" in 1992 of the "Zamia Motel" in Queensland, Australia (Figure. 1). Hotels are very useful from both the point of view of travellers, who need a place to stay, and proprietors, who operate hotels to make a profit. Is the hotel concept useful in analyzing the function of cycad cones? Can cycad cones be viewed as hotels for travelling insects? Below I elaborate on this idea that I call the "Cycad Hotel" analogy. In the paragraphs that follow I will compare cycad cones to human hotels– that is to say I will compare the activities of guests in human hotels to the activities of insect visitors in cycad cones to see how similar they are. I then examine the function of "cycad hotels" and see how well they match the function and purpose of human hotels. In doing so I will make a comparison between the economics of operating a human hotel with the economy of nature - that is the economics that cycad cones are exposed to, the costs vs. benefits over evolutionary time.

Figure 1 Photo of the Zamia Motel in Queensland, Australia published by Bryan Laughland in 1992.

Insect Activities in Cycad Cones

What do human visitors do at hotels? Several things come to mind: 1) Visitors go there to seek shelter and to rest – it is a warm, safe place to escape the cold, rain, and other hazards and to recuperate until the next day's travel; 2) Hotels are usually good places to get a meal; 3) Let's face it, hotels are common places for sexual encounters. When observing insects on cycad cones in the wild, a common activity for most of the day is to remain still and hide on or between the cone scales – this can be interpreted as "resting". Another common insect activity on cycad cones is feeding. Both larvae and adult insects on cones have been demonstrated either to eat tissue from cone scales or axes, pollen (if it is a male cone), or ovules or ovule exudates (if it is a female cone) (Norstog et al. 1992, Donaldson 1997, Mound and Terry 2001, Terry 2001, Terry *et al.* in press). This would indicate that for much of the time insect visitors, such as beetles and thrips, use the cone as a resting place – a place where they do not have to expend valuable energy trying to escape predators, as well as an easy place to get a nutritious meal. These observations match well with the idea that cones are functioning like a hotel with a restaurant. Cycad insects are often observed mating on cones (Tang 1987a, Norstog and Fawcett 1989, Hall 2001, Terry 2001). This happens when the cones are at the pollination stage of development and usually in the late afternoon or early evening. Based on observations on cones of *Zamia pumila*, Tang (1987a) has identified the cycad cone as a focal point for a particular type of mating behaviour of pollinating beetles, known as "resource defense polygyny" (Thornhill and Alcock 1982). This is a mating system commonly seen among insects and vertebrates in which animals use a congregation point to mate. The female insects flock to the cone because it is their nesting site, where they lay their eggs and where their young develop. Males gather in large numbers at the cone in order to take advantage of the abundance of females; it is favourable place to display themselves to potential mates, thus enabling them to complete the reproductive process. In this concept the cone functions much like a social gathering place, like the dance hall or hotel bar where humans like to gather to find mates. When observing beetles on cycad cones you can see the males jostling and pushing each other off the females as they attempt to mate. Often the bigger males prevail over the smaller ones. This is not unlike the bully on the beach who beats up on the skinny guy and gets the girl. There is one major difference between cycad "hotels" and human hotels, however, after mating cycad insects will lay their eggs in the cones and the young will develop in them. This is not something that is normally done at most human hotels.

The Function and Purpose of Cycad Hotels

Why do human beings start and operate hotels? A hotel owner invests resources into building and operating a hotel to make a profit. What kind of profit are cycad hotels engaged in? In nature, survival and reproduction are the currencies of profit. Cycad cones are clearly constructed by cycads to reproduce. Cycad "hotels" attract guests that help the plant send or receive pollen so they can make seeds. As any hotel owner knows, there are preferred guests, those that pay, and bad customers that sleep and eat there but don't pay their bills. Cycads must face the same problem in their cones. They produce cones that are safe places to hide and are a good source of food to attract their preferred guests, insects that are very efficient at carrying pollen from male "hotels" to female cycad "hotels". However, wherever you have food available, uninvited guests will come. Riffraff from all over the neighbourhood will be attracted. These insects will take up a large portion of the space and eat the food in the cone, without providing pollination services.

What is a cycad to do about riffraff? A cycad that can't control unwanted guests to its cones will not reproduce well. In time, as the lineage fails to reproduce, it will become extinct. The cycad solution to this problem, presented below, demonstrates the amazing adaptability of cycads.

Advertising for preferred customers: Most hotels advertise to attract their preferred customers, whether they are business travellers or ladies of the night and their clients. Hotels use billboards and neon lights. If the hotel analogy is accurate what do cycad cones use to attract their preferred customers? What is the cycad equivalent of neon lights? The answer appears to be heat and odours. Extensive samples from 9 cycad genera indicate that heat production is widespread in the male cones of cycads and is present in female cones as well as (Tang 1987b). Heat production is cyclic, lasting many days, and follows a daily pattern which is characteristic for each species. In most species cone temperatures begin to rise in the late afternoon and peak in the early evening, then cool down by late evening. These are time periods when beetles are most active. Other species, such as *Macrozamia lucida*, peak in the early afternoon shortly after noon time. Terry and coworkers (in press) have shown that this species is pollinated by another kind of insect, thrips. I have measured heat patterns in male cones of *Bowenia spectabilis* with two peaks in the day. Indeed, Irene Terry (2001) has found populations of *Macrozamia communis* that are pollinated by two different kinds of insects which respond to separate peaks in daily cone temperature. Why is heat important to insects? Insect activity is dependent on temperature. When the night is cool, as it often is in many cycad habitats, insects must raise their body temperatures to fly. Insect flight muscles are highly specialized and their temperatures need to be raised to approximately 40°C, before they can function. Heat from cones may thus be a direct gift of energy to the pollinators. The heating of the cone may coordinate the departure of resident insects at a particular time of day, perhaps launching them at an hour when pollination can be most effectively achieved. Indeed, Mound and Terry (2001) observed pollinating thrips leaving *Macrozamia macdonnellii* cones en mass near sundown, a time of day when cone heating usually occurs. Heat may not only be an attractant in itself, but appears to be used by cycad cones to tell the insect it is "check out time".

