ENCEPHALARTOS

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TYDSKRIF VAN DIE BROODBOOM VERENIGING VAN SUID-AFRIKA

NO. 36 DECEMBER / DESEMBER 1993 ISSN 1012-9987

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COVER / VOORBLAD : ***Encephalartos cupidus*, female plants in cone**

Photo: Johan Hurter

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FROM THE PRESIDENT

Members who are interested in scientific research on cycads will be pleased to learn (see "News from Council" on p. 36), that COUNCIL agreed in principle to make funds available in future on an annual basis in support *of cycad research.*

Pieter Stroebel who has served the Society for almost six years as Secretary/Treasurer retired from that position and from Council at the end of October of this year. The office he filled is an arduous but important one. With the assistance of his charming wife he took care of it in an honorary capacity with distinction whilst he simultaneously served as a devoted member of the Management Committee of the Eastern Cape's Regional Branch of the Society. For all his inputs we are very indebted to Pieter. Now that he has retired, we wish him and his wife a more relaxed and pleasant association with the Society which he has done so much to build.

Mr L.M.D. Vorster, father of Councillor Piet Vorster, is another stalwart whom for years has served the Society as its auditor. He annually drew up our financial statements for publication in "*Encephalartos*" with commendable scrutiny. His friendliness and unlimited patience with some of our office bearers whom were always late with their reports always amazed me. We *hope that, from* next year, Mr Vorster will be able to enjoy his retirement considerably more now that he has been relieved of the burden of checking our Society's financial affairs.

Mr Norman Kachelhoffer has kindly consented to act as our auditor from the beginning of 1994 as Mr Vorster's successor. We know that Norman will do a sterling job for us and we are most obliged to him for assisting the Society in this way.

As retiring President of the Society, I would like to *express my sincere appreciation* to the Councillors that *served* under me for their support and contributions. Despite the considerable amount of work that is associated with the Presidency, I can honestly say that I have thoroughly enjoyed the close association with the affairs of the Society. During my first term of office several incisive decisions were made which some councillors found hard to accept. The second term was much more peaceful and enjoyable. It included *inter alia* the holding of a very successful "CYCAD 93" in South Africa which gave me considerable satisfaction. Consequently I look forward very much to the publication in book form of the "Proceedings" of "CYCAD 93".

As is reported on elsewhere (see "New Council for the period Jan. 1994 to Dec. 1995" on p. 29) we are fortunate to have acquired the services of Prof. Hannes

VAN DIE PRESIDENT

Lede wat belangstel in wetenskaplike navorsing oor broodbome sal bly wees om te verneem (kyk "News from Council" op bl. 36) dat die RAAD onlangs in beginsel besluit het om in die toekoms jaarliks geld beskikbaar te stel vir navorsing oor broodbome.

Pieter Stroebel wat vir bykans ses jaar as die Vereniging se Sekretaris/Tesourier gedien het, het aan die einde van Oktober vanjaar uit die pos en die RAAD getree. Die amp wat hy beklee het was 'n veeleisende en belangrike een maar met die bystand van sy innemende gade het hy dit met groot onderskeiding en toegewydheid kosteloos behartig terwyl hy tegelykertyd ook 'n staatmakerrol in die Bestuurskomitee van die Oos-Kaaplandse Streektak van die Vereniging vervul het. Hiervoor is ons Pieter baie dank verskuldig. Noudat hy uittree, wens ons hom en sy gade 'n meer ontspanne en genotvolle betrokkenheid by die Vereniging waarvoor hy hom so lank beywer het.

'n Ander staatmaker wat die Vereniging vir jare op 'n baie vriendelike wyse met groot noukeurigheid en toegewydheid dien, is mnr L.M.D. Vorster, vader van Raadslid Piet Vorster. Mnr Vorster is nie lid van ons Vereniging nie maar het as ons ouditeur jaarliks die Vereniging se finansiële state opgestel vir publisering in "*Encephalartos*". Sy eindelose geduld met party van ons ampsdraers wat alewig laat is met hul verslae het my veral getref. Ons hoop dat mnr Vorster, vanaf volgende jaar, sy lewe as afgetredene baie meer sal kan geniet as toe hy met ons werk opgesaal gesit het.

Mnr Norman Kachelhoffer het goedgunstig ingewillig om van begin 1994 die ouditeurskap van die Vereniging van mnr Vorster oor te neem. Ons weet dat hy dit op 'n baie bekwame wyse sal doen en ons is hom baie dank verskuldig vir sy welwillendheid.

As uittredende President van die Vereniging wil ek die Raadslede wat onder my gedien het van harte bedank vir hul ondersteuning en insette. Nieteenstaande die groot hoeveelheid werk wat aan die Presidentskap verbonde is, kan ek eerlikwaar konstateer dat ek my betrokkenheid by die Vereniging se sake baie geniet het. Tydens my eerste termyn was daar heelwat ingrypende besluite geneem wat sommige Raadslede moeilik gevind het om te aanvaar. Die tweede termyn was veel rustiger en aangenamer. Dit het onder andere die aanbieding van die hoogs suksesvolle "CYCAD 93" in Suid-Afrika ingesluit wat ek as 'n hoogtepunt van my ampstermyn ervaar het. Ek sien dan ook met groot verwagting uit na die verskyning in boekvorm van die "Verrigtinge" van "CYCAD 93".

Soos elders vermeld word (kyk "New Council for the period Jan. 1994 to Dec. 1995" op bl. 29) is ons baie

Robbertse as our third President from the beginning of 1994 whilst Giel Fourie has already taken over from Pieter Stroebel as Secretary/Treasurer.

Finally, I want to use this opportunity to thank all our members for their support of the Society. I also wish you a most enjoyable and peaceful Christmas and express the hope that you will experience good health during a most stimulating and prosperous 1994.

Nat Grobbelaar

gelukkig om prof. Hannes Robbertse as derde President van die Vereniging vanaf begin 1994 te verwelkom terwyl Giel Fourie reeds as Sekretaris/Tesourier by Pieter Stroebel oorgeneem het.

Ek wil voorts van hierdie geleentheid gebruik maak om een en almal te bedank vir hul ondersteuning van die Vereniging en die hoop uitspreek dat u 'n besonder vreugdevolle en rustige Kersfees sal belewe en dat 1994 vir u 'n opwindende en voorspoedige jaar sal wees waarin u ook goeie gesondheid sal geniet.

Nat Grobbelaar

CONSTITUTION / GRONDWET

AMENDMENT TO THE CONSTITUTION

Of the 46 members that voted on the proposed amendment of Clause 4.2.1, 45 (98%) voted in favour of the proposed amendment. Consequently the proposed amendment has been duly approved. Membership fees should therefore be paid annually before December 31st.

In view of the lateness of the present amendment to the Constitution, members will, as a bridging arrangement, be **permitted to pay their dues for 1994 before January 31st, 1994.**

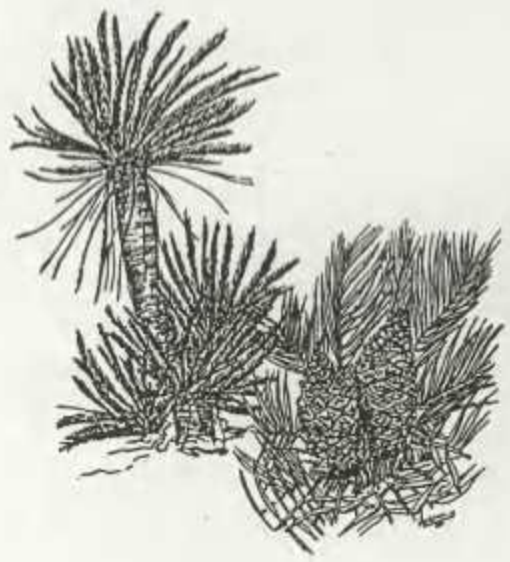
Nat Grobbelaar
President

WYSIGING VAN DIE GRONDWET

Van die 46 lede wat oor die voorgestelde wysiging van Klousule 4.2.1 gestem het, het 45 (98%) ten gunste van die voorgestelde wysiging gestem. Die voorgestelde wysiging is dus na behore goedgekeur. Ledegeld sal dus voortaan jaarliks voor 31 Desember betaal moet word.

Omrede die laatheid van hierdie wysiging van die Grondwet, sal lede, as 'n oorgangsmaatreël, **toegelaat word om hul ledegeld vir 1994 voor 31 Januarie 1994 te betaal.**

Nat Grobbelaar
President



FOCUS ON ... FOKUS OP ...

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

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

ENCEPHALARTOS CUPIDUS R.A. Dyer

Riekie Slabbert and Johan Hurter
P.O. Box 835, 1200 Nelspruit

INTRODUCTION

The Olifants River catchment area in the Transvaal contains a remarkably large number of cycad species. In one mountainous area, known as the Mariepskop-Wolkberg complex, there occurs within a radius of 50 km no less than eight described *Encephalartos* species as well as another taxon which probably qualifies to be

Figure 1 *E. cupidus* in habitat showing a plant with a reclining stem growing on a steep slope.

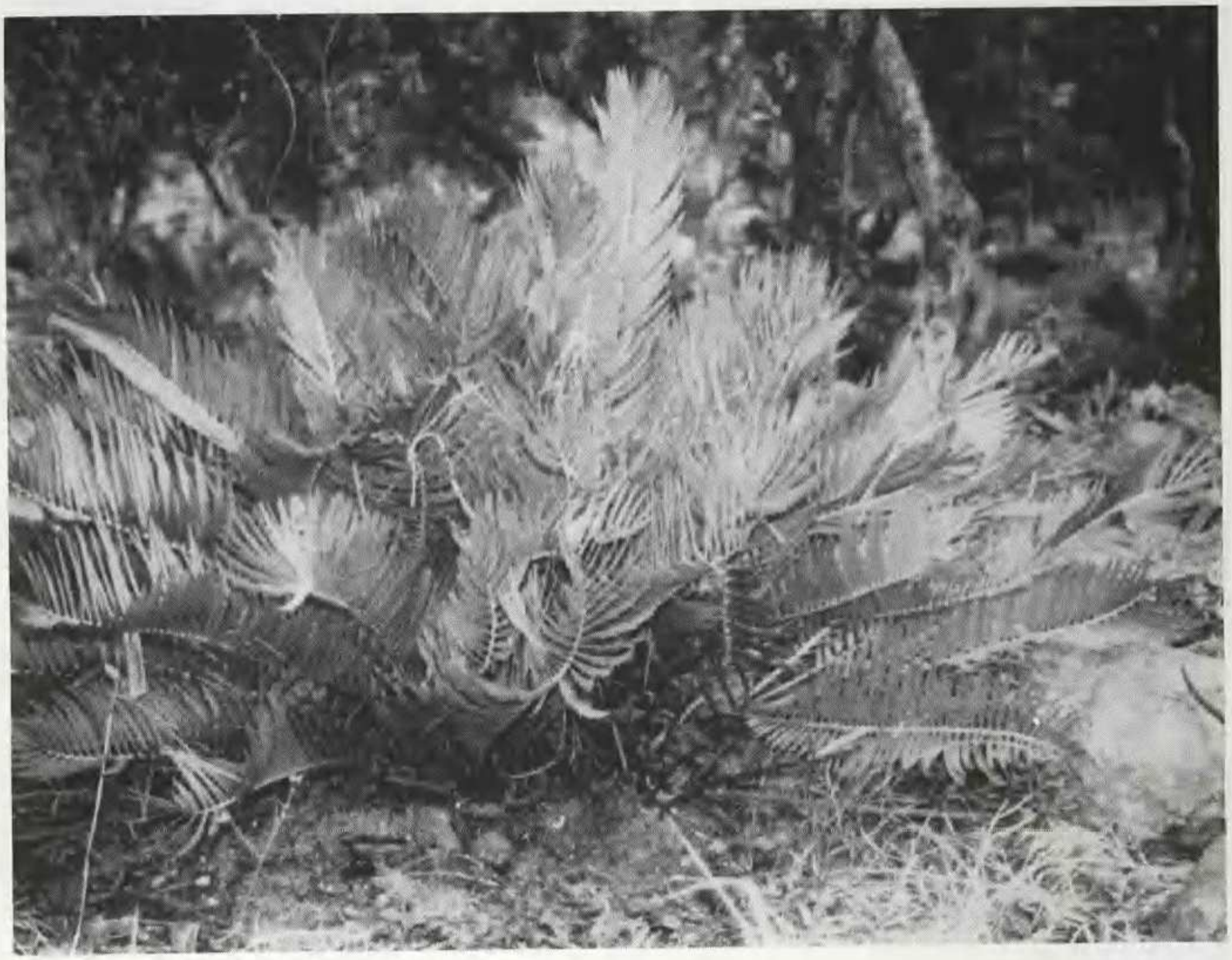


Figure 2 Suckering habit of *E. cupidus*.

described as a new species. In addition, a further two species occupy habitats further upstream. In this area, the Olifants River and tributaries break through the precipitous Transvaal Drakensberg escarpment, carving out some of the most spectacular scenery in the Transvaal. This area is also the home of *Encephalartos cupidus*.

Astonishment was expressed by Dr. R.A. Dyer in 1964, when first describing *E. inopinus*, that an undescribed species of this remarkable genus should be discovered at this comparatively late stage in the botanical exploration of southern Africa. This trend continued with the description of *E. cupidus* and still continues today, with several more species being discovered and needing further investigation.

The first indications of this new species came to light when a leaf was sent to the then Botanical Research Institute, Pretoria, by a Mr. J.S. Oliver from a plant in cultivation in the garden of Mr. D. van Heerden of White River. The parent plant had originated some time back from a farm on the Ohrigstad River, now part of the Blyde River Nature Reserve. Further investigations into the area by members of the then B.R.I. and Nature Conservation officials, made enough material available for a full species description to be published in 1971.

The meaning of the specific epithet, *cupidus*, refers to the passionate desire by collectors to collect the new species from the wild.

DESCRIPTION

The usually dwarf habit and bluish-green, somewhat glaucous, strongly armed leaves, distinguish this species from all its neighbours in southern Africa.

1. STEM

Stem well developed up to 2.7 m long and procumbent (Figure 1), but usually subterranean and suckering

(Figure 2) and 200-300 mm in diameter.

Figure 3 The leaflets of *E. cupidus* are inserted in a distinct V-disposition on the rachis.

2. LEAVES

The leaves are up to 1 m long, with mature leaves spreading and often touching the ground, or intertwined *in multi-headed* plants, leaf tips arching upwards. Leaflets are inserted in a distinct V-disposition (Figure 3) on the rachis and reduced to prickles on the lower petiole (Figure 4). Median leaflets are up to 150 mm long and 20 mm broad and are strongly armed with 4-6 spines on both margins (Figure 5). The leaves are a glaucous bluish-green to venetian blue, turning yellowish-khaki with age.

3. CONES

Male cones are green, usually single, subcylindrical, 200-300 mm long and 50 mm in diameter with a peduncle 50-100 mm long (Figure 6). The adaxial surface of the male sporophylls bears a slight median ridge with the terminal facet of the sporophyll glabrous in the centre.

Female cones green, turning apricot at maturity or staying green in shaded plants, usually solitary and rarely in pairs. The female cones are up to 300 mm long and 200 mm in diameter with a peduncle up to 60 mm long. The terminal facet of the sporophyll is smooth to slightly warty (Figure 5).

Figure 4 Detail of petiole and female cone of *E. cupidus*.

AFFINITIES

Although it is possible to confuse *E. cupidus* with *E. munchii*, they are not even remotely related. The affinities of *E. munchii* lie in the so-called *E. manikensis* complex whereas the affinities of *E. cupidus* probably lie within the so-called *E. eugene-maraisii* complex. The leaves are somewhat similar to the robust, so-called "Giant Cupidus", whose taxonomic description is now overdue. It differs remarkably though, in its distribution, habit, habitat and the size and morphology of its cones from this undescribed species, which occurs on steep mountainous areas further to the north of *E. cupidus*.

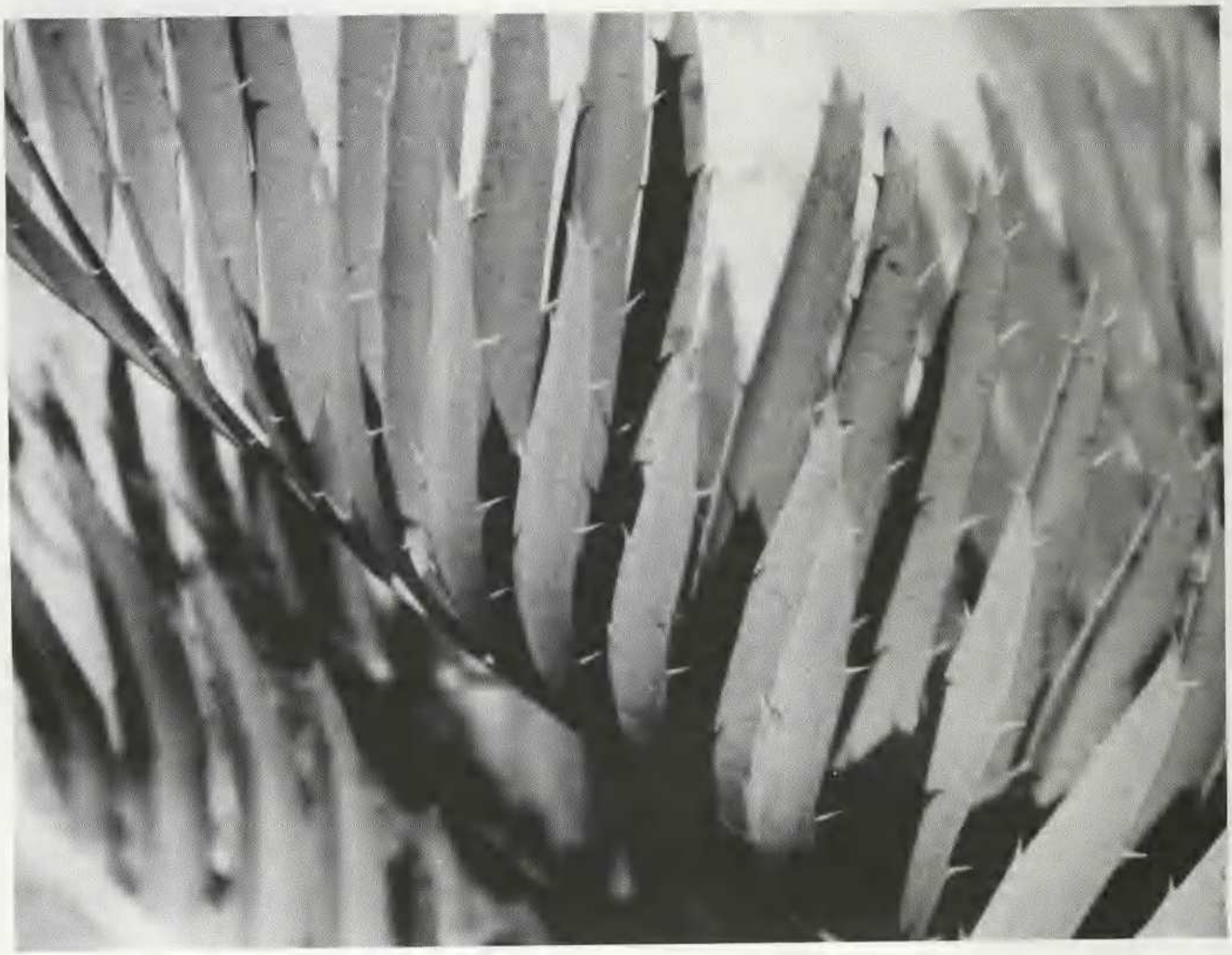


Figure 5 Leaves of *E. cupidus*, note spines on both margins.

DISTRIBUTION

E. cupidus used to occur within a restricted area of the eastern Transvaal Drakensberg escarpment area, between the Blyde and Steelpoort Rivers. At present populations appear to be confined to the Blyde River Nature Reserve, with some isolated plants sporadically being found further north between the Ohrigstad and Olifants Rivers.

ECOLOGY

This low growing cycad occurs individually or in small populations of up to 200 individuals in the Blyde River Nature Reserve. Plants grow in inaccessible spots on precipitous promontories and on boulder-strewn grassland or typical Bankenveld and sometimes along seepage areas bordering gallery forest as well as in dry forest (Figures 7, 8). It appears as if dolomites are preferred as substrate, but plants are also found on Black Reef quartzite of the Wolkberg group.