Heat also assists in vaporizing scents from cones. Both male and female cycad cones at the pollination phase release characteristics scents. The scents from different species can usually be distinguished by the human nose. Some, like those of *Zamia, Ceratozamia*, and *Bowenia* are sweet. Others like some *Encephalartos, Lepidozamia,* and *Macrozamia* are resiny. Still others such as *Dioon* and *Cycas* can be quite pungent and unpleasant. Chemical analyses indicate that some scent components, such as oil of wintergreen in cones of *Zamia pumila*, or linalool, a sweet smelling alcohol found in cones of *Z. furfuracea* and

E. altensteinii, are known to be attractants in orchid flowers pollinated by bees (Pellmyr *et al.* 1991, Tang 1993). Other scent components, like those found in *Cycas seemannii*, are not usually found in flowers and may function in attracting only particular insects and may be toxic to most others. Insects that specialize in eating, pollinating, and reproducing on cycad cones appear to use these scents to home in on the cones, enabling them to find these essential sites from great distances. This is essentially targeted advertisement that can bring in customers from far and wide.

Security: Specialized scents will exclude most insect visitors to a cycad cone, since only those insects equipped with the proper sense organs and brain connections can respond. However, besides pollinators, some insect pests will evolve to respond to scents. They will "learn", over evolutionary time, to associate cycad cone scents with food. So, some riffraff can "read" advertisement as well. Do cycads have another layer of security to keep them out? The answer appears to be yes. Cycad tissues are filled with toxins such as MAM-glycosides and BMAA. In male cones, such toxins appear to be concentrated into specialized cells called idioblasts (Vovides *et al.* 1991). Vovides and coworkers (1993) demonstrated that in one cycad, these idioblasts are safely eaten and stored by its pollinating beetle. Undoubtedly, most other visiting insects that come to take a bite, being unequipped to deal with these poisons, will fall ill or die. In female cones, cycad toxins appear to be dispersed throughout cone tissues, and no insect, pollinator or riffraff, can eat them. This appears to be so because female cones, unlike male ones, must survive the pollination phase to house the development of the seed. This added pressure on female cones to prevent wear and tear by their guests appears to have led to fundamental differences in male and female hotels. Male cones are generally disposable after pollination ends. Their cone tissues are often filled with nutritious starch, lipids and proteins (Tang *et al.* 1987) and they get chewed up and destroyed by their customers. Female cones, in contrast, are fairly Spartan in accommodations – they do not produce as much heat as male cones and are thus not as cozy a place to stay; their cone tissues have much lower content of starch, and except for a nutritious, but ephemeral, ovule exudate most visitors seem to be encouraged to leave quickly after providing pollination service, so that they do not "trash the joint".

How old are Cycad Hotels?

A recent fossil discovery in Antarctica suggests that insects have been feeding on and living in cycad cones since the Triassic period some 200 millions years ago (mya). Beetles, like cycads are an ancient group with origins in the Permian period some 300 mya. With hardened protective forewings covering most of their backs, beetles are well adapted to crawl into tight places like cycad cones. When did insect pollination and cycad hotels begin operating? The first insects living on cycad cones were likely herbivorous, feeding on cones without benefit to the cycad. Their foraging between cones, however, resulted in some pollination. In some habitats, like the dense, windless understorey of tropical forests, these haphazard beetle pollinations may have been more effective than wind. Those cycads with cones that were effective in attracting beetles would reproduce better. Beetles that were better able to find cycad cones also survived and reproduced better. A tighter symbiosis ensued and this host-customer relationship continues to this day.