Droughts and fires are frequent, causing a high mortality rate amongst seedlings. Recruitment is poor, although individuals from all age classes are present within the larger populations which appear to be expanding under strict protection by the Transvaal Division of Nature Conservation.

The leaves of *E. cupidus* are frequently attacked by larvae of the leopard magpie moth (*Zerenopsis leopardina*), which is also the case with *E. dyerianus* and *E. laevifolius*. Damage by baboons does not appear to be a problem (Figure 9) as cones appear only to be damaged severely or removed after pollination. (It appears from observations on *E. cupidus*, *E. laevifolius* and *E. middelburgensis* in the wild, as if the cones are unpalatable before pollination, but that this rapidly changes directly after pollination. Seed of all three species removed experimentally or by baboons within a week after artificial pollination, has shown no loss in viability.)

Figure 6 *E. cupidus*, male cone.

Figure 7 A very large specimen of *E. cupidus* in habitat in the Blyde River Nature Reserve.

CONSERVATION

Populations of this species used to exist over a much wider area, but this cycad has had its distribution severely reduced by collector pressure. This species is now specially protected in the Transvaal and all known wild populations are strictly monitored for illegal removal or disturbance. Although this species is now well protected within the Blyde River Nature Reserve, it unfortunately occurs in very inaccessible areas which makes it difficult for cycad enthusiasts to view the plants in their natural environment.

Figure 8 *E. cupidus* in typical Bankenveld habitat.

Figure 9 Female cone showing baboon damage.

This species must be considered as **endangered** by conservation authorities. Endangered status is afforded

to species that might possibly become extinct in the near future, if the factors causing their decline in nature are not stopped. This is mainly due to its severely localized range, intense past and present collector pressure and the taxon's low recruitment rate caused by natural and unnatural agents. There is a total ban on the species being transported from the Transvaal over provincial borders or being sold or donated to persons outside the Transvaal or the Republic of South Africa.

An intensive *ex situ* conservation project of this species is underway at the Lowveld National Botanical Garden and it is hoped to curb this species' rapid role to extinction by supplementing wild populations and relieving the collector pressure through artificially propagated specimens (Figures 10, 11).

Figure 10 *E. cupidus* seed orchard in the Lowveld National Botanical Garden.

CULTIVATION

This is a delightful frost-hardy species for temperate to tropical areas. The soil must be well drained with ample organic material. Plants sucker from an early age and may occupy and area of 2 m^2 at maturity. Although it will tolerate full sun, afternoon shade is preferred. It also makes an interesting container plant on a sun deck or patio.

Plants are not uncommon in collections, public or private, and several plants can be seen on display at the Lowveld National Botanical Garden in Nelspruit.

Figure 11 *E. cupidus* seedlings in the nursery of the Lowveld National Botanical Garden.

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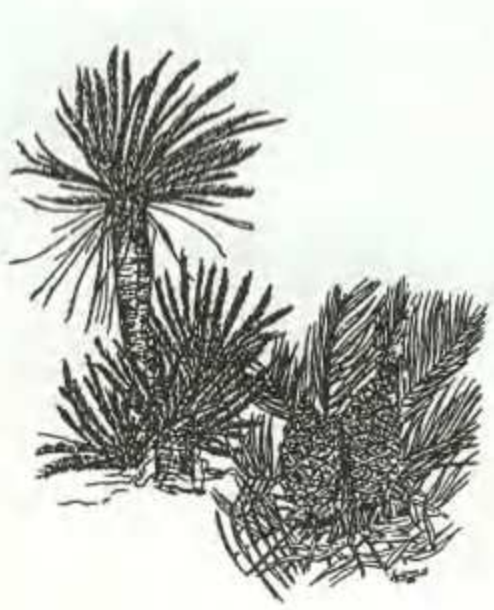

THE GOLDEN CYCAD OF FIJI, AND THE CORRECT NAME FOR THE NATIVE FIJIAN CYCAD

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Well-known Fijian horticultural identity and former Palm Society board member Dick Phillips recently pointed out an unusual cycad with bright yellow new growth that he thought was different to the native Fijian cycad (*Cycas seemanii*). This golden cycad is only known from gardens on the main island of Viti Levu, and only as female plants. It offsets freely, and has been widely propagated vegetatively. In fact, it is highly likely that all plants on Fiji came from a single clone. The same cycad is also on Vanuatu, again only as cultivated plants, observed in a number of localities by both myself and palm authority John Dowe.

The yellow coloration is caused by a lack of chlorophyll in the new growth, and is most pronounced when the plants are growing in full sun. Leaves gradually develop chlorophyll, partly in the shade of younger leaves. Three-year-old leaves will be deep green, with a little yellowing at the tips. Although this description could read as a sickly and deficient plant, this is not the case. Plants are quick-growing, and produce huge flushes of spectacular yellow leaves, often over 50 at a time. When growing in shade, new growth has some chlorophyll, and appears pale green. This is still a striking contrast to the deep green of the older leaves.

Plants offset from the base and along the trunk quite freely, and the offsets are easily rooted and grown on. The dramatic colour and ease of growth make this plant a potentially highly desirable horticultural subject. The Royal Botanic Gardens in Sydney, in co-operation with Dick Phillips in Fiji, are endeavouring to introduce it into cultivation in Australia, and we may soon see a lot more of the Golden Cycad of Fiji.

Both the golden cycad and *Cycas seemanii*, the species occurring naturally in Fiji, belong to the *C. rumphii* complex. The *C. rumphii* complex is uniquely defined by the presence of a spongy layer within the seed (Dehgan & Yuen 1983), together with reduced megasporophylls and dorsiventrally thickened, more or less truncated microsporophylls. Seeds of all members of the complex are larger than those of most *Cycas* species, and seeds take two years to mature on the plant, as opposed to one year for all the other *Cycas* species. Closer examination reveals slight but consistent differences between the two plants from Fiji. The golden cycad has relatively longer petioles that are consistently spinescent, usually throughout, or at least for more than half of their length. Leaves have fewer pinnae (Table 1) that are somewhat stiffer, and never show the undulating margins sometimes seen in *C. seemanii* in Fiji. Pinnae are also usually held at a higher angle to the rachis. Megasporophylls are similar in length, but those of the golden cycad lack the 20-30 regular short lateral teeth on the apical portion that are present in *C. seemanii*.

Table 1 Comparison of some regional variants in the *Cycas rumphii* complex.

	C. "Fiji Gold"	*C. seemanii*	*C.* "Guam"	*C. thouarsii*
Petiole, % of leaf	25-30%	15-20%	25%	20-30%
Spines, % of petiole	60-100%	0(-30%)	0	70-100%
No. of pinnae	140-160	180-230	140	160-220
Pinna/rachis angle	70-85°	50-70°	80°	45-70°
Megasp. tip, no. spines	0	20-30	15-20	12-20

Even more significantly in biological terms, the two appear to be reproductively separated. Where the golden cycad is growing with male and female Fijian cycads, the Fijian plants regularly set viable seed and the golden plants set no seed. This is despite the fact that many of the golden plants regularly (in some cases, annually) set large flushes of megasporophylls at about the same time of year as the Fijian species. This indicates that the two are biologically isolated from each other, and should be regarded as two separate species. This is the first observation of such reproductive isolation in the *C. rumphii* complex that I know of, and of considerable importance in the continuing debate over the specific limits within this complex.

A note on the debate over specific limits and nomenclature may be relevant here. The name *C. circinalis* was applied to many *Cycas* species in the very early days, and has been poorly understood and widely misapplied even to today. There are many plants of the *C. rumphii* complex in gardens throughout the world that are mis-labelled as *C. circinalis*, and the latter name has been misapplied to the former in the Western Pacific on many occasions (De Laubenfels 1972, Fosberg & Sachet 1975, Yuncker 1959). Although Dehgan & Yuen (1983) report the presence of the characteristic spongy layer in seeds of *C. circinalis*, recent collections from the type locality show no such layer, and likewise, early illustrations of dissections show no spongy layer (Rheede 1682, Hooker 1828). *C. circinalis* also has elongated, gently curved tips 40-50 mm long on the microsporophylls, while all plants of the *C. rumphii* complex have truncated tips, with or without short, sharply upturned spines. *C. circinalis sens. strict.* is restricted to the Indian subcontinent, whereas the *C. rumphii* complex has a wide distribution, from Madagascar and the Comoros in the west to Tonga in the east, south as far as New Caledonia and north to Indochina, Luzon and Guam (apparently excluding both China and Australia). It is clear that Dehgan & Yuen (1983) examined a mis-labelled plant belonging to the *C. rumphii* complex, and not *C. circinalis*.

Recognition of *C. seemanii* as a subspecies of *C. circinalis* (Schuster 1932, Kanehira 1933, Sykes 1970) is similarly indefensible. The affinities of *C. seemanii* are clearly with the *C. rumphii* complex, and it makes no sense to regard it as a subspecies of an unrelated species.

C. seemanii has also been regarded as a synonym (Kanehira 1931), a variety (Parham 1948), or a form of *C. rumphii* (Kanehira 1938, Parham 1965, Smith 1979). While the affinities are clearly with the latter, infraspecific rank cannot be supported in the light of the reproductive separation evident as discussed above. Likewise, inclusion of the Fijian cycad within the synonymy of *C. rumphii* cannot be maintained. The correct name for the Fijian cycad should thus be *C. seemanii* A. Braun.

Distribution of *C. seemanii* has also not been clearly established. Plants from Tonga differ very little from Fijian plants, being a little more robust and never showing the undulating pinnae sometimes seen in Fiji. They cannot be separated, however, on the diagnostic characters cited below. Plants from New Caledonia have been widely distributed as *C. neocaledonica*, but this name has never been legitimately published. These, together with plants from Vanuatu are also inseparable from the Fijian plants on the same diagnostic characters, and must be referred to the same species. Considerable variation occurs in this complex on The Solomons, Bougainville and the mainland Papua New Guinea, with at least some forms differing from *C. seemanii* in some of these characters, and further study remains to be done here. *Cycas* is absent from eastern Micronesia to the north, and plants from western Micronesia (Guam) are clearly different. Thus, at this time, the name *C. seemanii* should be reserved for all plants occurring from New Caledonia and Vanuatu to Tonga.

The origin of the golden cycad remains unknown, but proposed macromolecular studies of the *C. rumphii* complex at the Royal Botanic Gardens in Sydney may eventually solve this minor mystery. The golden Fijian plants are morphologically most like plants from Indonesia that are nearest to the original *C. rumphii*. However, they cannot be positively identified without at least mature seeds. There are a number of regional variants in the *C. rumphii* complex across its range, and much systematic research remains to be done. At least six species appear to be involved. The following are important diagnostic characters within the *C. rumphii* complex:

1. Extent of spinescence on petiole.
2. Relative length of petiole.
3. Leaf apex (spine or paired pinnae).
4. Number of pinnae.
5. Shape and spinescence of apical lamina of megasporophyll.
6. Presence or absence of a sharp ridge across the apex of the mature seed, or at least on either side of the micropyle (often obscured by the sarcotesta).
7. Length and shape of tip of microsporophyll.

These characters should all be noted when collecting seeds or specimens of the *C. rumphii* complex (and in fact of any other *Cycas*). Much of the confusion in *Cycas* taxonomy has resulted from decisions based on incomplete and inadequate basic data, and the gathering of more complete data is essential to the ultimate understanding of this complex genus.

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INITIAL OBSERVATIONS OF THE REPRODUCTIVE BEHAVIOUR AND AN INSECT POLLINATION AGENT OF *BOWENIA SERRULATA* (W. Bull) Chamberlain

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INTRODUCTION

The genus *Bowenia* Hook. ex Hook. f. contains two extant species which are restricted to transitional and rain forests of Central and Northern Queensland. The species are *B. spectabilis* and *B. serrulata*. Both species have subterranean stems, bipinnate foliage and stomata on both ab- and adaxial surfaces of the pinnae. Pinnae of *B. spectabilis* have entire margins, those of *B. serrulata* serrate. *B. serrulata* was initially described as a variety of *B. spectabilis* until work by Chamberlain resulted in the description by him of the second species in 1912.

The phylogenetics of the genus have been the subject of some debate. The genus was originally assigned to the Zamiaceae (J.D. Hooker 1863) but has recently been assigned to the subfamily Bowenioideae in the family Stangeriaceae (D.W. Stevenson 1992).

Chamberlain described *B. serrulata* from material collected from Byfield (22°51'S 150°39'E) in Central Queensland. This location is the most southern known for the species and much of the population is contained within the Bowenia State Forest under the control of the Forests Division of the Queensland Department of Primary Industry. The species is represented in Forestry Scientific Reserves and in the adjacent Byfield National Park but substantial areas of suitable habitat have been put to exotic *Pinus* species or cleared for residential or primary production purposes. Habitat modification, particularly by increased frequency of fire, is causing some concern for the welfare of this and other species. Northern populations of this species and *B. spectabilis* are variously protected in national parks and areas of the Wet Tropics World Heritage Listing. Both species are listed in Appendix II of the Convention on International Trade in Endangered Species (CITES) but are not listed in **Rare and Threatened Plants of Queensland 2nd Ed.** (Thomas & McDonald 1989).

Seed of the species are collected by the Forests Division and fronds and seed by licenced collectors for sale in the florist and nursery industries. Attempts to commercially grow the species for frond harvesting purposes have commenced.

In 1991 I commenced studies of the phylogenetics and ecology of the genus *Bowenia* and particularly of *B. serrulata*. This paper presents data from those studies.

MATERIALS AND METHODS

Observations of the coning frequency and phenology, and the pollination biology of *Bowenia serrulata* were made over a 22 month period from September 1991 to June 1993 at a study site at Byfield, Central Queensland. The observation period included two Wet/Dry Season cycles.

The study site was in transitional forest adjacent to the Waterpark Creek and had a nutrient poor sandy-loam substrate. The average annual rainfall (mean of 44 years) at the study site is 1649 mm, light levels on the forest floor are 10% of those on the canopy and *B. serrulata* is the dominant understorey species. A population of *Macrozamia miquelii* is located on slightly higher and less densely forested ground 300 m away.

The two species overlap in distribution. Two transects, 100 metres apart and each of 20 plants labelled with tags A1-20 and B1-20 respectively, and 10 female plants were monitored.

Twenty-two visits commencing September 1991 to Transect A and fourteen commencing May 1992 to Transect B were made during the study. Visits were made at one month intervals but access to the site was not possible in four months when roads were cut by flood waters or closed for repairs.

On each visit frond recruitment and morphometrics, the presence, size and sex of cones, the condition, and insect associations of the plant were recorded. Some data regarding pollen dehiscence and seed production of plants at the study site in the 1990/91 Season was collected from a university staff member who owns the adjoining property. These data are included in my graphed results and considered in the discussion.

RESULTS

Coning production and frequency

In Transect A seven (35%) in 1991/92 and two (10%) in 1992/93 of the plants produced cones. All cones produced, with the exception of a single cone by plant A11 in 1991/92, were male. A16, a male, produced a single cone in both seasons. Male A4 produced two cones in 1991/92 but none in 1992/93 and male A10 produced two cones in 1992/93 but none in 1991/92.

In Transect B male plant B1 produced two cones in 1992/93.

The 10 female plants monitored all produced cones in 1991/92 and two of them produced cones in 1992/93. One plant produced a single cone in both seasons and one plant produced two cones in each season.

A survey of 500 plants in May 1991, 1992 and 1993 revealed 1 in 9, 1 in 25 and 1 in 37 respectively with female cones.

Coning phenology

Male cones were first observed in September and female cones in October in both seasons.

Male cone growth (n = 7, 1991/92 and n = 5, 1992/93) was rapid with maximum pre-pollen dehiscence height being achieved in eight weeks. Pollen dehiscence occurred during the last two weeks of November in all three years and at a time of increasing rainfall and humidity and high mean wind speeds in the build-up to the Wet Season (Figures 1-3). Examination of rainfall records for 44 years for the study site revealed that the data for the two years of the study and of the year preceding it (1990) varied from the norm for the site but that the time of pollen dehiscence immediately preceded the onset of the Wet Season (Figure 4).

Pollination was amphiphilous with pollen distribution in the female cone being mediated by the weevil *Tranes subopaca* Lea. Adult weevils were collected from male and female cones. Male cones were destroyed immediately after pollen dehiscence by the weevil larvae burrowing in, and eating the tissue of the cone peduncle and microsporophylls.

Female cone growth (n = 10, 1991/92 and n = 3, 1992/93) was rapid for an initial four months but slowed thereafter with maximum size (mean = 102 mm) being achieved in seven months. Pollination occurred in November in 1990 (T. Susans, *pers. comm.*) and in 1991 and 1992. Female cones were disrupted and seeds dispersed by animal agents in late August/early September (mid Dry Season) in 1991 and 1992 but commencing early June (early Dry Season) in 1993 and in each case before the seed coat was fully coloured.

DISCUSSION

This paper presents data on the coning frequency and phenology, and aspects of the pollination biology of *Bowenia serrulata*. The study is on-going but some discussion of the initial results is useful.

Coning frequency

The observation that low Wet Season rainfall results in low cone production in the following year and the converse in good years indicates that cone production is, at least in part, a response to soil moisture content.

Drought is a common feature in the Australian environment and during this study the monsoon failed in both 1991/92 and 1992/93 when cone production was reduced. The 1990/91 Wet Season peak was the result of rains associated with a cyclonic weather system. On-going observations will reveal if cone production is down in 1993.

The observations that both male and female plants can produce cones in successive years indicate that periods of low productivity can be countered by periods of high productivity.

In a stable environment the population would not be at risk but continued land clearing, habitat modification, and frequent El Nino-Southern Oscillation (ENSO) events and associated drought in Eastern Australia suggest that cone production may fall in future years. In

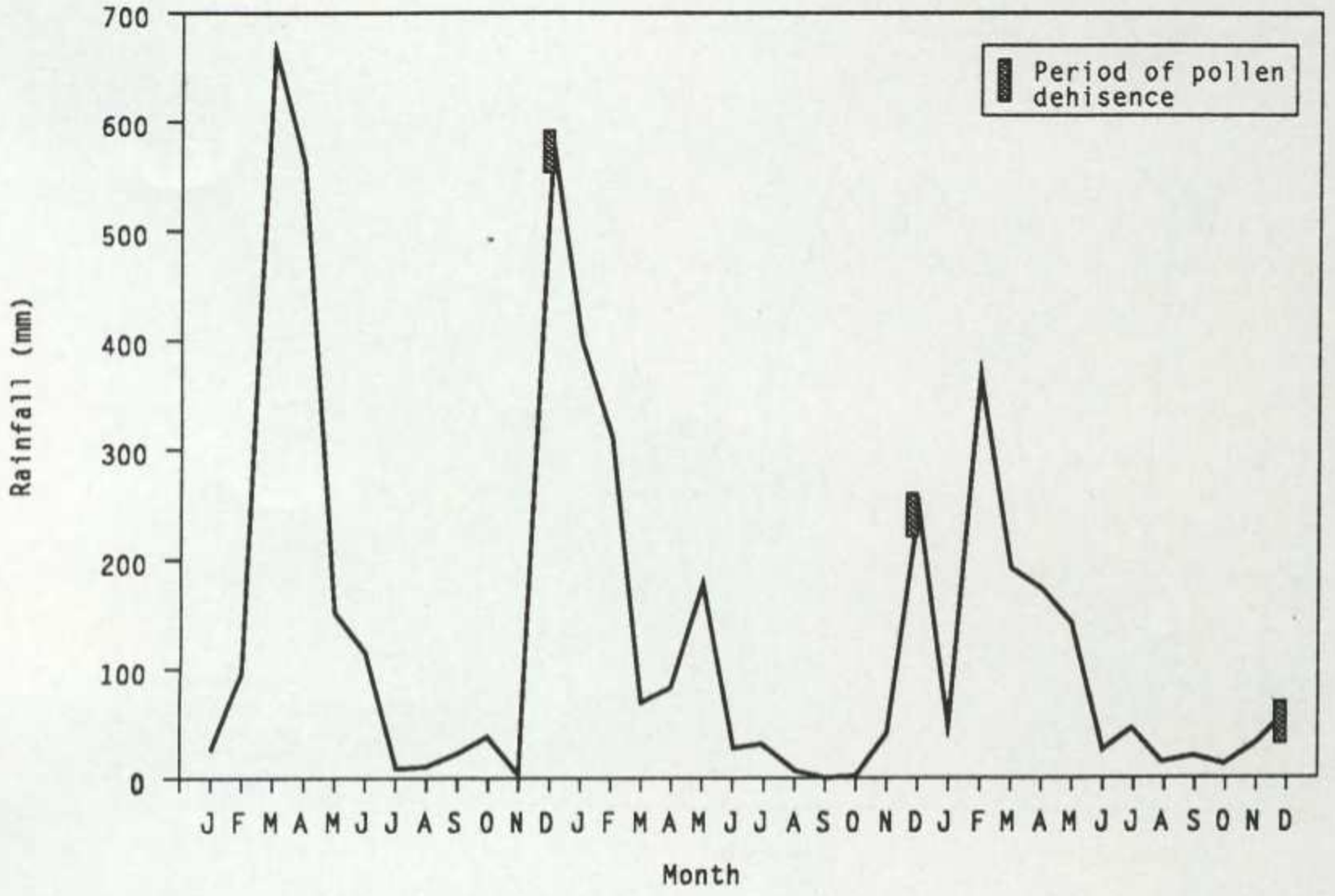

Figure 1 Monthly rainfall for the years 1990, 1991 and 1992 and the periods of pollen dehiscence of *Bowenia serrulata* at Byfield, Central Queensland.

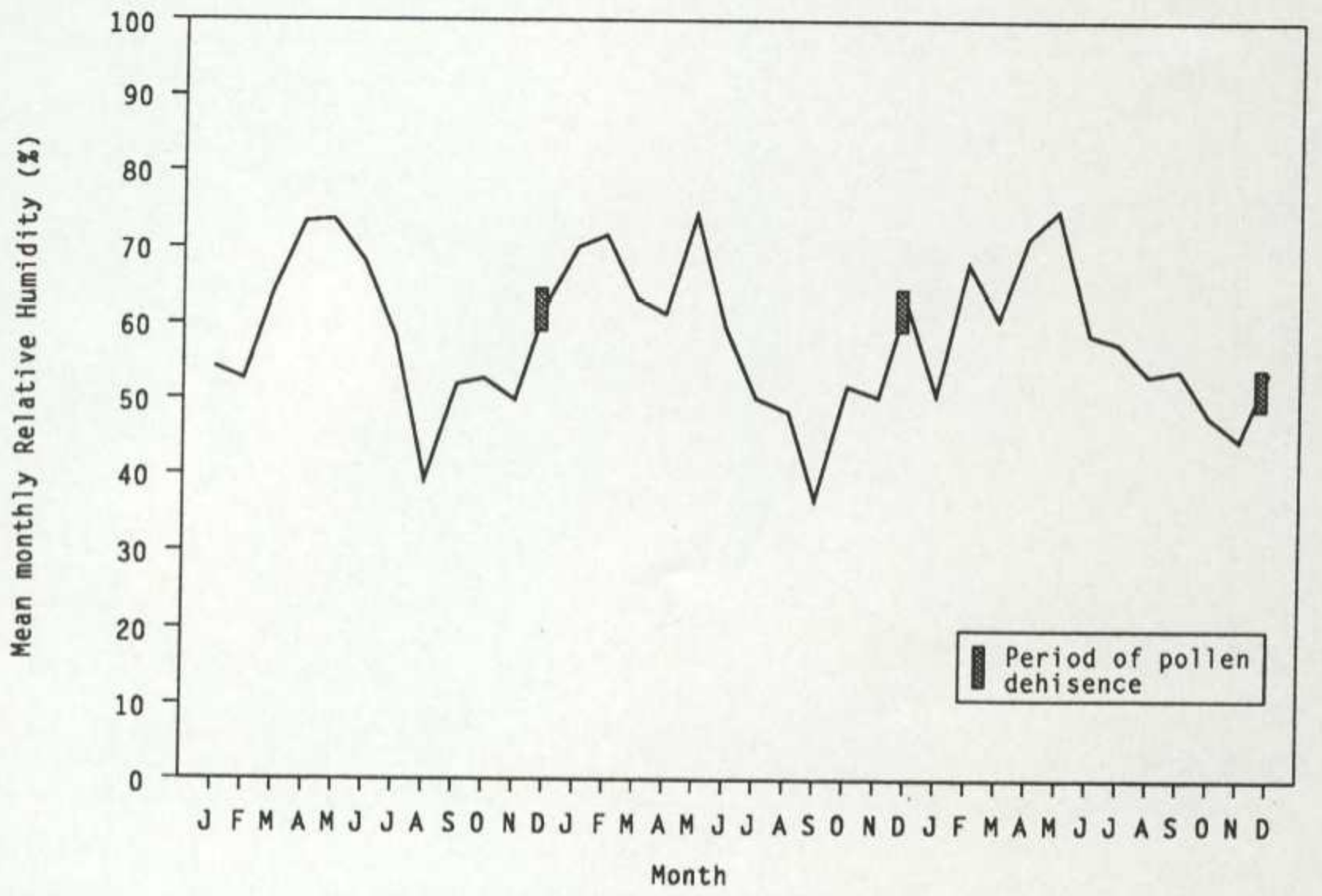

Figure 2 Monthly mean relative humidity (%) at 15h00 for the years 1990, 1991 and 1992 and pollen dehiscence of *Bowenia serrulata* at Byfield, Central Queensland.

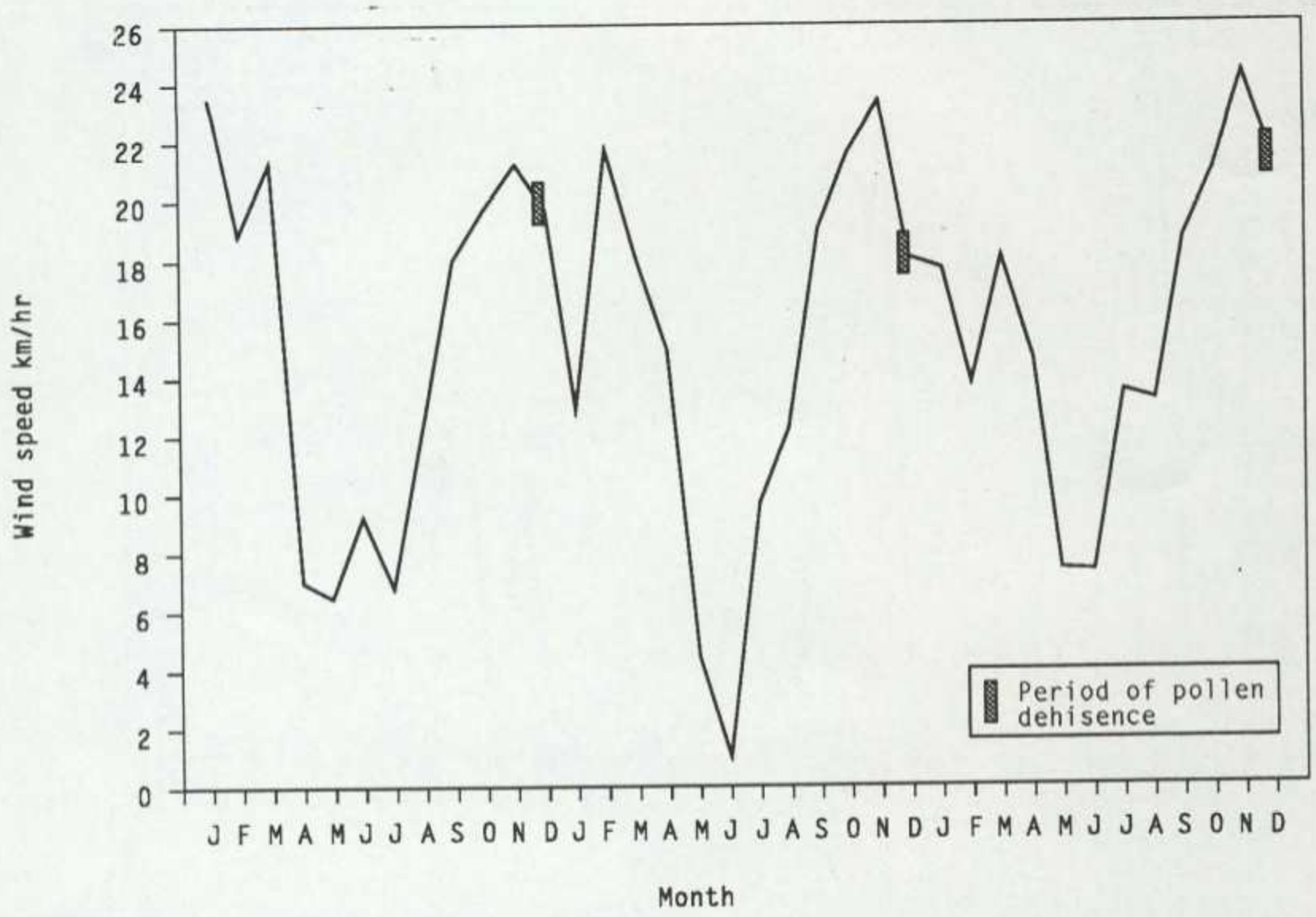

Figure 3 Monthly mean wind velocity at 15h00 for the years 1990, 1991 and 1992 and pollen dehiscence of *Bowenia serrulata* at Byfield, Central Queensland.

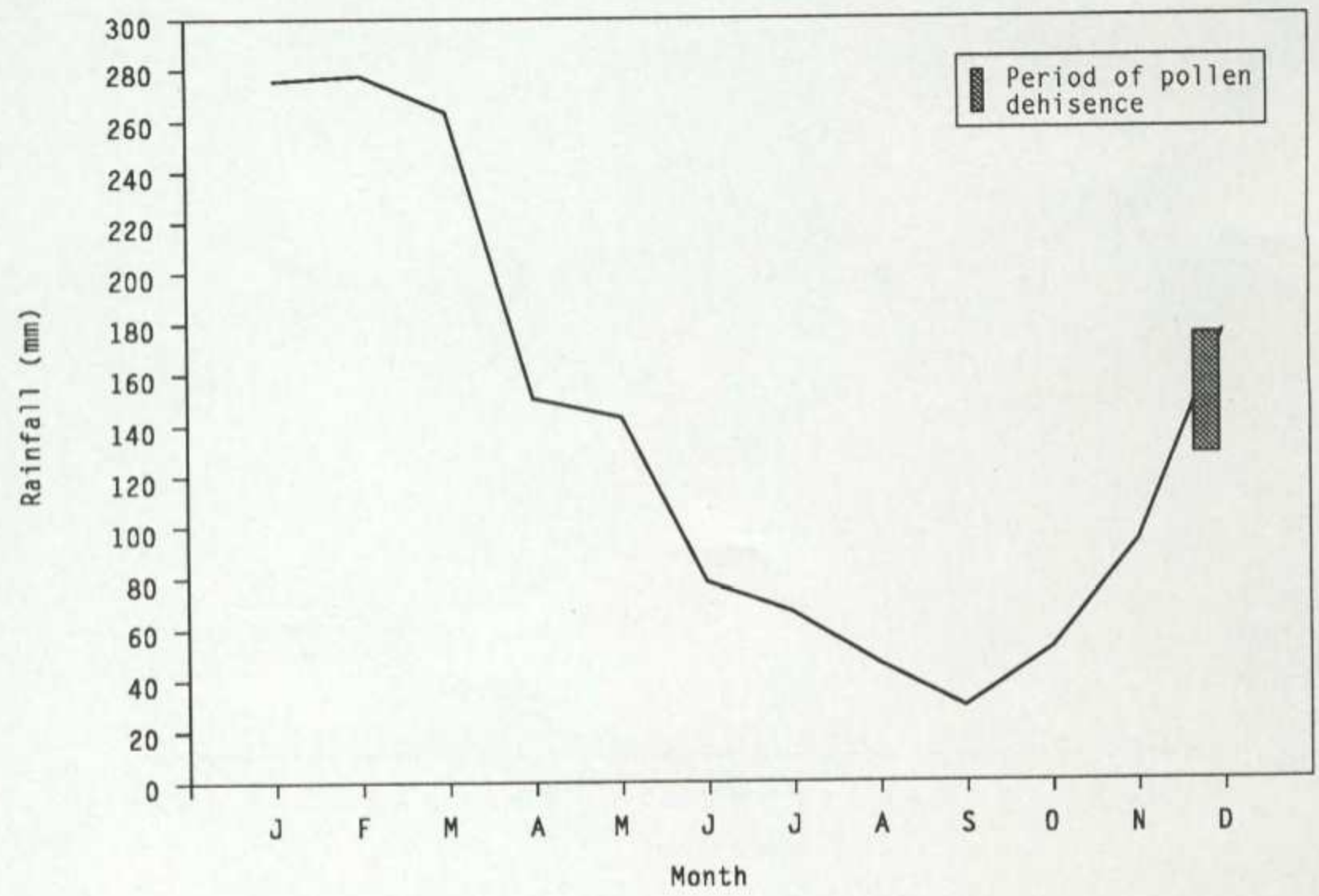

Figure 4 Mean monthly rainfall over 44 years at Byfield, Central Queensland and period of pollen dehiscence over three years of *Bowenia serrulata*.

such an environment the level of frond and seed collection requires close attention.

Cone phenology and pollination biology

The pollination of *B. serrulata* is amphiphilic (wind transfer followed by insect placement; Norstog 1987). The wind-mediated phase of this process occurs in an environment where totally anemophilic species are uncommon (Whitehead 1969, Bawa & Crisp 1980) and climatic conditions which favour wind pollination do not generally occur. In *B. serrulata* pollen dehiscence occurs during a brief time-window when conditions for wind dispersal of pollen are most favourable, they are not however, optimal. The likelihood of successful pollen transfer to the female cone is enhanced by a high male to female cone ratio.

The maximum rate of pollen deposition at ground from an elevated pollen source is approximately proportional to the square of the height of the pollen source (Colwell 1951, Tauber 1965). The concentration is approximately proportional to the strength of the emitting source (in grains per second) and inversely proportional to the degree of turbulence and wind velocity (Gregory 1961, Tauber 1965). The pollen of *Bowenia* is aerodynamic in shape, of medium size, ca. 30μm (Dehgan & Dehgan *1980) and readily* able to be conveyed by air currents.

However, in *B. serrulata* the pollen source, the male cone, is only centimetres above the ground and the distance of maximum ground level concentration correspondingly close, and at female cone densities indicated by this study, unlikely to include a female cone. The density of surrounding vegetation, particularly of grasses about the cone, further reduces pollen dispersal.

The discovery of the weevil *Tranes subopaca* involved in pollen transfer to the axially-orientated micropyle of the ovary indicates that total anemophilous pollination is not a successful strategy in *B. serrulata*. The role of the weevil is the more interesting in that the species was described from a single female and the male and the species habits were totally unknown until this study (Zimmerman, *pers. comm.*).

Superficial and unprotected stomata are found on both surfaces of the pinnae on *B. serrulata* and *B. spectabilis* and in the Eocene warm-temperate to subtropical *B. papillosa* and *B. eocene* (Hill 1978). This suggests that *Bowenia* has existed in a mesic environment for some 45 million years, that anemophilic pollination may not have been a successful strategy for the whole or part of that period, and that the *Bowenia/Tranes* association may be of considerable antiquity.

The study population is the most southern of the extant species and the species' distribution extends as far north as the McIlwraith Range (13°30'S) in Far North Queensland. All populations of *Bowenia* are subject to a monsoon climate but the variation in factors such as photoperiod, wind-speed, rainfall, and humidity which may affect coning phenology lessen as the latitude. Tang (1985) notes that pollen dehiscence in *B. spectabilis* grown in the subtropical conditions of the Fairchild Tropical Garden in Miami, Florida occurs in late April and May. This period is prior to the Wet Season of the Northern Hemisphere and suggests that photoperiod and/or similar factors to those described above may be operational at both locations. Comparisons between the two populations and species can be useful but should be made with caution.

Borchet (1992) observes that "most manifestations of plant and animal life in tropical forests are periodic, even where seasonal variation in temperature, water availability, and photoperiod are small". The time of expression of climatic and environmental factors have changed substantially in the life of the taxa of *Bowenia*, a change in photoperiod has occurred but it has been a gradual and sequential change easily adapted to by the plant. Accordingly photoperiod could be suggested as a factor in the timing of pollen dehiscence. However it is unlikely to be a primary factor as such a cue would be of little use if the other factors required for a successful pollination event in a closed or rain forest species were not optimal. The observation by me that male *B. spectabilis* plants grown at this latitude consistently produce cones two weeks prior to local *B. serrulata* also suggests that photoperiod is not the prime cue.

The coning phenology of *B. serrulata* is likely to be a result of a complex interaction between selection pressures for optimum pollen dispersal and environmental parameters. Continuing studies of the Byfield population and of the northern populations of this species and of *B. spectabilis* and particularly of Northern Hemisphere nursery stocks should clarify the various effects of these factors.

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SPERMATOZOIDS OF *ENCEPHALARTOS VILLOSUS*

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That cycads have motile, multiciliated male gametes has been known for about 90 years (Schuchmann 1990). Although these spermatozoids have been studied microscopically in eight of the eleven currently known cycad families (Norstog 1990), there has as yet been no report in the literature on the structure of *Encephalartos* spermatozoids.

While I was dissecting artificially pollinated female cones of *E. villosus* plants growing in the southern part of the Pretoria Botanical Gardens, I was disappointed in noticing the large number of ovules per cone that did not contain pollen tubes. Eventually I came across a cone with an unusually large number of successfully pollinated ovules. Among the sporophylls I found a few weevils of a *Porthetes* species that has, as yet, not been described (R.G. Oberprieler, *pers. comm.*). On 19 April co-worker Isabella Claassen pollinated this cone by strewing fresh *E. villosus* pollen onto the opening apical megasporophylls. She also transferred a number of weevils of the above-mentioned *Porthetes* species (identification confirmed by Rolf Oberprieler), that occurred inside the male cone from which the pollen was collected, to the female cone. Unaware of the date of this action, though observing the pollen on the cone, Dawie Strydom and I again pollinated the cone on 20 April by injecting a suspension of pollen grains into the cone as previously described by Steyn & Strydom (1993). Pollen from the same batch had been used to pollinate the other plants in the southern part of the garden as well as the plants on the northern side of the ridge.

In the well-pollinated cone investigated during the present study, the first pollen tubes were found emerging from the nucellus on 13 August. Seven days later, 92% of 50 dissected ovules, collected from the apex to the base of the cone, contained tubes that varied between 12-32, with a mean value of 22 per ovule. These results suggest that the weevils that were transferred to the cone may have been responsible for the successful pollination of the cone. It seems possible that the insects had dispersed not only the dry pollen grains, but also the wet grains injected into the cone the following day, among the ovules.

Under a dissecting microscope, pollen tubes were carefully torn away from the nucellus caps, placed into drops of 12 % sucrose on glass slides and studied under a Vanox photomicroscope.

In well-developed pollen tubes the large spermatozoids could easily be seen through the tube wall as two dense masses near the tip of each tube (Figure 1). In some of the tubes the spermatozoids showed no movements at all. They might have been injured during dissection of the tubes. In many tubes the pointed apices of the spermatozoids showed a rapid pulsating movement. The spiral ciliated bands were visible, but the transparent cilia could not be easily observed through the wall of the tube. Within the tubes, actively swimming spermatozoids were not seen, nor did I notice any tube bursting of its own accord. I therefore tried to open the tubes. After many unsuccessful attempts to tear the tube wall, I succeeded in freeing the spermatozoids. Some of them swam vigorously in the drop of sucrose, then slowed down and rotated slowly. Seen from the side, a spermatozoid at this stage resembled a spinning top. They were approximately 270 µm long when the apex was projected forward and 220 µm (approximately one-fifth of a millimetre) in diameter. After several minutes they became stationary, except for the cilia that continued to move (Figure 2). After two hours all ciliary movements stopped and the cell apex was retracted (Figures 3, 4). The spiral ciliated band that consisted of at least four coils and encircled the anterior half of the living cell (Figure 2), could be seen more clearly in these motionless spermatozoids (Figures 3, 4).