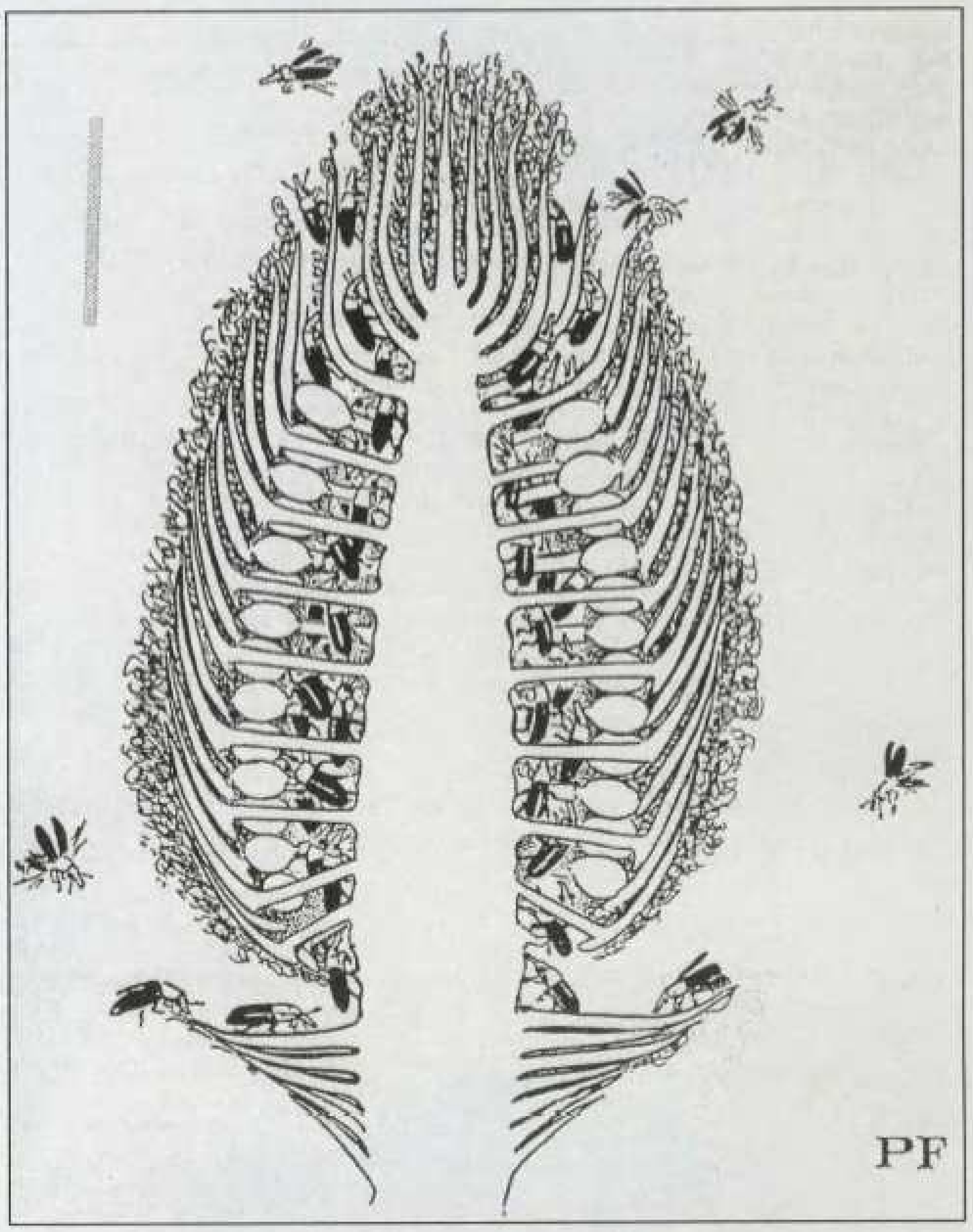

Figure 2 Illustration of *Dioon califanoi* cone by Priscilla Fawcett, showing insect guests at the "ground floor entrance" and in various chambers inside. The existence of exits at the top of the cone is speculative and has not been verified. Scale bar = 30 mm.

Who were the first beetles to colonize and pollinate cycad cones? A global census of cycad cone insects has been under way for over 10 years (Vovides 1991a, Forster *et al.* 1993, Oberprieler 1995, Tang *et al.* 1999). One family of beetles, the Erotylidae (formerly Languriidae), is found on cones in every major cycad region: Africa, Asia, Australia, and the New World. Those erotylid beetles in Asia and the New World cycads are in the same genus (Leschen 2003, Oberprieler pers. comm..) (see Figure 2). Does this association suggest a special affinity in erotylid beetles for cycads or is there a deeper explanation? In the Triassic the continents were united into one great landmass, Pangaea, and the global cycad flora was probably more uniform. It is probable at this early stage that a group of beetles specializing on cycad cones could spread throughout a world without major geographic barriers. Soon after, in the Jurassic period, the world began dividing, splitting into northern and southern landmasses, Laurasia and Gondwana. Gondwana then broke apart so that by the early Cenozoic it formed South America, Africa, and Australia. On each new continent cycad pollination then evolved in isolation down different paths, but the traces of its origins may remain in the telltale distribution of the Erotylidae (see Table 1),

Table 1. Beetle and thrips genera found on cycad cones in various regions of the world. Based on Oberprieler 1995, per. comm., Tang et al. 1999, Leschen 2003)

Geographic region	Cycad genus	Erotylidae	Weevil group*	Other insects**
S. Asia	*Cycas*	*Pharaxonotha*	*Tychiodes* (Cossoninae)	*Biphyllus* (Biphyllidae)
N. Australia	*Cycas*	*Hapalips*	Undescribed genus (Cossoninae)	*Ulomoides* (Tenebrionidae)
Australia	*Bowenia*	-	*Miltotranes* (Molytini)	-
	Lepidozamia	-	*Tranes* (Molytini)	-
	Macrozamia	*Xenocryptus*	*Tranes* (Molytini)	*Cycadothrips* (Thysanoptera) *Paracucujus* (Boganiidae)
Africa	*Encephalartos*	Undescribed genus	*Amorphocerus, Porthetes* (Amorphocerini) *Antliarhinus, Platymerus* (Brentinae)	Metacucujus *(Boganiidae)*
N. & C. America	*Ceratozamia*	*Pharaxonotha*	-	-
	Dioon	-	*Rhopalotria* (Oxycorininae)	-
	Zamia	*Pharaxonotha*	*Rhopalotria* (Oxycorininae)	-

*Genus followed by subfamily or tribe of weevils in parenthesis
** Genus of insect followed by order or family in parenthesis