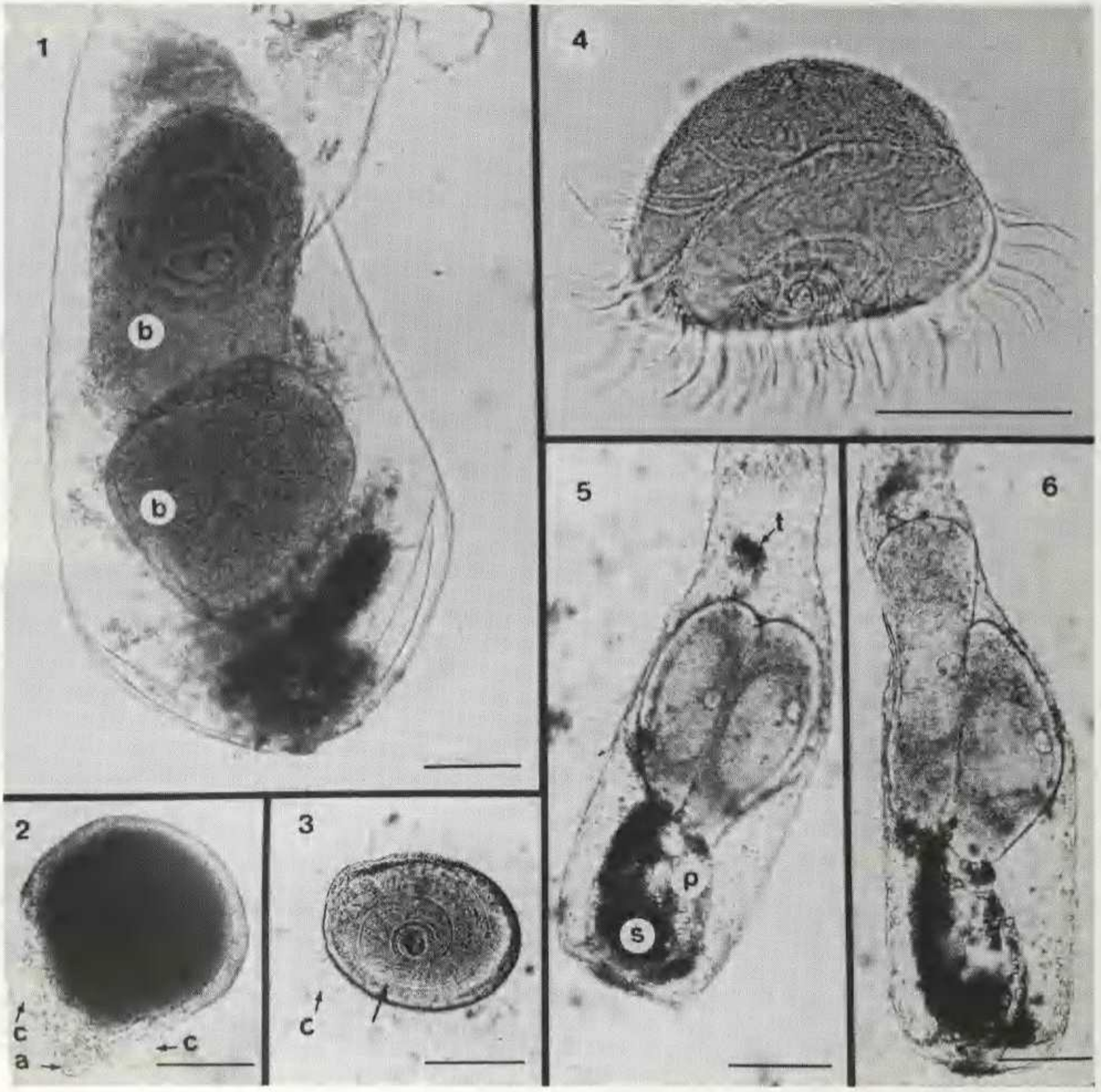

Figure 1 Photomicrograph of a well-developed pollen tube with two mature spermatozoids (b). Scale bar 0.1 mm. **Figure 2** Photomicrograph of a live spermatozoid dissected from a pollen tube and photographed after it had become stationary, except for the movement of the cilia (c). Note the projected apex (a). Scale bar 0.1 mm. **Figure 3** Motionless spermatozoids as seen from beneath. Note the spiral ciliated band (arrow) and cilia (c). Scale bar 0.1 mm. **Figure 4** Side view of motionless spermatozoid at a larger magnification than in Figure 3. Note the flattened apex, the four coils in the spiral band and the well-developed cilia. Scale bar 0.1 mm. **Figures 5, 6** Photomicrographs taken at the same magnification as Figure 1, showing an under-developed pollen tube with two immature spermatozoids. **Figure 5** illustrates two seemingly identical young spermatozoids. Note the large nucleus in each cell and the faintly visible tube cell (t), sterile cell (s) and prothallial cell (p). **Figure 6** illustrates the same pollen tube as in Figure 5 after three minutes in a 12% sucrose solution. Note that the spermatozoids have changed in shape. Scale bar 0.1 mm.

Dispersed among the numerous large pollen tubes, small tubes with immature spermatozoids often occurred (Figure 5). The latter had obviously resulted from a longitudinal division of the spermatogenous cell. That the young spermatozoids were alive, could be deduced from the fact that they were slowly changing their shape inside the tube (compare Figures 5 and 6). Three additional cells could be see in the tube, namely a small tube cell (Figure 5), a large prothallial cell and a dark-staining sterile cell ("stalk cell" of older literature,

according to Norstog 1990) that partly encircled the prothallial cell (Figures 5, 6).

Results obtained during the present study indicated that spermatozoids of *Encephalartos*, at least as far as their number per pollen tube and external characters are concerned, are similar to those described for *Macrozamia spiralis* (Brough & Taylor 1940) and *Zamia* sp. (Norstog & Overstreet 1965, Schuchmann 1990). The results also suggest that in a cycad population, environmental factors such as temperature may have a significant influence on the rate of pollen tube growth within individual cones. In *E. villosus* plants, located on the southern side of the ridge running through the Pretoria Botanical Garden, pollen tube growth was slower than in those growing on the northern slopes. In the latter plants pollen tubes had entered the archegonial chambers approximately two months after pollination (Steyn & Strydom 1993). In the plant on the southern side, pollen tube growth took four months. Whether temperature does have a regulating effect on the rate of pollen tube and/or embryo growth should perhaps be investigated under controlled laboratory conditions.

ACKNOWLEDGEMENTS

I wish to thank the National Botanical Institute at Pretoria for providing the infrastructure to execute this study, Isabella Claassen who supplied literature that describes a method for procuring live spermatozoids, and Rolf Oberprieler, National Collection of Insects, Plant Protection Research Institute, who identified the weevils.

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A NEW SPECIES OF *ZAMIA* FROM AMAZONIAN PERU

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This article is dedicated to the memory of Dr. Alwyn Gentry, Senior Curator of Botany at the Missouri Botanic Garden and generally recognized before his recent death, as the greatest living authority on neotropical botany. I had the great pleasure of taking a field class from Dr. Gentry and found him possessing a very rare combination of two characteristics. He was both a supreme expert in his field in addition to ready, willing and able to convey his knowledge to beginning students.

There are no described species of *Zamia* from the Amazonian area of north-east Peru although they are known to exist there. This is not at all surprising as there are several species of *Zamia* known in Colombia which is the country to the immediate north of Peru. It is also known that Amazonian Peru is the most biodiverse area in the world and this has resulted in this area being relatively well studied. The fact that there is much left to be studied in this is accentuated by the fact that the palm species *Manicaria saccifera*, which is a very wide ranging species known from Central and northern South America, was only very recently found to exist in the relatively well studied forest between the Napo and Amazon rivers near Iquitos. One small area in southern Peru has 100 known species of frogs, and one sixth of the world avian fauna (that is 1,700 species) is found in Peru. The figures for plants are equally impressive with 25,000 species of vascular plants known from the Amazon rain forest with many more remaining to be discovered and/or described. Even Ecuador, the tiny neighbour of Peru has an estimated 13,000 species of vascular plants which is more than the total flora of Europe.

Although my degree is in Entomology, my interests have somewhat shifted to plants, especially cycads. Most of my field studies have been in southern Africa but I have been concentrating more and more on Latin America with its extreme biodiversity. Earlier this year, I visited the Iquitos area of Peru and went down the Amazon and Napo rivers.

In the Iquitos area I made the acquaintance of three

field botanists and asked them if they knew of any cycads in the area. The answers I got ranged from "there are none here" to "there are at least three species here". I now know from personal experience, that there are at least two very different species here. I find that it is always somewhat difficult locating plants when I do not have precise locality data and this is especially true with plants like cycads that often have seemingly very restricted habitat preferences. I find it very amazing that in the neotropics, two areas can look identical (to me) however some species are found in one and not the other. This fact is readily illustrated by the fact that two areas can appear virtually identical and yet one will contain several epiphytic orchid species and the other will have none.

Figure 1 The author and *Zamia* sp., Amazonian Peru.

I walked and walked through several areas near the Napo River looking for Zamias. It was somewhat difficult to concentrate on this as there are so many things to be distracted by. There is always a new insect or snake, or frog, or palm, etc., to see. It is also very hot and humid there which limits the time that one can spend in the field. There are many, many species of ferns and small palms that first looked like *Zamia* but were nothing but false alarms.

One day I was at a small river camp waiting for something to eat and decided to photograph some of the orchids that were blooming. I started to climb up into one of the trees to photograph one of the orchids and was continually stabbed by the spines of the plant growing next to it. I was ready to cut these leaves off when I noticed that they belonged to a *Zamia* with leaves about eight feet long. All this time, I was looking for a rather small plant and here I was within a few feet of this monster for several hours and never saw it until I practically fell in it. I asked one of the local people about it and he told me that it was called the plastic plant (because of the plastic-like nature of the leaves) and that it was quite common nearby.

Figure 2 Leaf detail of *Zamia* sp., Amazonian Peru.

After receiving detailed instructions from this man as to where to look, I immediately set out to find more. His last admonishment was: "Don't get lost!". Good advice as this would have been very easy to do (and not so easy to undo!). I looked for about two hours and could not find a single plant even though I was quite sure that I was in the area that I was sent to. I returned to the man

who had directed me and told him my problem and asked him to go with me. We set out together and upon reaching the same area that I had searched, he too found nothing. We continued for about another hour with this man telling me to wait as he disappeared into the forest, returned and disappeared again. Finally he found another plant. The plant was close to a trail and thus had all but one of the leaves cut off (Figure 1).

This species has leaves slightly less than three metres long although the trunk is quite small being slightly larger than a man's fist. The leaves are covered with lichens, moss and similar plants which does not surprise me as the humidity was very high. The leaves are similar to those of *Zamia manacata*, which is found in western Colombia and adjacent southern Panama, in that the leaflets are petiolulate, that is they are not attached directly to the petiole but are subtended by a small petiolule. Like *Z. manacata*, this species is also characterized by the presence of a collar or gland-like structure on the petiolule (Figure 2). To the best of my knowledge, this petiolule and collar-like appendage is found only in this species and *Z. manacata*, although *Z. wallisii* from western Colombia does have a petiolule alone.

When I attended the first international cycad conference, CYCAD 87, in Beaulieu-sur-Mer, France in April 1987, Sergio Sabato gave a lecture on the West Indian and South American cycads. He briefly mentioned a species from Amazonian Peru similar to this species and I believe that the plants I saw are the same as those that he referred to.

As far as I know, this species can not be formally described as the cones are as yet unknown. When the species is formally described, I would like to suggest the name *Zamia gentryi*.

SOME *CYCAS* SPECIES WITH UNDULATE LEAFLETS

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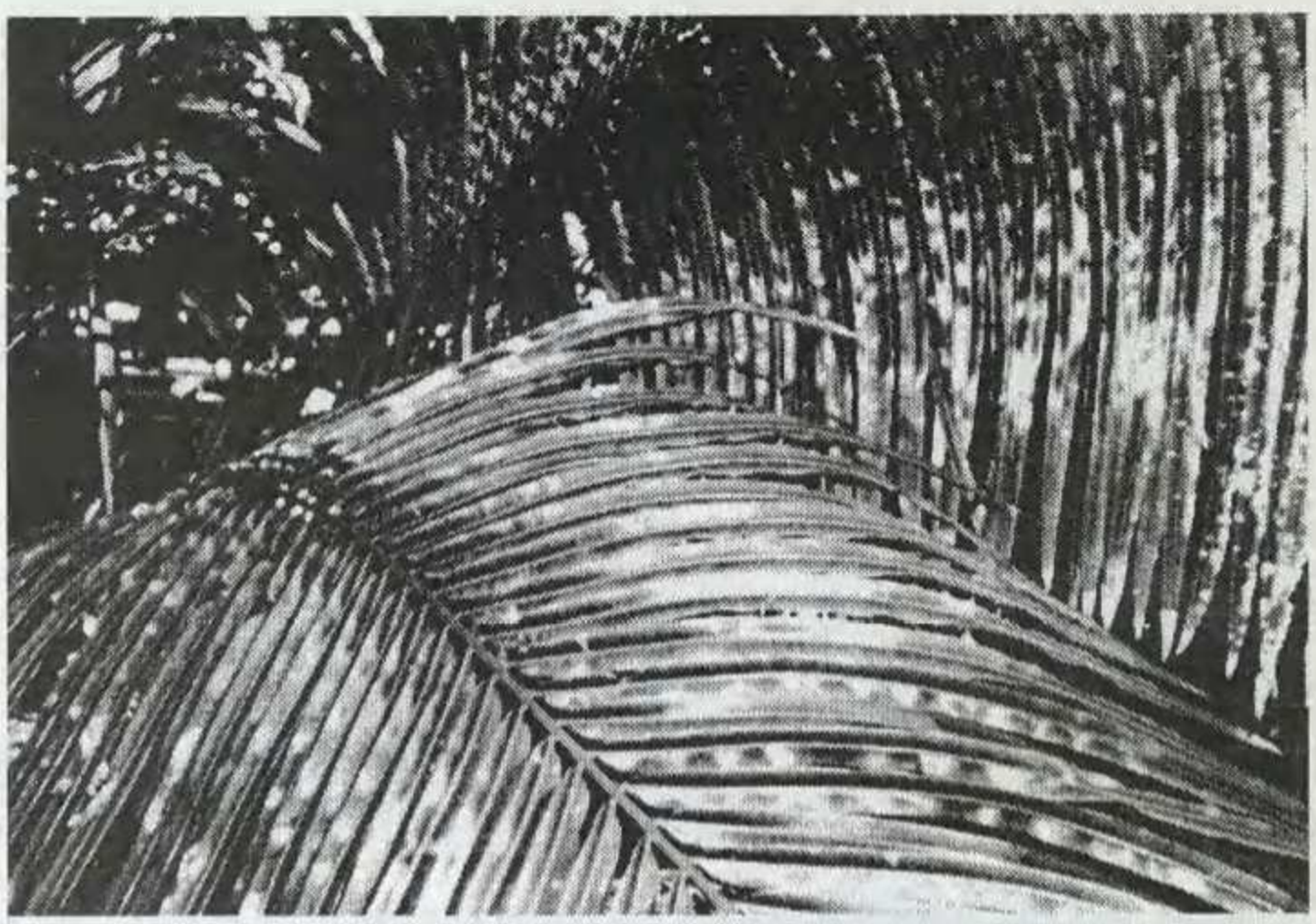
The matter of identities of *Cycas* species with undulate leaflets was raised in "*Encephalartos*" 5: 33 when John Hendricks explained that there may be two taxa which have this undulate effect. One is *Cycas micholitzii* var. *simplicipinna* (Smitinand 1971) from continental S.E. Asia while the other is *Cycas rumphii* forma *seemanii* (Kanehira, 1938) which is described from Fiji.

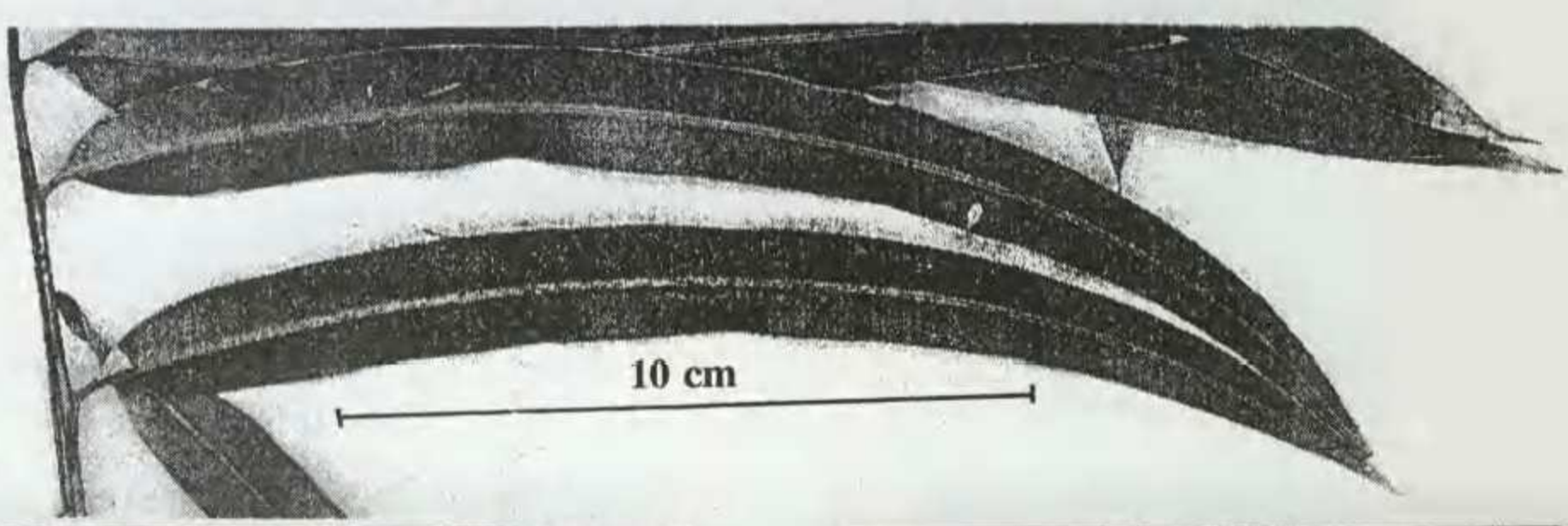
As a result of my own observations, I can confirm these findings but I also believe that there may be further variation which may warrant classification at a different specific, subspecific or varietal level. I feel that only careful fieldwork and data collection can resolve the current *Cycas* vagaries.

The first plant I have studied, illustrated in Figure 1, is recorded from Chiang Mai in northern Thailand, thus falling within the distribution area of *C. micholitzii* var. *simplicipinna*, details of which are shown in Figure 2. The Chiang Mai plant has a finely-dissected fringe at the end of the megasporophylls which are golden in appearance and it has lax, lime-green leaves. By contrast, *C. micholitzii* var. *simplicipinna* has a heavier aspect to the sporophyll blades, does not show the golden sporophyll appearance, and has erect, stiff, dark green leaves. Both plants have very glossy leaf surfaces but the leaflets of the Chiang Mai plant are long, wide and slightly falcate, with gentle undulations, while those of the named variety are narrower and linear, with regular and distinct undulations. The Chiang Mai plant has long petioles and holds only a few leaves at a time while *C. micholitzii* var. *simplicipinna* has shorter petioles with closely-spaced prickles. Because of the Chiang Mai plant's larger leafbases, its caudex has prominent "knobs" while *C. micholitzii* var. *simplicipinna* has no obvious leafbase scars. The Chiang Mai plant generally has a single stem, while the named species clumps profusely. Caudices of the unnamed plant are tan in colour; those of the named plant are reddish brown and appear woolly. In cultivation, plants of the Chiang Mai population in filtered shade appear to be deciduous, while the *C. micholitzii* var. *simplicipinna* plants have a consistent appearance in both full sun and in deep shade.