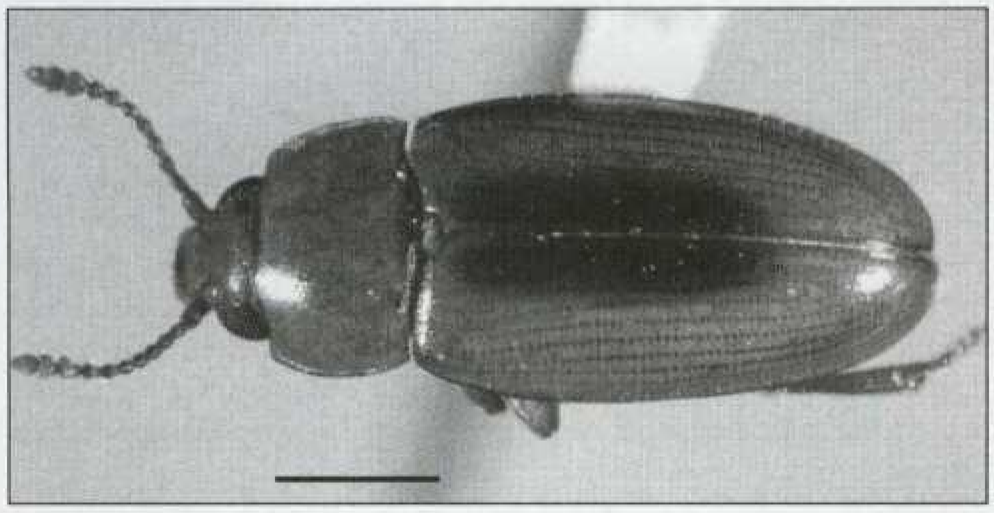

Figure 3 Photo of an erotylid beetle from a cone of *Cycas dolychophylla* from Yunnan, China. Formerly placed in the genus *Xenocryptus* by Tang *et al.* (1999), this beetle is now considered to be in the same genus, *Pharaxonotha*, as beetles on *Zamia* cones in the New World. Scale bar = 1 mm.

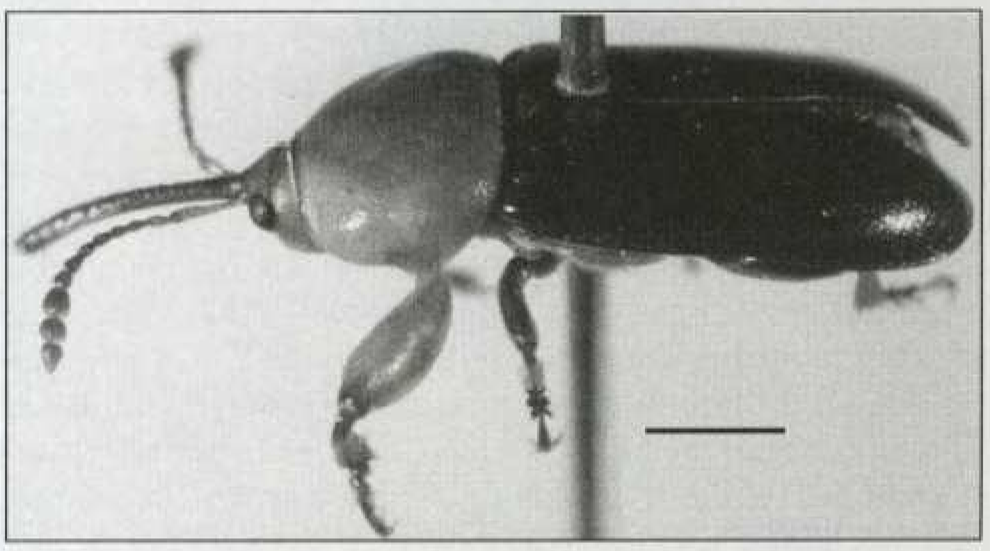

Figure 4 Photo of a *Rhopalotria* weevil from a *Dioon purpusii* cone from Mexico. The beetle is dorsiventrally flattened to allow it to move easily in the narrow spaces between cone scales. Scale bar = 1 mm.

which remain on cycads in every one of these continents.

In any hotel the clientele changes with time. The proprietor may want to attract new, more lucrative customers. The hotel may then be remodelled and the billboard and neon lights altered to suit new guests. Over the last 200 million years many groups of plants and animals became extinct and others rose. As their surrounding conditions changed, so did cycad hotels. New guests came to visit. Many at first were riffraff, but over time some became effective pollinators themselves and were incorporated with the old ones and in some cases supplanted the old ones completely. Erotylid beetles may have been the first pollinators on cycads or they may have come soon after. Over the hundreds of millions of years of cycad existence several more waves of colonization on cycad cones occurred. One example is the boganiid beetles, found only on cycad cones in Africa and Australia. These likely colonized cycad cones in the Cretaceous, when these continents were still connected in eastern Gondwana. They never reached Asia or the New World which were then separated from eastern Gondwana by oceans. Another probable late colonizer of cycad cones is primitive thrips of the genus *Cycadothrips*, known only in Australia on *Macrozamia*. Besides new colonizers, other members of the Erotylidae, not previously on cycad cones, may have colonized and supplanted older erotylid symbionts in some cycads species, thus obscuring an ancient pattern. The last and possibly most important wave of colonization was the weevils. Weevils began an explosive radiation when flowering plants began to cover and dominate the world's forests in the late Cretaceous. It appears that weevils of distinct lineages colonized cycad cones independently in separate parts of the world. In North America the primitive weevil subfamily Oxycorininae colonized *Dioon* and *Zamia* cones (see Figures 3, 4). In Africa and Australia weevils in the lineages Amorphocerin, Molytini, and Cossinae invaded cycad cones. Another cossinine weevil lineage, *Tychiodes*, appears to have originated somewhere in the Indo-Pacific region and spread onto the more advanced Asian *Cycas* species groups. The most primitive *Cycas* appear to remain pollinated by erotylid beetles.