Other *Cycas* plants with an undulate leaflet appearance comprise a population of *C. rumphii* var. *seemannii* from Fiji (See "*Encephalartos*" 19: 48-50). Seedlings we have grown in filtered light have glaucous leaflets with strong undulations and we are told that this is characteristic of at least one of the habitat populations. Of two populations studied, one of about 40 plants at Viti Levu near Nadi, and the other at Vanna Levu, only one has produced seedlings with undulate leaflets margins. However, it seems that *C. rumphii* var. *seemannii* itself may not be typically undulate. Figure 3 illustrates a



A



B

C

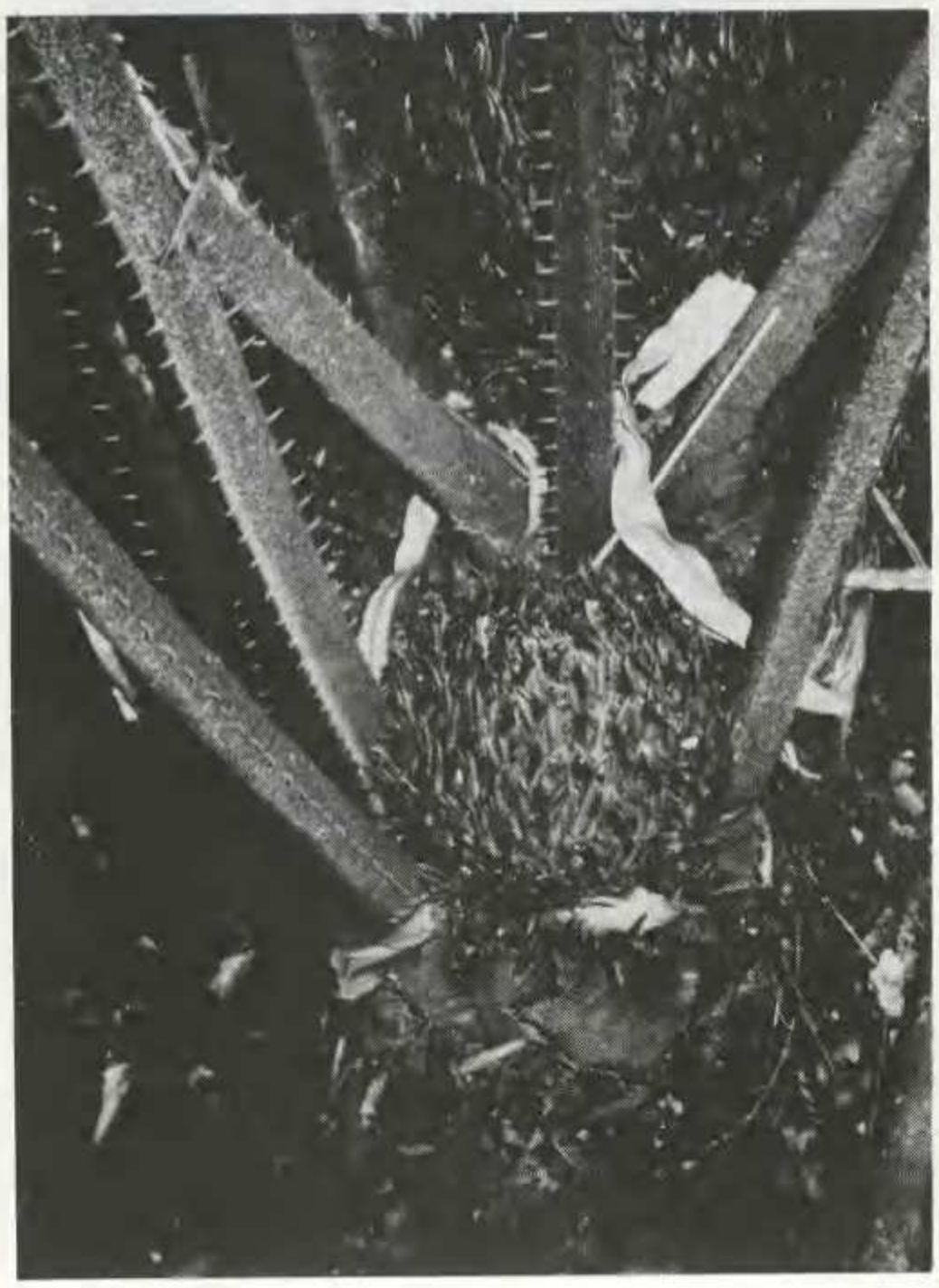
D

Figure 1 *Cycas* sp. from Chiang Mai, northern Thailand.
A: Leaf detail showing gentle undulations. **B:** Leaflet detail.
C: Caudex showing leaf base pattern and the petiole appearance, with few prickles. **D:** Megastrobilus showing the megasporophyll appearance.

A

10cm

B

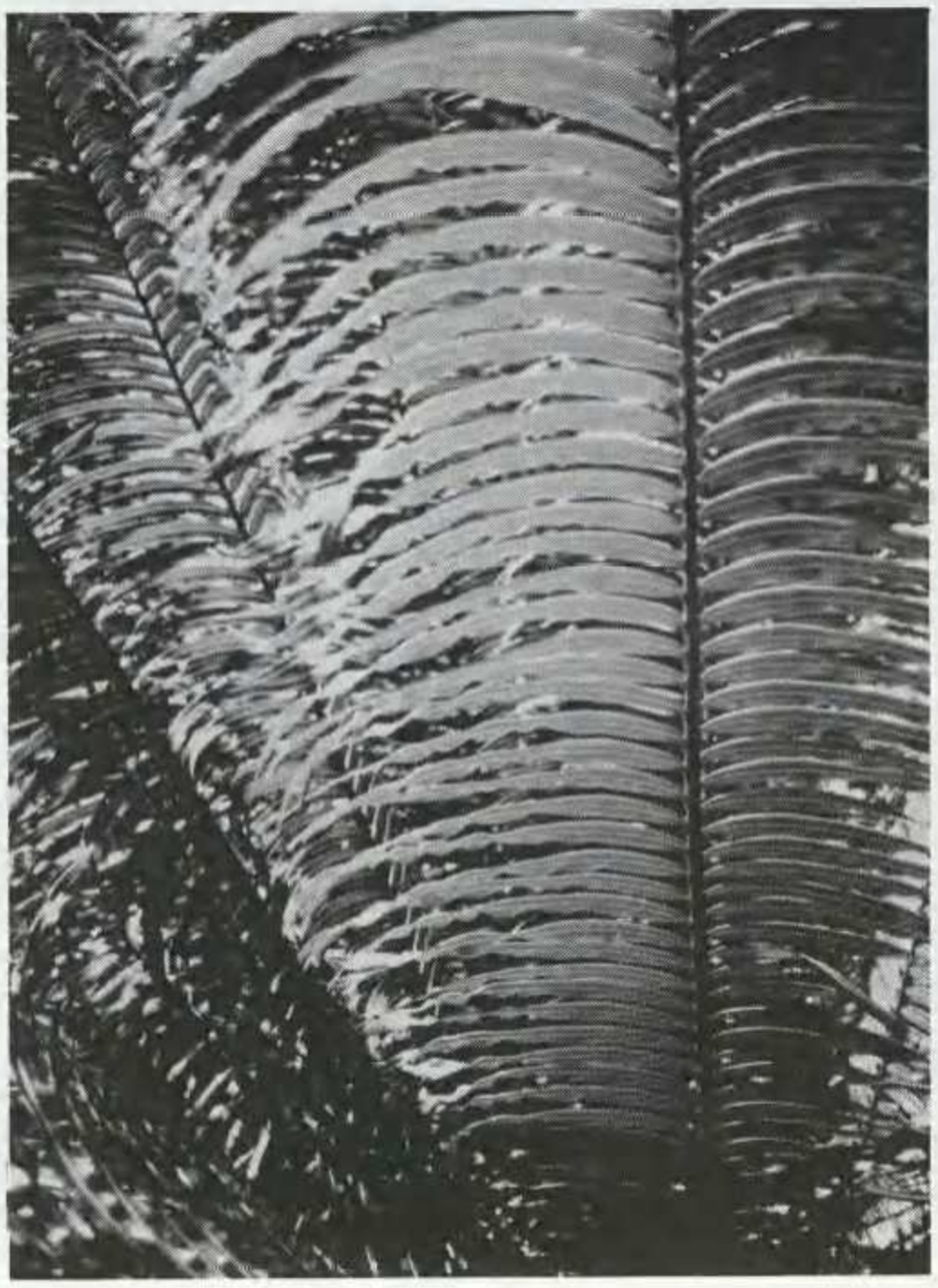


C

5 cm

D

Figure 2 *Cycas micholitzii* var. *simplicipinna*. **A:** Multi-headed appearance. Note strong, regular undulations. **B:** Leaflet details. **C:** Caudex and petiole detail, showing numerous prickles. **D:** Megasporophyll detail.



A

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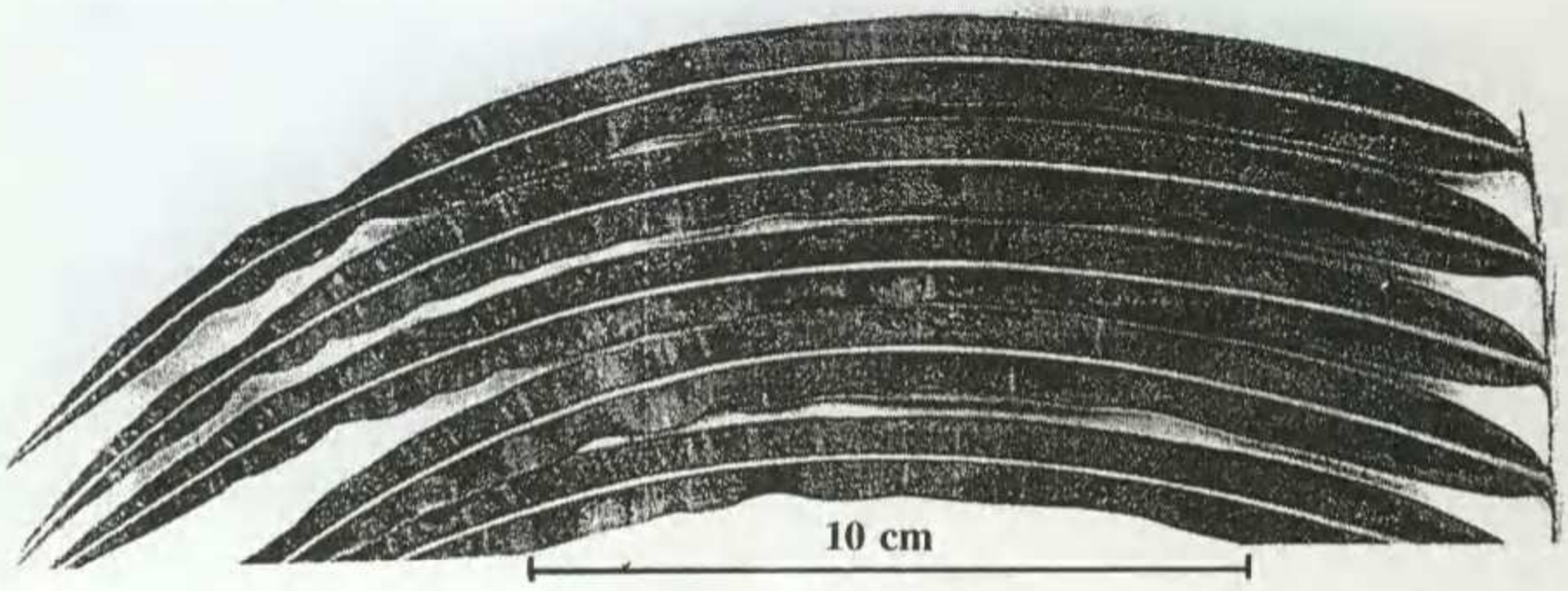

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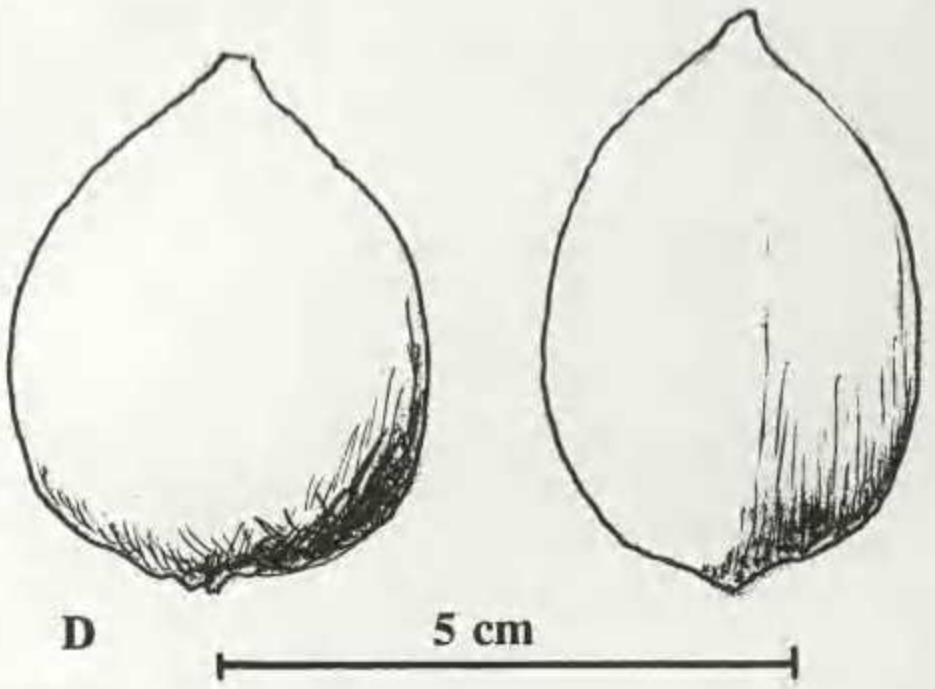
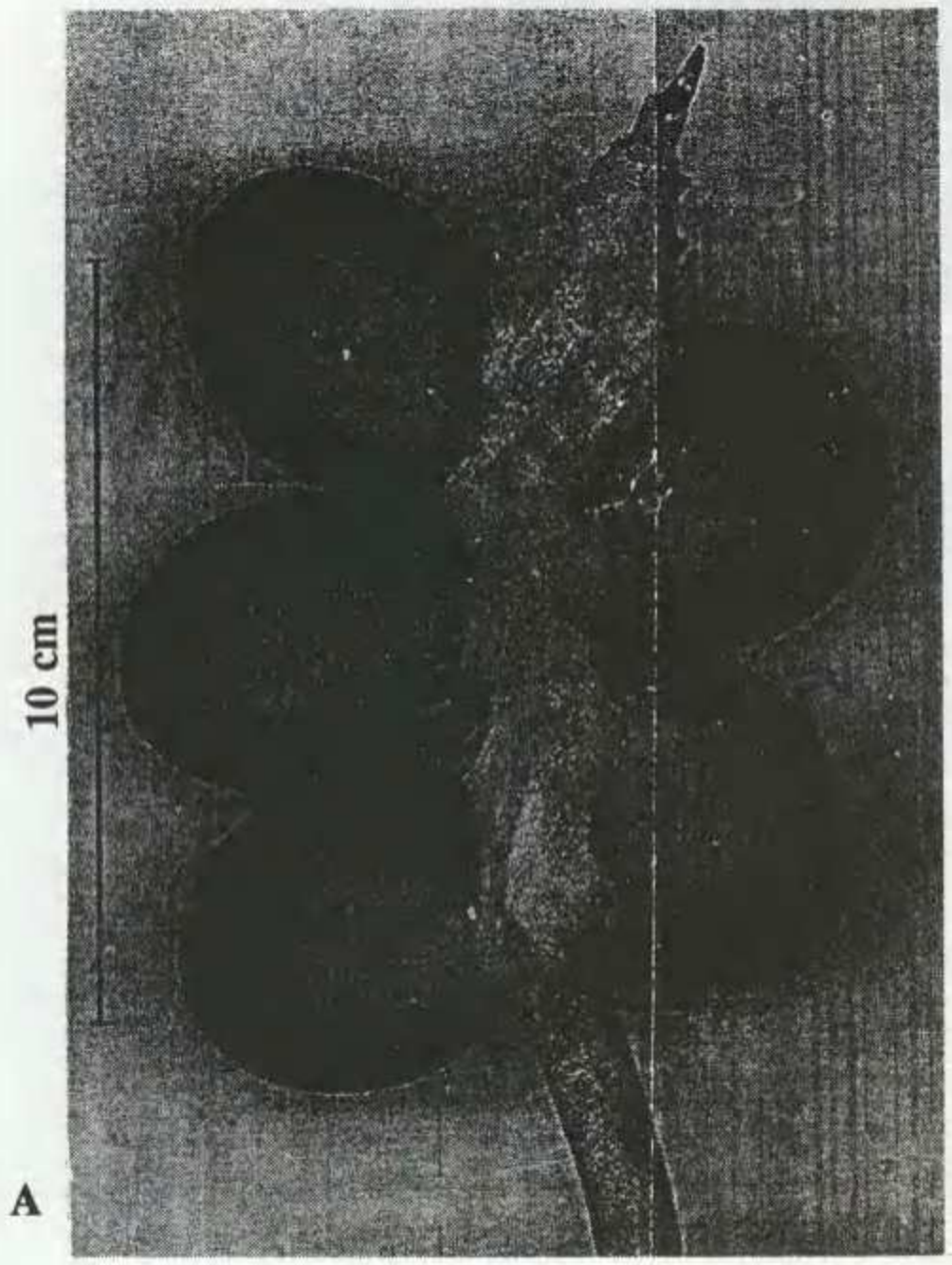


D

Figure 3 *Cycas rumphii* complex. Specimens from a population on the Marianas Islands, showing undulate leaflets. **A:** Leaves and general vegetative appearance. **B:** Megasporophyll detail. **C:** Leaflet detail. **D:** Seed detail.



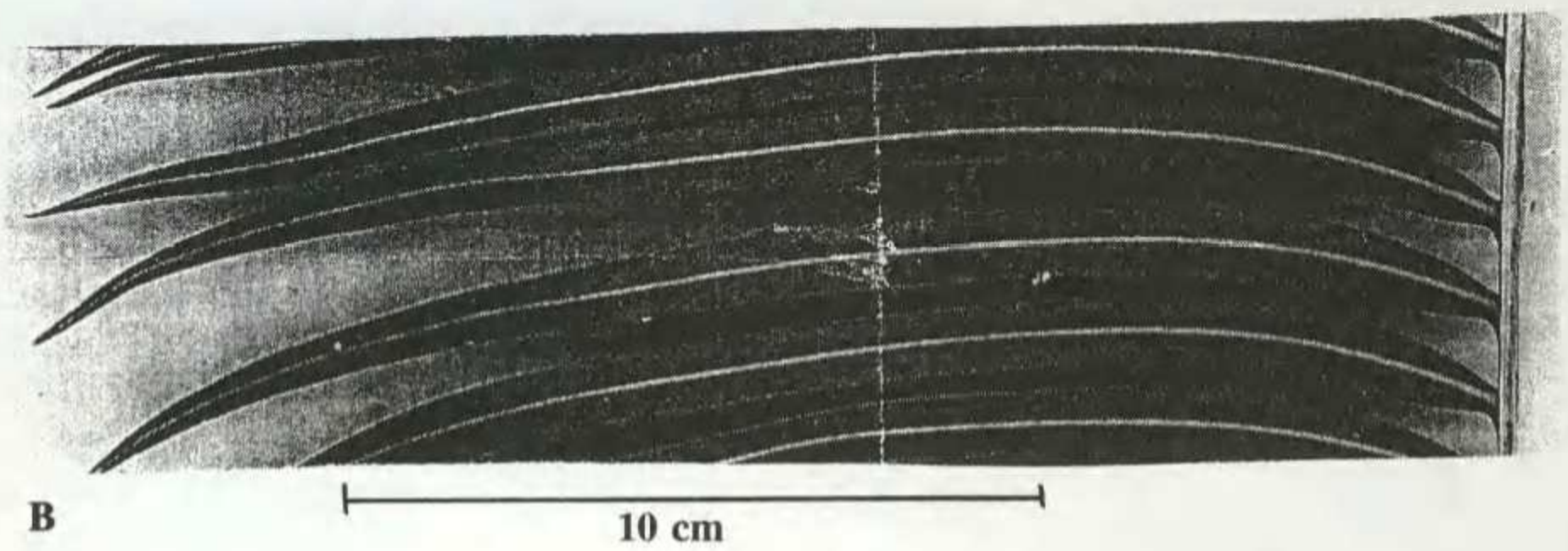


Figure 4 *Cycas rumphii* forma *seemannii*. The "typical" form. **A:** Megasporophyll bearing near-mature seeds. **B:** Leaflet detail.

Cycas specimen from the Marianas Islands which shows a strongly undulate leaflet appearance; Figure 4 shows the "typical" form.

Polymorphic species such as *Cycas rumphii* illustrate an important point. In cultivation I have seen seedling specimens with undulate leaflets margins, which later loose this characteristic. I have witnessed these undulations appear/disappear/reappear. The presence, absence or relative abundance of petiole prickles can also vary through a plant's life or manifest itself only on certain fronds. Furthermore, the megasporophylls of specimens of *C. rumphii* var. *seemannii* which I have seen exhibit teeth on the apical blade, quite different to the current concept of the type.

As a final note, I am very uncomfortable about the current status of several *Cycas* species. Since many characters are very variable, it is important that stable morphological markers are identified; this can only arise from complete and accurate field studies.

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[Leland has submitted these comments very much as a contribution for discussion. Can any of our *Cycas* enthusiasts add to the above? Write to the Editor or directly to Leland Miyano - **Roy Osborne.**]

MATE CHOICE IN CYCADS

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Choosing a mate is one of the most important decisions in life. Whether it is a human being looking for a spouse or a bird or an insect during the mating season, elaborate rituals and courtships are often employed before pairing and the exchange of gametes can begin. The reason for these elaborate behaviours is that the female can only produce a limited number of eggs and offspring and therefore must screen and carefully choose the best mate before allowing him to fertilize her eggs and father her offspring.

How about plants? If mate selection is such a basic and widespread phenomenon among animals, wouldn't we find it occurring among plants, and indeed in cycads? The answer appears to be yes, however, in plants the process of mate selection is subtle and difficult to detect through human eyes.

POLLEN TUBE GROWTH - A RACE TO THE FERTILIZATION CHAMBER

Mate selection in plants begins when pollen from male organs land on the entrance to the egg chamber. In the flowering plants this entrance is located on the stigma of the flower (see Figure 1). Once there the pollen will germinate and grow a tube toward the egg chamber, called the ovary in flowering plants. How quickly the pollen tube grows depend on its inherent vigour and the genetic compatibility between the male (pollen) and the female [receptive flower] (Sari Gora *et al.* 1975). The first pollen grain to land does not necessarily reach the egg chamber first. A late arrival to the stigma which is more compatible with the female and thus more vigorous may outgrow its competitors to the egg chamber. The female imposes its choice on the pollen with the length of the style, the tube between the entrance and the egg chamber. A long style will amplify small differences in growth rate in pollen tubes, ensuring that the most vigorous arrives first to the egg chamber (Mulcahy & Mulcahy 1975).

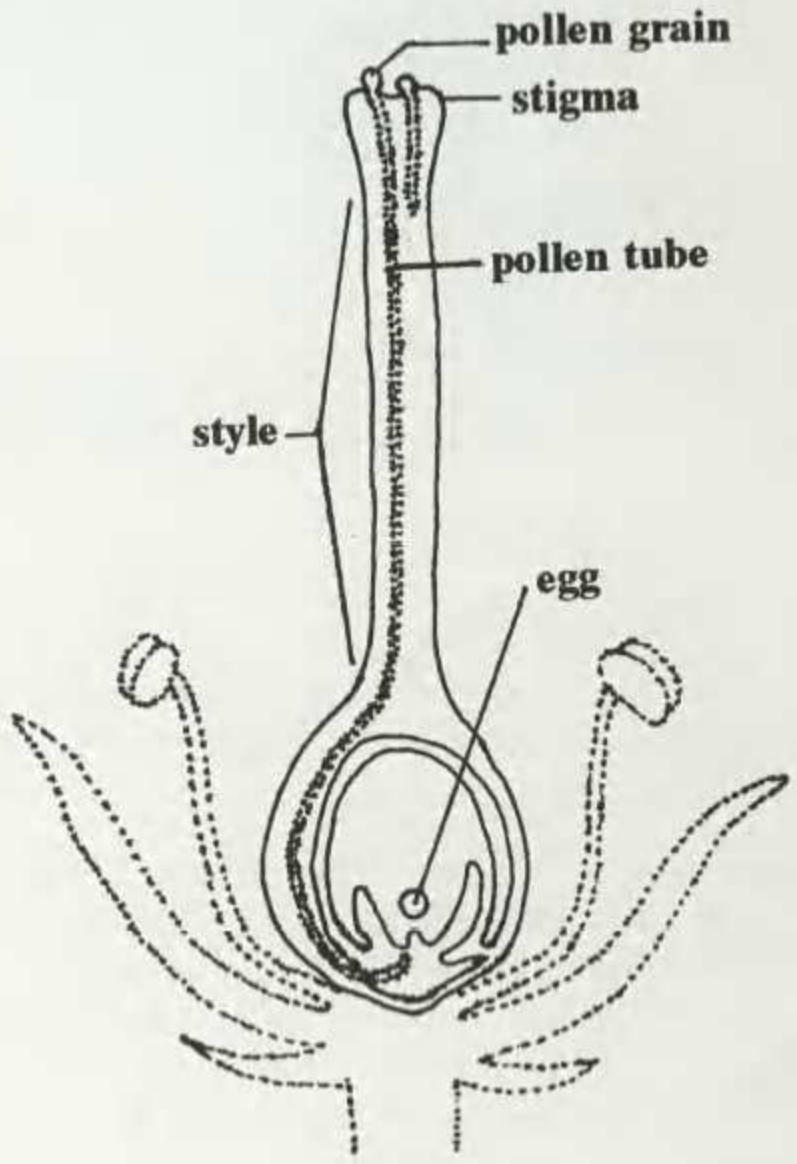

Figure 1 A generalized flower showing the receptive end (stigma), the egg chamber (ovary), and the column between them (style). The longer the style, the longer the distance the pollen tubes must grow, thus amplifying any difference in vigour between pollen grains. The length of the style provides the female with an ability to "select" which male will enter the egg chamber first.

In cycads we see a similar competition among pollen tubes. In cycads, as in flowering plants, pollen tube growth rate appears to be influenced by the female. The germinating cycad pollen grain sends a root-like process (haustorium) into the nucellus (the tissue surrounding the fertilization chamber) and draws nourishment from the female (Choi & Friedman 1991, see Figure 2). As

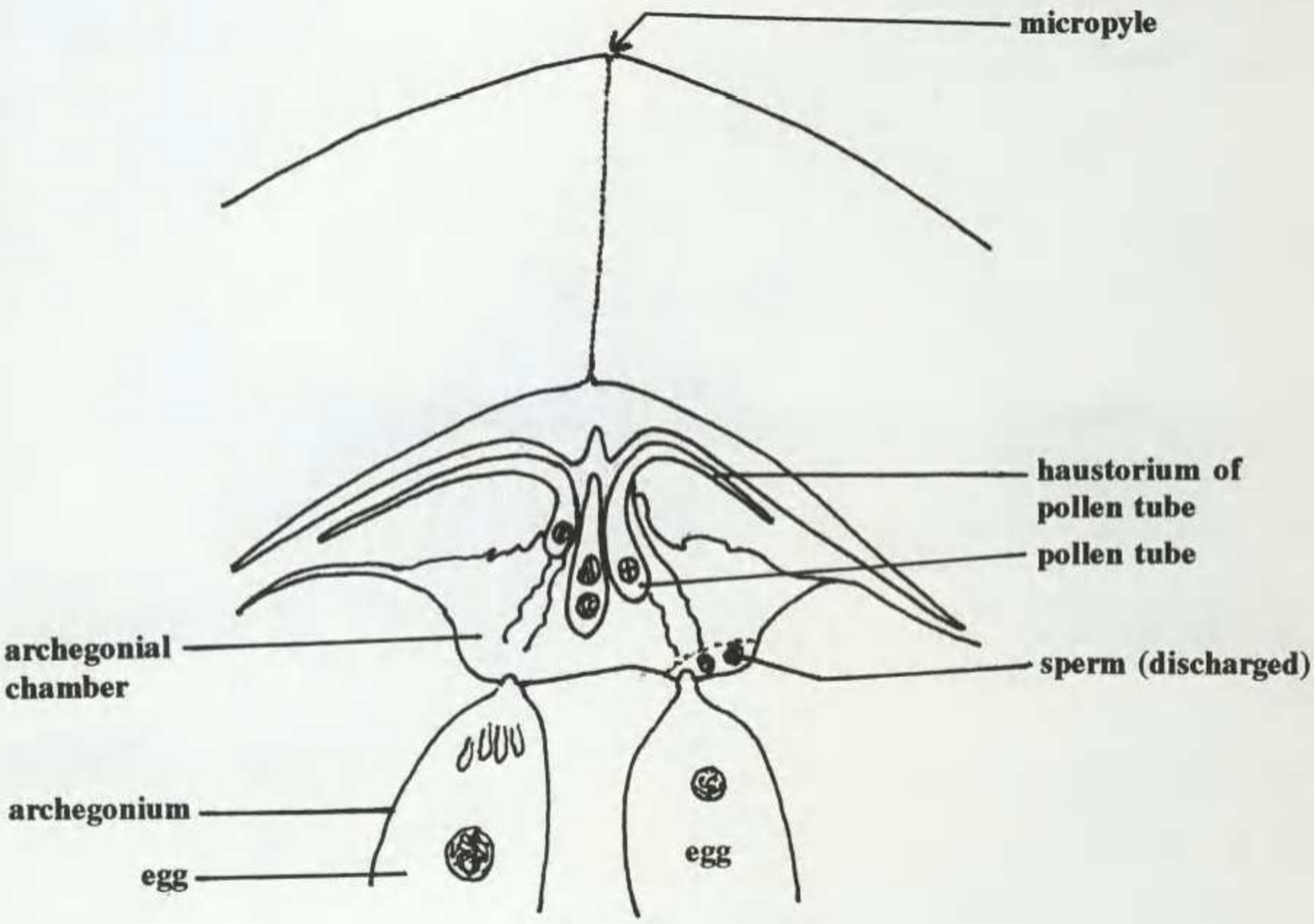

Figure 2 A view of the ovule of *Dioon edule* showing five pollen tubes growing in the fertilization chamber. Two of the tubes have discharged their sperm, which are swimming and about to enter the two eggs. Modified from Chamberlain (1935).

in flowering plants, we can predict that the rate of pollen tube growth in cycads depends on the chemical and therefore genetic compatibility between the pollen grain and the female. Unlike flowering plants where it takes only hours or days, pollen tube growth in cycads may take 4-6 months before sperm can be released to the waiting eggs (Chamberlain 1935). Whereas flowering plants use distance to amplify differences in vigour of pollen, female cycads appear mainly to use time to amplify differences in vigour in pollen tube growth in choosing among male suitors. A slight difference in growth rate between two pollen grains will result in a very large difference in pollen tube and sperm development after 4-6 months of growth.

SPERM COMPETITION

When pollen tube growth is completed ciliated sperm are discharged into the archegonial chamber where fertilization takes place (see Figure 2). Here begins another phase of mate selection by the female. The archegonial chamber provides an arena for competition among sperm. The more vigorous, faster swimming sperm have the best chance of entering and fertilizing an egg. In most cycads two sperms are released by each pollen tube. In *Microcycas* up to 16 sperms may be released by a single pollen tube (Norstog 1990). The greater the number of sperm, the greater the likelihood of that male succeeding in fertilization.

COMPETITION AMONG FERTILIZED EGGS

Most species of cycads have ovules with more than one egg. Usually there are 1-6 eggs in an ovule. In *Microcycas* there may be as many as 200 (Norstog 1990)! More than one egg in a single ovule may be fertilized (a situation known as polyembryony), however, only one of the resulting embryos will develop. Only on rare occasions are two (Rao 1964) and sometimes three (author - unpub. observation) embryos found in mature seed. This situation provides another possible mechanism for mate selection by the female. The female can influence which of several fertilized eggs will develop into a full-sized embryo. There is evidence that

this occurs in conifers (Crook & Friedman 1991), which, like cycads, also have polyembryony (Willson & Burley 1983). This is the third stage of mate selection in the female cycad. After pollen tube competition and sperm competition the female can still select among several fertilized eggs within a seed. We can surmise that in cycads the most vigorous among these, sired by the most compatible male wins out.

CONCLUSION

So, what is the practical importance of this lesson in cycad sex? Those of you who have germinated cycad seeds may have noticed that certain batches are unusually vigorous in their growth while others are slow and result in sickly seedlings. One cause for this variability is undoubtedly the pollen used to pollinate the female cone. Pollen from a male that is less vigorous or genetically less compatible will result in less vigorous offspring. This fact is long known among breeders of food crops. Crop plants that are pollinated with pollen of more than one male often produce offspring that are more vigorous than those of females that are pollinated by only one male (Sari Gora *et al.* 1975). In the case of cycads how do you decide which males are most vigorous or compatible? The best solution is: collect pollen from as many males as you can and inject it into the female one. The female can choose by itself which pollen will produce the strongest offspring.

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SHORT COMMUNICATIONS / KORT MEDEDELINGS

NEW COUNCIL FOR THE PERIOD JAN. 1994 - DEC. 1995

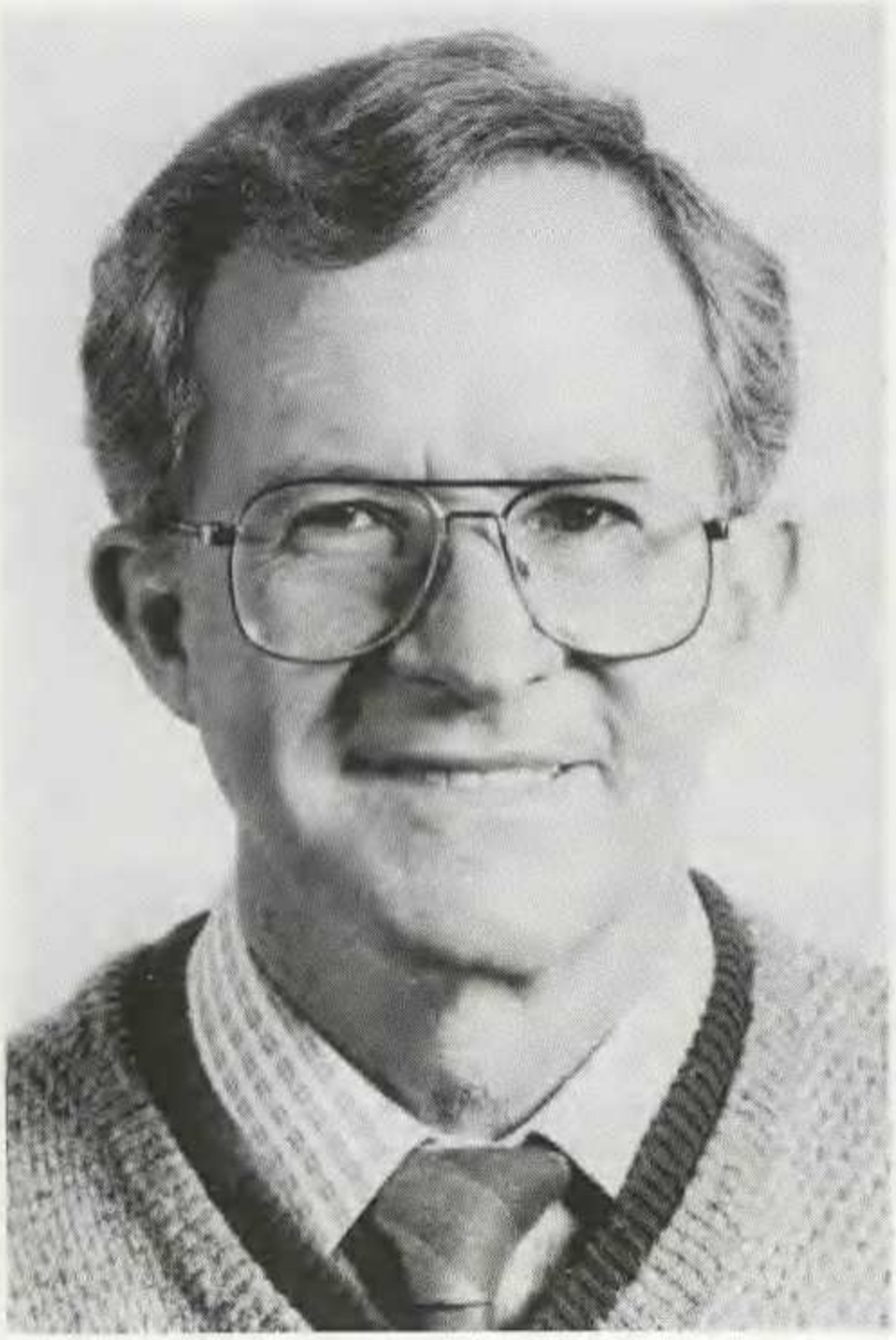
Nat Grobbelaar
P.O. Box 15357, 0039 Lynn East

The following Council members have been elected unopposed for the next two-year term starting on January 1st, 1994:

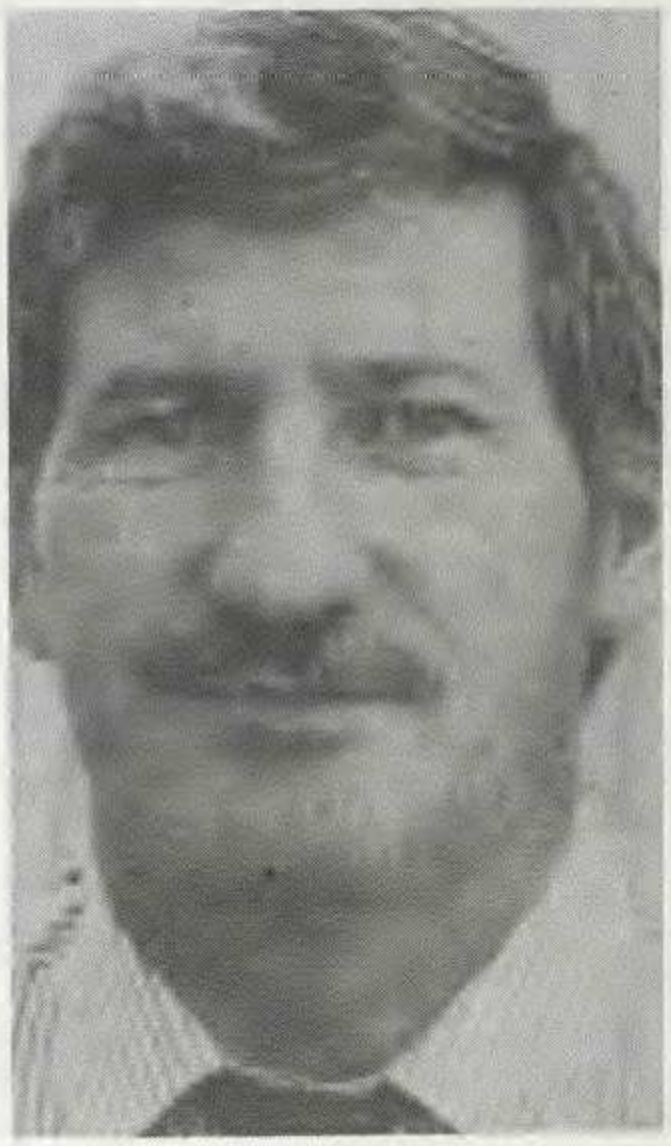
President: Professor Dr P.J. (Hannes) Robbertse
Secretary/Treasurer: Mr Giel Fourie
Printing and Dispatch Officer: Dr Piet Vorster
Editor of "*Encephalartos*": Dr Isabella Claassen
Back Copies Officer: Mr Roy Shooter

The Representatives from the three Regional Branches have, at the time of writing (October, 1993), not yet been appointed.

Hannes Robbertse, our new President, has for many years been interested in cycads and he has published several papers on these plants. He retires from the Department of Botany, University of Pretoria at the end of this year where he was mainly involved in the teaching of plant anatomy and morphology. He was director of the Margaretha Mes Institute for Seed Research of the Department of Botany of the University of Pretoria for several years. Until his retirement his main research activities centred on aspects of seed development and germination in the Institute. As an eminently well-qualified person for the post, we welcome Hannes to the helm of the Society and trust that he will derive much pleasure from a closer association with the affairs of the Society.