CONCLUSION

The comparison of cycad cones with human hotels appears to be a useful one. Current knowledge of pollination in cycads, the structure, physiology and chemistry of cones, and behaviour of visiting insects all fit well with activities in the functions of human hotels. This analogy allows us to place a complex process within a familiar framework. Hopefully, this presentation will foster a greater appreciation of reproduction in these magnificent plants and the need to preserve cycad insects, as well as cycads in their wild settings, so that an age old miracle of nature will continue.

ACKNOWLEDGEMENTS

The ideas for this article came to fruition in CYCAD 2002 in Thailand, during sessions of the Cycad Pollination Working Group on the bus to various destinations - I thank Irene Terry, Rolf Oberprieler, John Donaldson, Paul Forster, and Roy Osborne for stimulating discussions.

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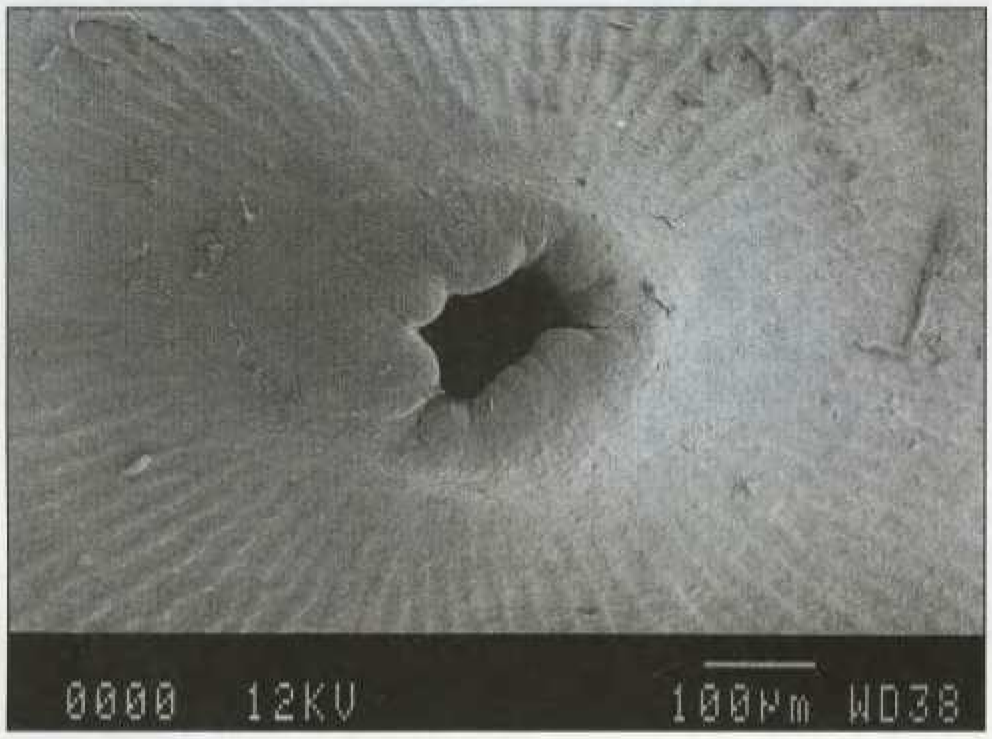
ENCEPHALARTOS TRANSVENOSUS: INTERESSANTE FOTO'S / INTERESTING PHOTOGRAPHS

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

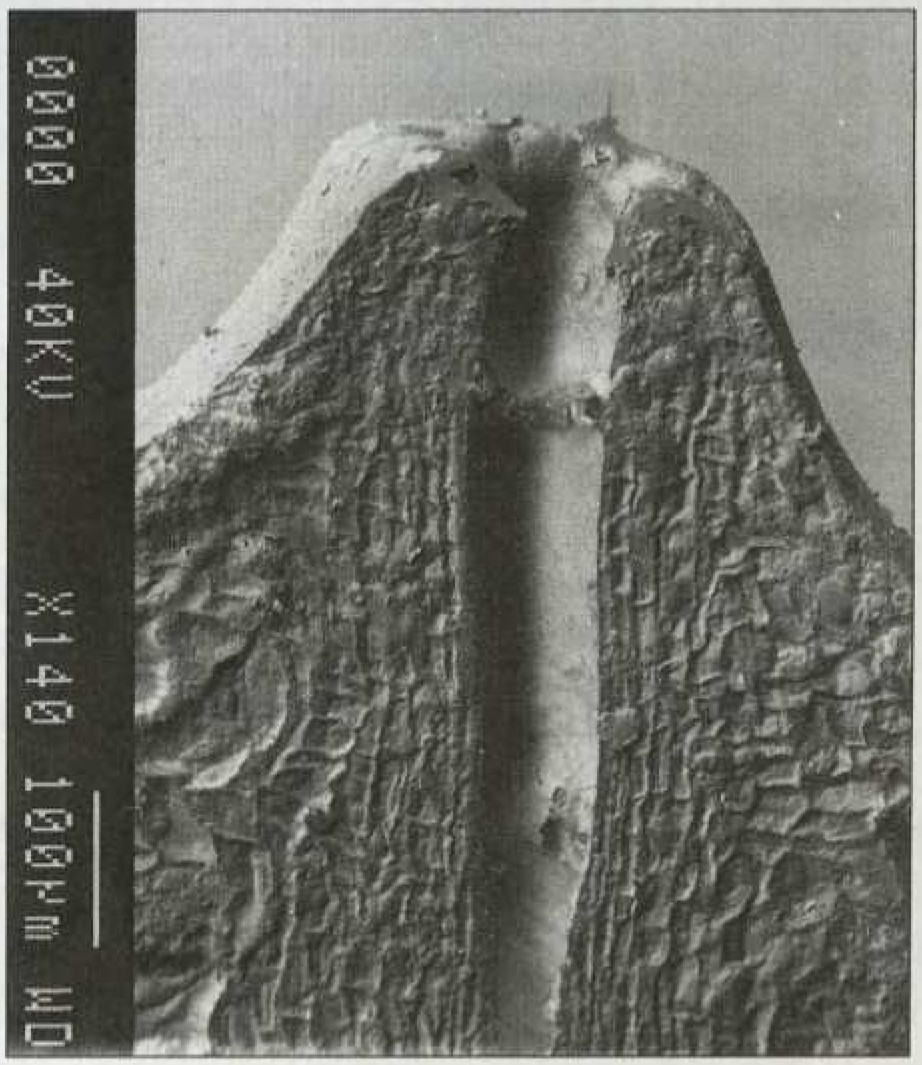
Received 1 July 2003

Figuur / Figure 1 Elektronmikroskoopfoto van die mikropilum van 'n volwasse saadknop van *Encephalartos transvenosus*; sydelingse aansig. / Electron microscope photograph of the micropyle of a mature ovule of *Encephalartos transvenosus* as seen in side view.



Figuur / Figure 2 Elektronmikroskoopfoto van die mikropilum van 'n volwasse *E. transvenosus* saadknop: vooraansig. / Electron microscope photograph of the micropyle of a mature ovule of *E. transvenosus* as seen in front view.

Die mikropilum van 'n volwasse saadknop van *Encephalartos transvenosus,* soos onder 'n elektronmikroskoop gesien, is in Julie 1987 by die Universiteit van Pretoria gefotografeer. / The micropyle of a mature ovule of *Encephalartos transvenosus*, as seen under an electron microscope, were photographed in July 1987 at the University of Pretoria. Foto's/Photos: J. Coetzee en/and C.F. van der Merwe.



Figuur / Figure 3 Elektronmikroskoopfoto van die mikropilum 'n volwasse *E. transvenosus* saadknop soos in mediane lengtesnee gesien. / Electron microscope photograph of a median longitudinal section of the micropyle of a mature *E. transvenosus* ovule.

LETTERS TO THE PRESIDENT AND EDITOR
BRIEWE AAN DIE PRESIDENT EN REDAKTEUR

PROPOSAL FOR "*ENCEPHALARTOS*"

I am writing this letter to you, after I have read the plea and dilemma of the President, as in his opening column of the last "*Encephalartos*".

It is in the true sense a dilemma if none of the management or committee members, or portfolio members can continue with their respective roles, and there is no one to give it over to.

Maybe there is a solution. I have been a chairman and exec committee member of a similar association that went through the same motion about four years ago. What we have implemented is a system of commercialization or paying for services. All the activities of the organization have been defined in specific entities and each one is run on a commercial basis,

The first one is the membership database and correspondence. The activity with all its aspects and deliverables has been defined after which proposals have been asked from any suitable candidate to run it for the organization. A contract has been awarded and it is running successfully. The time spends for the contractor entails about four full days a month for 11 months of the year. The person can do it in his own time, but must deliver the goods on time before payment is made. This semi full time person could also form the beginning of a permanent secretariat and office for the association. The income from the membership fees covers the cost and there is also a small amount for the kitty of the organization.

The next item is the newsletter. The same concept has been followed. What is required has been captured in a document and submitted to respected tenderers. The concept that has been followed is that the contractor will have to get advertisements, on the hints of the management committee. The income from the advertisements will cover the printing cost and a commission for the contractor to compile the articles after submission from the members, as well as printing costs.

These two initiatives will, however, not cover all the costs of the association. It has been decided to have at least one major income generation activity like a conference combined with a show. These are usually good money-spinners, and if organized well could boast the bank account of the association. Professional conference organizers can assist in this regard.

There are other initiatives as well, but if these three are run as the initial process, it could make the ends meet.

What are the benefits of this?

First it takes a massive load of the shoulders of the chairperson and the management committee. Due to the fact that you pay for services, you can demand a high standard and ensure a sustainable process. People are more willing to work if they are paid.

The negatives? Yes you will have to increase your membership fees slightly to get the initiatives off the ground. The current fees are below par compared to other organizations.

Jaap Viljoen, *P.O. Box 17835, 2059 Mulbarton, R.S.A.*
Jaap.Viljoen@bhpbilliton.com or **jnjv@telkomsa.net**

[If this proposal is put into practice the membership fees will have to increase considerably as the present membership fees just about cover the printing costs and postage of our journal. Since the establishment of the Cycad Society of South Africa none of the Council members received any financial compensation for their hard work. **- Secretary-treasurer.**]

ENCEPHALARTOS HEENANII

The photo (Colour Figure 23 on p. 20) was taken of a magnificent *Encephalartos heenanii* growing in the Lowveld Botanical Gardens, Mpumalanga.

Pieter van der Walt, *P.O. Box 913, 2158 Olivedale, R.S.A.*

Received 6 October 2003

TYPOGRAPHICAL ERRORS in: "From the President" (*Encephalartos* 74: 3, June 2003)

It was with surprize (*sic.*) and amazement that I read your letter in the latest Encephalartos journal. The amount of typographical errors in the 4 paragraphs of that short letter (English portion) was the cause of this reaction.