Hannes Robbertse, President of the Cycad Society of South Africa from January 1994.



Giel Fourie, Secretary/Treasurer of the Cycad Society of South Africa from November 1993.

Giel Fourie is the other new Council Member. He has already taken over from Pieter Stroebel at the beginning of November at Pieter's request. Giel works on one of the mines on the Rand and has been an active member of the Management Committee of the Transvaal Regional Branch of the Society for the past two years. The post he fills on Council is very important and time-consuming and we are most grateful to Giel for accepting this responsibility.

REPORT ON THE CITES PLANTS COMMITTEE MEETING

Cynthia Giddy
(IUCN Species Survival Commission: Cycad Specialist Group)
P.O.Box 45, 3730 Umlaas Road

The fourth CITES Plants Committee meeting was held in Brussels in September 1993. The meetings are held in a different region every year - Africa, Asia, Europe, North and South America, and Oceania (Australia, New Zealand and the Pacific). Present were the Regional Representatives, their alternates and various observers representing a number of conservation related organizations, e.g., TRAFFIC, the various IUCN Specialist Groups, The Flora and Fauna Preservation Society (the UK equivalent of our Wildlife Society), representatives from the Management and Scientific Authorities of member countries, and other interested

groups. A total of 35 persons attended the three-day Brussels meeting which was held in the Conference Centre of the European Community. This meeting followed on the Joint Meeting of the CITES Plant and Animal Standing Committees.

The agenda covered a wide range of plant related issues pertaining to the international trade in Endangered Species which are listed on Appendix I and II of CITES. Among the main points for discussion were problems in the enforcement of the Convention, the new criteria to amend the CITES Appendices, the down-listing of some species, the medicinal plant trade, tropical timber issues, a proposed study of the South African succulent trade and the adoption of a draft resolution for CITES registration of nurseries.

The latter is of particular interest to members of our Cycad Society. This matter has been under consideration since the Buenos Aires Convention of the Parties in 1985 and several draft resolutions have been discussed and amended by the Plants Committee in the past and circulated to various organizations and persons in the trade for comment. Prominent among these are the various Specialist Groups, e.g., Orchid, Cactus, Succulent and Cycad Groups as well as to the Management and Scientific Authorities of member countries who will have to implement the registration of such nurseries.

CITES recognizes that the artificial propagation of endangered plant species is an important tool for their conservation. Once artificial propagated specimens are available in large quantities, there will no longer be a need to collect them from the wild. However, the bureaucracy involved in the issuing of the relevant documents often discourages nurseries from propagating and trading in endangered plants. Comments received from exporting nurseries in several countries indicated that they refrained from large scale propagation of Appendix I plants because of the difficulties and in particular the long delays in obtaining the necessary export permits. The purpose of the registration is to facilitate the trade in endangered plants by such CITES registered nurseries through the possible pre-issuance of export documentation as well as the recognition by the importing countries that such shipments can then be exempted from inspection. This can be achieved by the strict monitoring of such nurseries in their countries of origin.

The registration will be on a voluntary basis and restricted to nurseries that propagate and export large volumes of Appendix I plants. (In terms of cycads this includes all the *Encephalartos* spp., *Stangeria*, *Cycas beddomei*, *Microcycas* and *Ceratozamia* spp.) Requirements for registration are that such nurseries do not have any wild collected Appendix I specimens other than those that have been registered as parental stock and were acquired in accordance with the national legislation of the country of origin. Such registered parental stock will be checked annually to ensure that they are not depleted by the disposal of specimens other than through natural causes unless the Management Authority agrees to their transfer to another registered exporting nursery.

The purpose of the registration is to facilitate the documentation for propagating nurseries and therefore middlemen or plant brokers that buy in plants from other sources will not qualify for these exemptions as the source (legality) of their plants is often difficult to establish. Plants may only be exported under the proposed registration if the export permit clearly states that the plants were artificially propagated by the exporter. Such plants must be propagated from seed, spores, callus tissues or cuttings by the nursery concerned.

The present impasse re the export of Appendix I cycad seed will also be solved by such registration, as registered exporting nurseries will be inspected annually and the size of the parental stock as well as the number of plants and seed produced from it will be noted. At present some of our provincial authorities are reluctant to issue export permits for seed because garden collected seed is not readily distinguishable from wild collected seed.

The draft resolution furthermore recognizes that the artificial propagation of Appendix I species could form an economic alternative to traditional agriculture in the countries of origin and would provide an incentive for increased interest in the conservation of the species in their areas of natural distribution in terms of sustainable yield of a natural resource. The resolution also takes cognizance of the fact that the transfer of germplasm is regulated under the International Agreement of Phytogenetic Resources (FAO). This is an agreement which protects the plant resources of a country from commercial exploitation by another country as has happened in many Third World countries by the large multinational pharmaceutical firms.

Prior to the meeting the Chairman, Dr. Jim Armstrong from Australia, Dr. Noel McGough from Kew who is the representative for Europe and myself from the IUCN Specialist Group were invited by the German Scientific Authority to visit selected nurseries in Germany to assess the volume of trade and evaluate the percentage of wild collected versus artificially propagated CITES plants in trade. This proved to be very interesting as large quantities of CITES listed plants are imported annually into Germany.

[Interested persons may obtain a copy of the draft resolution on the proposed CITES Nursery registration by contacting Cynthia Giddy at Tel. 0332-510478.]

COMMENTS ON SOME ISSUES RAISED IN "*ENCEPHALARTOS*" NO. 35

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A number of issues raised in "*Encephalartos*" No. 35 call for a comment:

"FISHTAIL" *ENCEPHALARTOS TRANSVENOSUS* (pp. 20, 21)

This fusion of leaflets is not uncommon in *Cycas*. Previously I have seen it in:

1) A seedling of a Northern Territory *Cycas*, in a frond which developed in mid-summer.
2) In a small offset of *Cycas thouarsii* rooted under a constant temperature of 30°C.
3) In a whole leaf flush of one of those *Cycas rumphii*-like plants from coastal Thailand, which was produced during November under temperatures which were by no means high.

It also seems to be similar to the abnormality in *Encephalartos inopinus* reported by Martin Schwellnus in "*Encephalartos*" 33: 33.

I would guess that the condition is the result of a hormonal imbalance. In none of the examples which I encontered, was it permanent, and the next fronds produced were normal.

"BLUE" CYCADS (p. 24)

Certainly whole populations of either "blue" or green-leaved *Encephalartos longifolius* and *E. laevifolius* exist. Reports of green-leaved *E. princeps* have not been substantiated, and like the so-called green *E. trispinosus* mentioned by myself in "*Encephalartos*" 34: 38, are almost certainly hybrids with *E. altensteinii*.

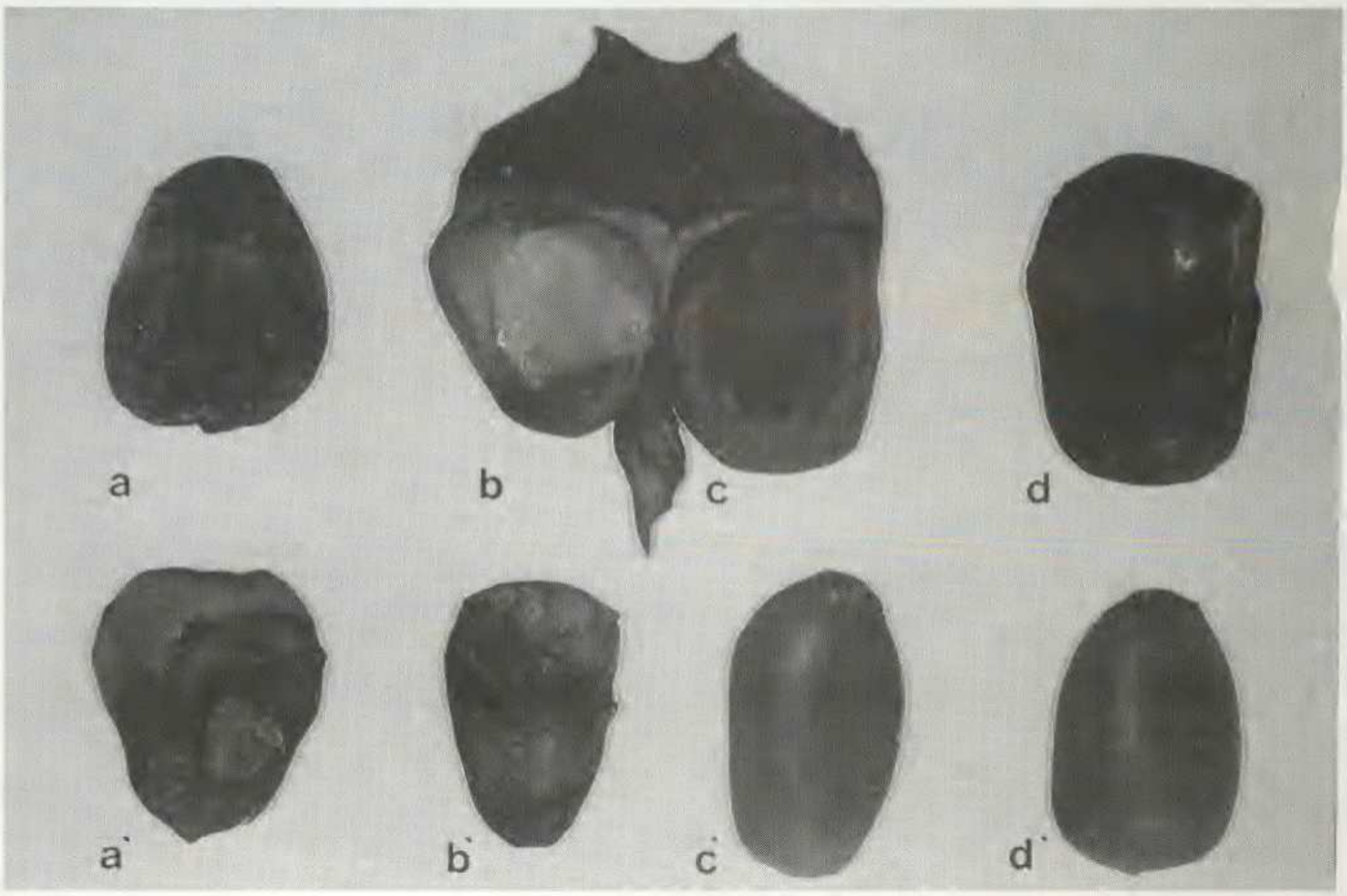

Figure 1 *Ceratozamia mexicana* seeds showing the "soft shell disease". Top row, seeds with intact sarcotesta; bottom row, seeds with sarcotesta removed. **a, b:** infected seeds; **c, d:** normal seeds. Scale bar: 50 mm.

OBSERVATIONS ON *ENCEPHALARTOS INOPINUS* (p. 25)

The distressing condition of shell-less seeds with jelly-like interiors has been reported more than once in *Encephalartos inopinus*, and recently I lost two whole cones to it. I have also been plagued with the same thing in *Ceratozamia mexicana* (Figure 1). Roy Osborne in "*Encephalartos*" 31: 38 surmised that it may be the result of pathogenic infection. In *Ceratozamia mexicana* the situation is very marked: The normally white fleshy seed coat (sarcotesta) turns brown and soft on ripening, often almost while one watches, and with slight pressure the kernel pops cleanly out. In infected seed, either the whole seed or more often only half, retains the white sarcotesta, which does not ripen. The other half does turn brown, but does not become soft. If the whole sarcotesta is scraped off, it can be seen that only that part of the kernel (sclerotesta) underneath the white sarcotesta has developed, while that underneath the browned sarcotesta remains soft and undeveloped, and such seeds never germinate.

Personally I don't think this condition is due to lack of fertilization, as unfertilized seeds are quite different.

What I would like to know, is if this condition is analogous to that found in *Encephalartos laevifolius* by Kevan Zunckel.

GREEN CONES IN *ENCEPHALARTOS LEHMANNII* (p. 37)

Coincidentally such an untypical cone is illustrated on p. 205 of Jones' newly published book "Cycads of the World" (reviewed on p. 36 of "*Encephalartos*" no. 35).

YELLOW LEAVES (p. 38)

Such pale chlorotic fronds not uncommonly occur on the acid iron-rich red sands of the central Transvaal, which are not unduly acid. Surprisingly on such iron-rich soils, this is often caused by iron deficiency. This is due to the iron in the soil being in a form inaccessible to the plant, and the condition is exacerbated by poorly aerated soils. It can be remedied by treating the plants with iron chelate, and by improving the soil structure not by loosening mechanically which damages the coralloid roots, but by means of a surface mulch which encourages earthworm activity. The yellow leaves will not become green, but subsequent leaves should be better.

I once experienced a similar condition which no amount of iron chelate or mulching would remedy. Eventually I discovered that it was due to a heavy eel-worm infection which rendered the root system almost useless.

YELLOW LEAVES IN CYCAD SEEDLINGS

Nat Grobbelaar
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In response to the letter by Dr. R. Schutte of Sandton which appeared on page 38 of "*Encephalartos*" no. 35, I wish to make the following comments:

1. First check whether the roots of the affected plants are not badly infected with nematodes. Should this be the case, I doubt whether there is anything one can do to rectify the situation other than surgically remove all the fine and affected roots and surface sterilize the remainder of the underground system before transplanting the treated plant to nematode-free fertile soil. Surface sterilaization can usually be effected by immersing the plant for about five minutes in a commercial bleaching solution (sodium hypochlorite solution) such as "Javel", that has previously been diluted 1 to 10 with water. After the sterilization treatment, the plant must be rinsed thoroughly with water before it is transplanted.

2. Most of our indigenous cycad species in nature grows on soils that are slightly acidic (pH about 6.5).

3. The addition of lime to a potting mixture will tend to make the soil more alkaline in which case most of the heavy metal ions such as iron, zinc, copper and manganese, will tend to become more insoluble and therefore relatively unavailable to the plants.

4. If plants with normal green leaves suddenly produce white to yellow new leaves (see Figure 1), it usually is typical of a deficiency in the trace elements iron and/or zinc.

5. Soils rarely contain a real deficiency of iron but under alkaline conditions iron, like the other heavy metal trace elements, zinc, copper and manganese, which might be present in ample concentrations can become relatively insoluble and therefore relatively unavailable to the plant. On the other hand, sandy soils commonly suffer from a real zinc deficiency.

6. To determine the pH of the soil, shake up 2.5 volumes of the soil with one volume of distilled water and after the soil has settled, measure the pH of the water layer with a calibrated pH meter. Should the pH be alkaline (pH 7 or above) the plants probably suffer from a deficiency of the heavy metal trace elements due to the high soil pH. In such cases it is not advisable to enrich the soil with the trace elements because they will simply become unavailable to the plant when they come in contact with the alkaline soil. Rather spray a dilute solution of a

commercial trace element mixture on the leaves of the plant at weekly intervals. If the very young yellow leaves gradually turn green, you can be sure that the yellow leaves are due to a deficiency of iron and/or zinc. Older yellow leaves usually remian yellow permanently. To permanently rectify the problem it is best to transplant the plant into fertile slightly acidic soil. The acidification of alkaline soil is a tricky and time-consuming process.

Figure 1 *Encephalartos altensteinii* seedling with stunted yellow new leaf - a typical sympton of an acute zinc deficiency experienced by the plant after the limited amount of zinc in the sandy soil had been used up in the previous growth of the plant.

7. Should the pH of the soil be slightly acidic (pH 6.0 to 6.7), it is very likely that the soil is inherently deficient in zinc. To test this, spray the leaves of the plant at weekly intervals with a dilute solution of zinc sulphate. If the very young yellow leaves turn green during development you can be sure about the zinc deficiency. In this case it is best to add a solution of zinc sulphate to the soil in a single treatment and renew the treatment whenever the symptoms return or more conveniently, in the case of a few plants, to add a commercial preparation of a complete trace element mixture to the soil.

   I find it convenient to prepare a stock solution of 0.05 gram zinc sulphate per litre water. For spraying purposes, I dilute one ml of this stock solution to 100 ml with water and add a few drops of a commercial soap solution such as "Teepol" to the solution before spraying to increase the wettability of the spray solution on waxy leaf surfaces. For soil applications, I add about 250 ml of the diluted zinc sulphate solution (but without a wetting agent) per litre of soil to the container in which the plant grows.

I hope this information will enable Dr. Schutte to improve the growth of his plants.

MULTIPLE MALE CONES IN *CYCAS*

William Tang
Fairchild Tropical Garden, Miami,
Florida 33156, U.S.A.

In the genus *Cycas* male cones are usually solitary - that is only one cone forms at a stem apex in any given season. I have observed many cultivated plants over the years and have not seen any exceptions until my visit to Australia in CYCAD 90. There I was shown a population of *Cycas* near Irvinebank on the Atherton Tableland by Marie Trefeu and Will Kraa. According to the latest study (Hill 1992) this population is of hybrid origin, intermediate between *C. platyphylla* and *C. media*. Here I observed several plants in a particular patch with two cones at the stem apex from the previous season. Two plants were found to have three cones at the apex (see Figure 1). The cones were dry and beginning to break apart, but they appeared to have

Figure 1 Photograph of a *Cycas* plant near Irvinebank, Australia, with three male cones at the apex. The cones are dry and the one on the right has nearly completely disintegrated.

been formed at the same time with no intervening leaf production.

The presence of several, indeed many males with two or three cones at the apex within a small area would suggest that this is a common feature in this particular patch of plants. I think we can rule out the possibility that all these plants had recently branched at the apex and that each new branch subsequently produced a cone - one would not expect dichotomous branching of the stem to occur on so many plants in one season.

Recently, during CYCAD 93, I spoke to Ken Hill about these observations. Ken is just completing a review of the Australian *Cycas*. He has observed a few instances of double male cones in wild *Cycas* plants in the Northern Territory, but never three cones to an apex.

REFERENCE

HILL, K. 1992. A preliminary account of *Cycas* (Cycadaceae) in Queensland. *Telopea* 5: 177-206.

NATALSE PARKERAAD REAGEER OP PRESIDENT SE VERSOEK AANGAANDE TOESTEMMING VIR DIE UITVOER VAN BROODBOOMSAAD

Nat Grobbelaar
Posbus 15357, 0039 Lynn-Oos

Na aanleiding van vertoë wat die President tot die Natalse Parkeraad gerig het aangaande die uitvoer van broodboomsaad na die buiteland, het die Hoofuitvoerende Beampte van die Natalse Parkeraad onlangs soos volg geantwoord:

"Geagte prof. Grobbelaar

TOEPASSING VAN CITES-REGULASIES AANGAANDE BROODBOME

U skrywe van 26 Februarie 1993 het betrekking.

Die uitvoer van broodboomsade uit Natal word soos volg hanteer:

(a) broodboomsaad kan tussen twee geregistreerde wetenskaplike instellings uitgeruil word vir bewaringsdoeleindes;

(b) broodboomsaad wat kunsmatig gekweek is in 'n kwekery wat deur die Natalse Parkeraad geregistreer is, kan uitgevoer word vir kommersiële doeleindes;

(c) broodboomsaad ('n maksimum van tien sade per soort) wat onder die toesig van 'n beampte van die Raad vir stokperdjie-doeleindes versamel is kan uitgevoer word, met dien verstande dat sodanige versameling onderhewig is aan:
   (i) die skriftelike toestemming van die grondeienaar,
   (ii) 'n versamelpunt van die Natalse Parkeraad verkry is,
   (iii) 'n uitvoerpermit vir die saad, soos van toepassing, verkry is.

Alle broodboomsaad, hetsy òf uit kunsmatige voortplanting òf natuurlike voortplanting word deur CITES beheer.

In antwoord op die laaste paragraaf van u brief, wat handel oor *Stangeria eriopus*, dien dit gemeld te word dat my Raad die handel in *Stangeria* op voortgesette grondslag moniteer. Die vraag na *Stangeria* op muthi-markte is slegs matig, vergeleke met die van ongeveer 60 ander hoëprioriteitspesies. Die meeste *Stangeria*-plante wat te koop aangebied word, kom vanuit Transkei en KwaZulu en kom algemeen voor in baie dele regoor die Natalse Kusagterland. Hulle kom ook, in gesonde bevolkings, in veertien beskermde gebiede voor. Raadspersoneel het verlede jaar op ongeveer twintig 50 kg-sakke *Stangeria* beslag gelê en alle lewensvatbare materiaal word in Raadskwekerye aangeplant as teelvoorraad vir latere gebruik deur erkende instansies.