Surely someone should be checking the copy received before sending it for publication? Perhaps your spell check is not working!

Yours faithfully

Douglas Goode, *10 Hudson Bennett Crescent, Gillits, 3610.*

Received 26 June 2003

[Mr Goode, **Constructive criticism** is always welcome. Why don't you volunteer to be the editor of our journal as from January 2004? Then our members/readers can look forward to a wonderful **error-free (?)** journal compiled by you. **–Editor.**]

THANKS TO THE MEMBERS OF THE LOWVELD BRANCH OF THE SOCIETY AND APOLOGIES EX ERRATA

I was recently invited to participate on the field trip to the *Encephalartos lebomboensis* population growing on the Mananga mountains in Mpumalanga near the Swaziland border.

It was an opportunity for a poor student/collector to finally get to grips with the objects of his passion and to meet fellow enthusiasts. I do wish to apologize to those members of the Society whom I confused with my assertions that the plants on the mountain were *E. senticosus* rather than *E. lebomboensis*. According to the species concept set up by Dr. Vorster the plants are *E. lebomboensis* with some intermediate traits, the chief difference being the numbers of cones produced, those on the Mananga mountains (male and female) producing fewer cones on average (1 per plant) than *E. senticosus* (which produces 3–4). Forgive the confusion which stems perhaps from the fact that I am most familiar with the type population (as described by Inez Verdoorn) in Piet Retief, known in the trade as *E.* sp. "Retiefii", and cultivated plants.

Thanks again for a wonderful trip. For those who asked me what the aloe growing so prolifically on the mountain is called, it is *Aloe spicata* (previously known as *A. sessiliflora* according to my references).

I would also like to reiterate that anyone who would like to help with my Master's Thesis, entitled "Proposals for Proactive and community-led Cycad Conservation in South Africa" can write to me anytime at:
11663219@puknet.puk.ac.za even if you just want to talk plants!

Jason Sampson, *38 Pitts Ave, 1709 Discovery, R.S.A.*

Received 18 July 2003

ZAMIA

There was a question in *"Encephalartos"* **74** re: a *Zamia* (last photo in journal) (see Colour Figure 36 on p. 26 in this issue). This is it! I was in the habitat in April of this year and saw some beautiful plants (Colour Figure 35 on p. 26). As you can see it is a large cycad that is distinguished by papery leaflets and large numbers of leaves. It is not closely related to *Z. tuerckheimii*. If you would like additional information let me know.

Loran M. Whitelock, *4524 Toland Way Los Angeles, CA 90041 U.S.A. Phone: (323)255-6651; Fax: (323) 344-0858*

Received 28 August 2003

COMMENT ON PHOTO IN "*ENCEPHALARTOS*" 74

I just returned from a 30-day collecting expedition to Honduras, and I was intrigued by the full-page photo of "*Zamia tuerckheimii*?" in the most recent issue of "*Encephalartos*". I can say with about 95% certainty that the plant in the photo is not *Z. tuerckheimii*, but rather is an undescribed *Zamia* that, as far as I can tell at this point, is endemic to two hillsides in the Merendon mountain range in northwestern Honduras. I saw and collected the plant – including what is likely to become the type specimen. What the photo doesn't show is that this *Zamia* is arboreal and grows a trunk of up to 2 metres in height.

Another point I would like to make is with respect to the caption underneath the photo. Although it is true that *Zamia tuerckheimii* has been reported from Honduras, all of the herbarium specimens that I have seen are actually of an undescribed *Ceratozamia* – which I also visited, photographed, and collected. *Zamia standleyi* (which is misspelled in the caption, by the way) is widespread throughout northern Olancho and into the departments of Yoro and Atlantida as well. I did not see *Z. variegata*, nor did I hear any reports of it, but I will try to determine if that species occurs in Honduras on my next trip.

Probably the most amazing thing of all about this expedition, however, was the sheer number of plants (> 500,000) and the incredibly wide distribution (> 30 populations scattered across an are approximately 6,000 km^2) of *Dioon mejiae*. The ultimate size of these plants was also quite striking – with trunks up to 10 metres!

Jody Haynes, *9525 Jamaica Drive, Miami, Florida 33189, U.S.A..*

Received 12 August 2003

VERNACULAR NAMES OF CYCADS

Professor Mark Bonta, of Delta State University, Mississippi, USA, and I, are compiling a compendium of all vernacular names used for cycads throughout the world. This has already provided much interesting information that has never previously been collated. A rich tapestry of names has been found in Asia and central America, but we are surprised how few names we have gathered for the South African species of *Encephalartos*. We believe that there must be many other names in African dialects, which have never been recorded in the cycad literature.

We would very much like to hear from any of your readers who know of such names, and particularly, if they can tell us the language and, if possible, the meaning of the word.

Table 1: Scientific names, localities and vernacular names of African cycads

Scientific name	Locality	Vernacular name	References 56
Cycas thouarsii R.Br. ex Gaudich.	E. Africa, Indian Ocean Islands	Betseleo—*fahou, fahu, voafaho*; Hoya *Batsimisaraka* (man eating plant), *fatzon Fato, fatra, voafako*; Fr.—*faux sagoutier, samble*; Swahili—*mpapindi, mtapu, mtapo*	Schuster 1932; Vorster & Vorster 1973; Williams 1949
Encephalartos altensteinii Lehm.	South Africa (E. Cape)	Xhosa—*iSundu, umGuza*	Dold & Cocks 1999.
Encephalartos barteri Carruth. ex Miq.	Benin, Ghana, Nigeria	Krobo—*kpadei-atah, pardi attar* (both ghost palm); Twi-akapim—*mamponmere*	Dalziel 1937; Prain 1917; Schuster 1932
Encephalartos ferox Bertol. *F.*	Mozambique, South Africa (KwaZulu-Natal)	Ronga—*chipissana;* Tsonga—*chihanga* (vegetable coal); Zulu—*isiqiki somkhovu*	De Koning 1993; Whitelock 2002; P. Capela pers. comm.
Encephalartos gratus Prain	Malawi, Mozambique	Chichewa (?)—*gwerekwe*; Yoa—*lichaungwe*	Binns 1972
Encephalartos hildebrandtii A. Braun & Bouché	Kenya, Tanzania	Boni—*tielle*; Sanya—*balacha, muka*; Swahili—*mapo, mkwanga, msapo*	Beentje 1994 Dharani 2002 H. Beentje pers. comm.
Encephalartos kisambo Faden & Beentje	Kenya	Taita—*kisambo*	Faden & Beentje 1989
Encephalartos laurentianus De Wild.	Angola, Dem. Rep. Congo	Kiyaka—*malele, bundi-nguma*	Engler 1908; Lebron 1930; Prain 1917
Encephalartos macrostrobilus S. Jones & Wynants	N. Uganda	Madi—*ci-cia* (like a date palm)	Jones & Wynants 1997
Encephalartos manikensis (Gilliland) Gilliland and allied species incl. *E. chimanimaniensis* R.A. Dyer & I. Verd., *E. munchii* R.A. Dyer & I. Verd. and *E. turneri* Lavranos & D.L. Goode	Mozambique Zimbabwe	Ronga—*chipissana*; Ronga & Shona—*untopani* (palm-like plant); Shona—*unguarara* (dwarf plant); Tsonga—*chihanga* (vegetable coal)	De Koning 1993; P. Capela pers. comm.
Encephalartos poggei Asch.	Dem. Rep. Congo	Baluba—*biondo*; Kanioka—*tchiondo*; Lulua—*kalaba kabo, kalala kabo, lulondo*	Gentil 1904; Prain 1917; Schuster 1932
Encephalartos schaijesii Malaisse, Sclavo & Crosiers	Dem. Rep. Congo	Ndembo—*makindu ya dilungu*	Malaisse *et al.* 1993
Encephalartos septentrionalis Schweinf.	Sudan, Uganda	Bongo—*kagga-kunda, kaggo kondo*; Kredj-Nduggu lang.—*kotto*; Niam-Niam lang.—*mevul-pia, mwue piah*	Prain 1917; Schuster 1932; Schweinfurth 1871
Encephalartos tegulaneus Melville	Kenya	Samburu—*lpision*	Beentje 1994
E. umbeluziensis R.A. Dyer	Mozambique, Swaziland	Tsonga—*muanga*	De Koning 1993
Encephalartos villosus Lem.	South Africa (E. Cape, kzaZulu-Natal), Swaziland	Xhosa—*umGuza, umPhanga*	Dold & Coc.ks 1999.
Encephalartos spp. (generic)	South Africa	Afrikaans—*broodboom* (bread tree)	Common knowledge
Stangeria eriopus (Kunze) Baill.	South Africa (Eastern Cape, kwaZulu-Natal)	Pondo (?)—*finguane, juma*; Xhosa—*umFingwane* (whole plant), *umNcuma* (cone); Zulu—*imFingo, inFingo*	Osborne *et al.* 1994; Vorster & Vorster 1974

Such information can be sent to us by e-mail at:
cycad@iprimus.com
or by conventional mail to P.O. Box 244, Burpengary, Queensland 4505, Australia.

On p. 43 you will find part of our compendium which summarises the names we known for the "African" cycads at the present time.

Roy Osborne, *P.O. Box 244, Burpengary, Queensland 4505, Australia.*

REFUGEES FROM ZIMBABWE SELLING CYCADS

I am not sure to whom I am writing. I live in Maun, Botswana. We have recently had an influx of refugees from Zimbabwe flooding into Botswana and slowly moving to Maun. I pity these guys in some ways because they are running away from a dreadful situation. Unfortunately when they get to Botswana their currency lasts only about a week by which time they usually have not managed to find work nor sort out permits. Result – crime.

Recently their latest way to survive is to sell cycads. I found one chap going from window to window outside Shoprite trying to take orders for cycads. From him I learned that they get the cycad seed from Cabora Bassa, Mozambique (?). I bumped into him again after a few weeks and he offered cycads. I asked where he was keeping them and he led me to the back of the shopping centre where he had what looked like a bulb around the size of a football and brown/beige in colour. I do not know anything at all about cycads and so have no idea what I was looking at. He wanted $200 for this and $100 for a smaller one.

I just laughed him off and said that these things will be eaten in one day by the termites of Botswana and secondly if this does not happen they will certainly die from the heat and lack of humidity.

Since I was so dim on cycads I did a search and found your webpage. I thought that you might find this little bit of useless information interesting.

Shane Seaman, **seamans@botsnet.bw**

Received 15 September 2003

ENORMOUS FEMALE CONE OF *ENCEPHALARTOS LONGIFOLIUS*.

This photo (Figure 1) shows a female cone on an *Encephalartos longifolius* plant growing in the Durban Botanical Gardens. The cone was enormous with approximately the same girth as the plant's stem.

Pieter van der Walt, *P.O Box 913, 2158 Olivedale, R.S.A.*

Received 9 September 2003

Figure 1 **Large *Encephalartos longifolius* female cone.**