Ek vra om verskoning vir die vertraging in my antwoord maar vertrou dat die inligting vir u van nut sal wees."

Dit is verblydend dat die Natalse Parkeraad dit nou vir onder andere, ons Natalse Saadbankbeampte, moontlik maak om onder sekere voorwaardes, klein hoeveelhede broodboomsaad na ons lede in die buiteland uit te voer. Uit 'n telefoniese navraag wat ek gedoen het, blyk dit dat die Saadbankbeampte, met die nodige toestemming [kyk (c) hierbo] op een slag sê 300 sade van 'n sekere broodboomspesie mag versamel om aan sê 30 buitelandse lede te stuur.

Van my kant is ek verheug oor die Natalse Parkeraad se toegewings oor die uitvoer van broodboomsaad sonder dat dit die voortbestaan van ons plante sal benadeel.

Dit is verder ook verblydend om te hoor dat daar goeie voorsiening gemaak word vir die behoud van verskeie *Stangeria*-genepoele. Tog voel mens ongelukkig oor die feit dat daar nie met dieselfde fermheid teen die onwettige handel in hierdie plantsoort opgetree word as wat met ander broodboomsoorte die geval is nie.

NEWS FROM COUNCIL

Nat Grobbelaar
P.O. Box 15357, 0039 Lynn East

Council recently decided in principle to make funds available in future for scientific research on cycads. Because our funds are rather limited, it will in all probability initially have to be a very modest amount.

In order not to burden members unduly with this added financial commitment, it is likely that Council will opt for a proposal to use only donations that have been made to the Society for this purpose. In any event, Council still has to decide on several aspects concerning the administration of this new project which will hopefully be initiated in March of next year after all the details have been published in the "*Encephalartos*" of that month.

Council will be pleased to receive your views on this proposed venture.

CYCAD 96

Nat Grobbelaar
P.O. Box 15357, 0039 Lynn East

At CYCAD 93 it was **provisionally** decided to hold CYCAD 96 in Panzhihua City, Sichuan Province, People's Republic of China from April 29 to May 3, 1996. Professor Chia-Jui Chen, Vice Chairman of the CYCAD 96 Organizing Committee, has recently confirmed that the Cycad Society of China will act as the official host to CYCAD 96 and that the conference will definitely be held in the People's Republic of China as proposed at CYCAD 93.

CONFERENCE : BOTANICAL DIVERSITY

Roy Osborne
Department of Chemistry, University of Natal,
4001 Durban

Approximately 200 delegates from South Africa and other African countries attended a Conference on the Conservation and Utilization of South African Botanical Diversity, held at Cape Town in September 1993. The cycad "feature" was a presentation by **John Donaldson** and **Ingrid Nänni** of the Conservation Biology Research Unit at Kirstenbosch, their title being "Cycads as a resource - an incentive for conservation". In the abstract of this presentation, the authors argue that with respect to cycad populations on privately-owned land, "the landowners derive little or no benefit from their cycad populations but are subject to restrictive legislation regarding the removal of plants or seeds from populations. There is therefore little incentive to conserve cycads outside of reserves. Despite restrictive legislation, cycads represent a potential resource for private landowners and for rural communities". In their analysis on the effect of gathering of seeds from wild populations, the authors state that "the harvest of seeds, even in large numbers, may have no detrimental effect on recruitment".

NEWS FROM NATAL

Avis Meresman
P.O. Box 4726, 4000 Durban

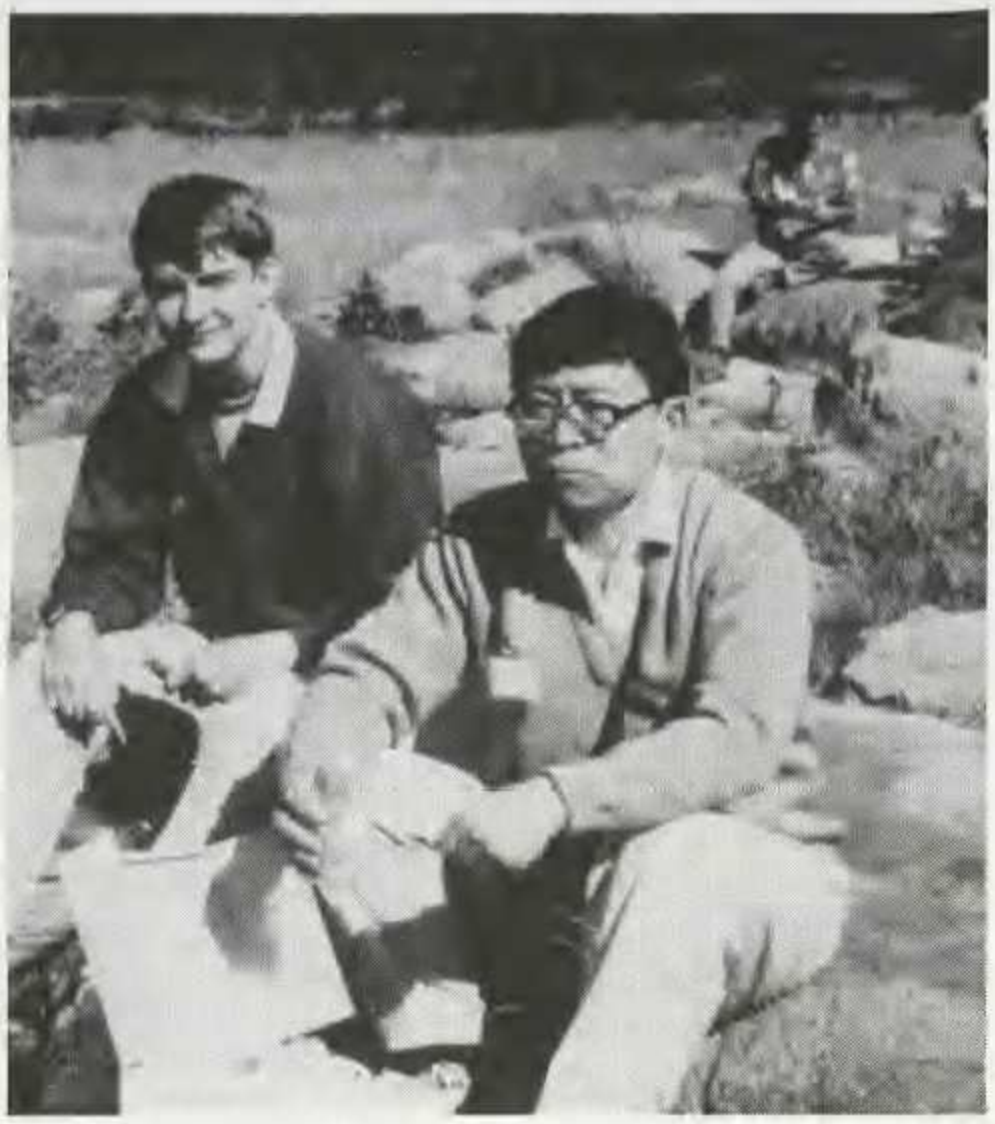
Once again a successful Enviro 93 show was enjoyed by the Natal Branch of the Cycad Society. We had an honorary stand at the latest show and we exhibited a number of plants from our local Botanic gardens. Much interest was generated and we are sure that many new members will be enlisted from this area.

Danie Nel spoke on Radio Lotus, Radio Highveld, Radio Port Natal and a TV interview was done for a programme which is to be released later in this year. There also was a write-up in the daily newspaper of the Enviro show.

A REPORT ON THE THIRD INTERNATIONAL CONFERENCE ON CYCAD BIOLOGY PRETORIA, JULY 1993

Roy Osborne
Department of Chemistry, University of Natal, 4001 Durban

The photographs on this page are part of Roy Osborne's paper on CYCAD 93 in the September issue. Unfortunately they reached me too late to be included in Roy's paper (see "*Encephalartos*" 35: 28-34) - **Editor.**



Andrew Shaw and Chia-Jui Chen enjoying a picnic lunch at Starvation Creek, Kaapsche Hoop.

Chia-Jui Chen making notes on the leaf structure of *E. middelburgensis*. Prof. Chen is the Vice Chairman of the CYCAD 96 Organizing Committee (see "CYCAD 96" on page 36).

Tony King, Kevan Zunckel and Doris Francis at Kaapsche Hoop.

Roy Works paying homage to John Medley Wood in the Durban Botanic Gardens.

LETTERS TO/FROM THE EDITOR

CONGRATULATIONS AND THANK YOU CYCAD 93 ORGANIZING COMMITTEE

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Dear Editor

We both had a wonderful time in South Africa and thoroughly enjoyed meeting all the people. A big thank you to the organizers of CYCAD 93 for their efforts and to all friends for their hospitality.

It took us both more than a week to recuperate when we arrived home. The body clock was certainly running a little slow. It was definitely a case of needing a holiday to get over the holiday. We are also experiencing a few withdrawal symptoms from the lack of the good South African wines - that's something we'll both miss.

***Stan and Jane Walkley**, Australian Rare Palm Supplies, Queensland, Australia.*

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Dear Editor

We would like to congratulate the organizers of CYCAD 93 on a very successful and most enjoyable Conference.

***Ollie and Leona Minnie**, P.O. Box 137, 3935 Mtubatuba.*

****

Dear Editor

We wish to congratulate the organizers of CYCAD 93 and all their helpers on a truly wonderful Cycad Conference.

What a pleasure it was to meet all the members of the Cycad Society who took time to come to this event.

Some really wonderful friendships were built in those days and I am sure that they will last for many years to come.

Also we wish to thank all the wonderful folk who supported the Cycad Centre, without them it wouldn't have been such a success.

***Danie Nel**, Cycad Centre, P.O. Box 4726, 4000 Durban.*

****

Dear Editor

Jan and I had a wonderful time at CYCAD 93. Thanks to those involved for the fine organization throughout and the knowledgeable tour-leading. Even though we had not attended the previous two cycad conferences, everyone was so friendly and helpful we quickly felt right at home. The conference itself exceeded my expectations. I've never attended any other multi-day scientific conference at which I found myself present at every single presentation.

Jan and I both especially enjoyed Durban Botanic Garden and it was good to see their venerable collection and visit the father of Lotusland's *Encephalartos woodii* specimens.

***Steven Timbrook**, Director, Lotusland, California, U.S.A.*

****

Dear Editor

Just a note to thank all those involved for their efforts during our visit to South Africa and the CYCAD 93 Conference. It was the best conference we have attended and the tours also were excellent. We finally made it back to Australia on 1 August after an unscheduled stop in Brunei for three days due to aircraft trouble in Singapore.

***Derek and Vera Wilson**, Winnellie, Northern Territory, Australia.*

****

Dear Nat

I wish to express my sincere congratulations and heart felt thanks for the efficient way in which CYCAD 93 was organized. I am sure I speak on behalf of all the participants in saying what a wonderfully enjoyable and rewarding time it was. The untiring efforts of Roy, Cynthia and Piet, apart from yourself need special mention. Even the smallest detail or matters were attended to and I personally was amazed at how events ran so smoothly with such a cosmopolitan group.

I am just a devoted Cycad enthusiast attempting to learn all I can about these "magic" old plants and we certainly learnt a lot and made many friends who are like-minded. It was indeed a fun time and above all I learnt so much and made so many long lasting friends I am sure.

Thank you really sincerely for all your efforts and for staging a successful CYCAD 93.

Best wishes.

Gerry Camp (Also and Old Rhodian), 1 Neville Road, 3630 Westville.

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THANK YOU, NAT GROBBELAAR

Thank you really sincerely, Mr. Retiring President, for your kind support and guidance during my recently expired first year as editor of "*Encephalartos*".

I appreciate your refereeing of manuscripts and meaningful suggestions which have been of great help to me. Please note that I am still going to ask your advice in this connection in future.

I wish you a restful and enjoyable retirement with more time to spend on all your other "irons in the fire".

Isabella Claassen, P.O. Box 11322, 0011 Brooklyn.

.....

Dear Ms Claassen

FUSED LEAFLETS

Referring to your very interesting article in "*Encephalartos*" 35: 20, I feel that **fused leaflets** are fairly common in cycads. I experienced them in *Ceratozamia hildae, Zamia "latifoliolata"* and *Z. furfuracea*, and received photographs of a totally "fishtailed" *Zamia*, which Mr. Landry (in CYCAD NEWSLETTER Vol. XV no. 2) diagnosed as *Z. furfuracea*. Being no botanist, I should appreciate to learn more about this phenomenon with cycads in general in a future issue of "*Encephalartos*"

Dr. Helmut Schlegel, Wilh.-Haspel-Str. 30/2, 71065 Sindelfingen, Germany.

[We invite any of our readers who have come across fishtail-like leaves in cycads to write and tell us about their observations - **Editor**.]

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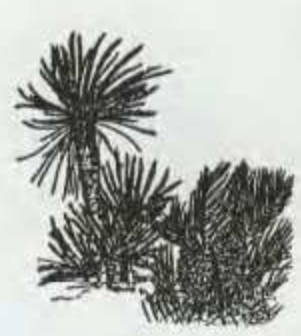

NEW SCIENTIFIC REPORTS

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Authors' address: Department of Biology, "Tor Vergata" University, Rome 00133, Italy.

Chirgwin, S.K.* & Wigston, D. 1993. A new species of *Cycas* from the Northern Territory. *Journal of the Adelaide Botanic Garden* 15: 147-148. [This paper describes *Cycas conferta* Chirgwin; the soft, sea-green coloured leaves, the crowded isobilateral pinnae and the pear-shaped ovules with prominent micropyles being features which distinguish this taxon from other Northern Territory *Cycas* species. The new species occurs in small numbers in groups in and near the Kakadu National Park.]
Author's address: School of Biological Sciences, Northern Territory University, P O Box 40146, Casuarina NT 0811, Australia.

Hizume, H., Ishida, F. & Kondo, K. 1992. Differential staining and *in situ* hybridization of nucleolar organizers and centromeres of *Cycas revoluta* chromosomes. *Japanese Journal of Genetics* 67: 381-387. [Examination of the metaphase chromosomes (2n=22) of *Cycas revoluta* by staining and hybridization techniques provides details of their composition and genetic character.]
Authors' address: Faculty of Education, Ehime University, Matsuyama, Japan 790.

Osborne R.*, Salatino A., Salatino M.L.F., Sekiya C.M. & Vazquez Torres M. 1993. Alkanes of foliar epicuticular waxes from five cycad genera in the

Zamiaceae. *Phytochemistry* 33: 607-609. [The waxy covering from the leaflet surfaces from species of *Ceratozamia*, *Dioon* and *Zamia* were analyzed from n-alkane content. Results indicate cycads generally differ from other gymnosperms and from angiosperms in this chemotaxonomic respect.]
Author's address: Dept of Chemistry, University of Natal, King George V Avenue, Durban 4001, South Africa.

Osborne, R. & Paschke, R.T. 1993. Morphometric analysis of vegetative characters of *Encephalartos woodii, E. natalensis* and an apparent intermediate. *South African Journal of Botany* 59: 455-456. [The small colony of plants from Krantzkloof Nature Reserve, near Durban, appears to be intermediate between *E. natalensis* and *E. woodii*.]
Authors' address: Department of Chemistry, University of Natal, King George V Avenue, Durban 4001, South Africa.

Seawright, A.A., Brown, A.W., Nolan, C.C. & Cavanagh, J.B. 1992. A cycad neurotoxin. *Toxins Targets* 81-86. [The pathology of rat brain lesions induced by a single dose of BMAA is discussed].
Authors' address: Department of Biology, Queensland University of Technology, Brisbane, 4000 Australia.

Compiled by ***Roy Osborne****, Department of Chemistry, University of Natal, 4001 Durban.*

NEWSPAPER CLIPPINGS / KOERANTUITKNIPSELS

New Scientist 19 June 1993 No1878

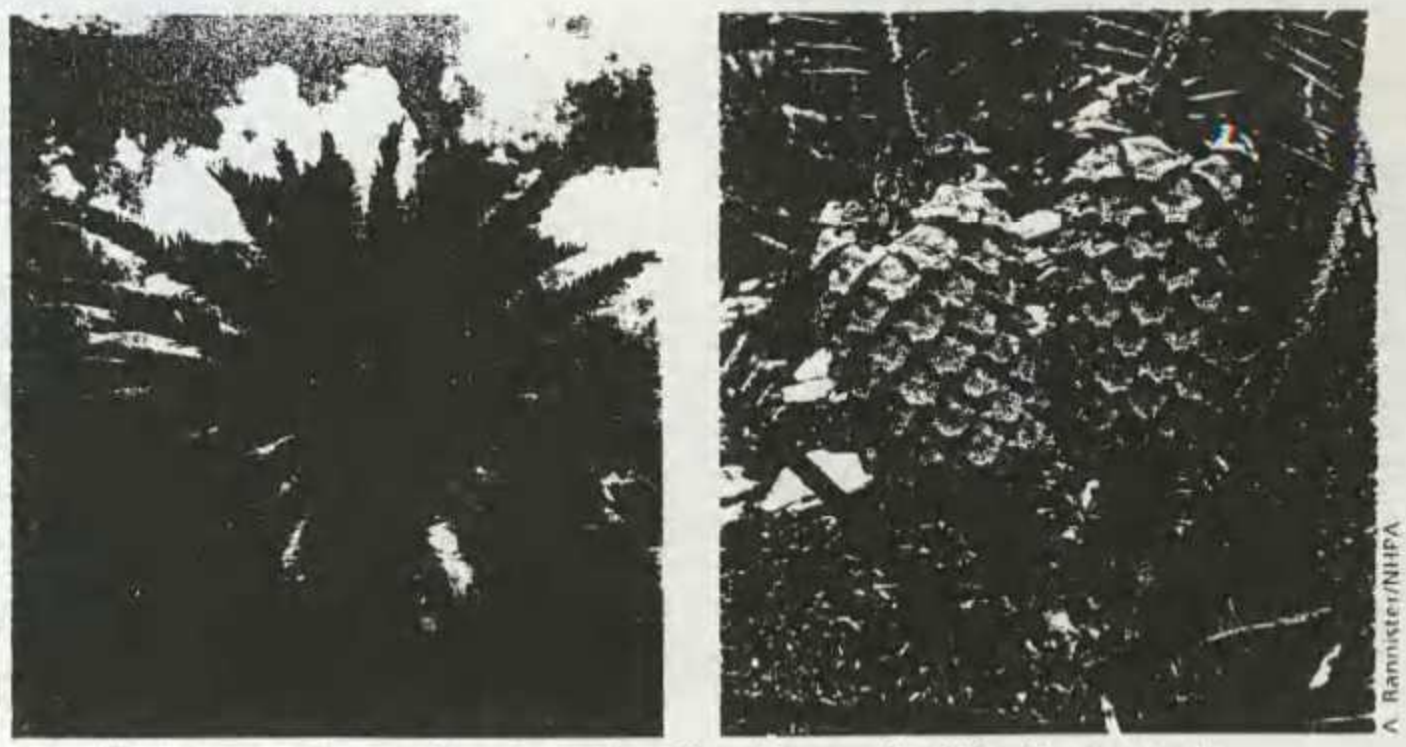
Why cycad sex is hot and sticky

Paul Simons

CYCADS, the palm-like plants which have survived from the time of the dinosaurs, are not nearly as primitive as people once thought. They have developed a way of attracting insects for pollination which is identical to that used by some much more advanced flowering plants.

In common with their cousins, the conifers, cycads reproduce using cones instead of flowers: female cones set seed with the aid of pollen which is shed from male cones. The botany textbooks say that cycad cones are pollinated with the aid of the wind, but this is not what one American biologist has discovered. William Tang of the University of Miami at Coral Gables says that cycads achieve fertilisation by heating up and attracting insects.

Tang studied the cycad *Zamia pumila*. A male cycad cone is a succulent, juicy, club-shaped organ. As it matures, it rapidly lengthens and the scales that protect its pollen sacs break open. Tang found that at the time the pollen sacs are revealed, a cone warms up noticeably—in some species, by almost 5 °C. This is typical of flowers that are pollinated by insects rather than the wind, so Tang examined the cones more closely. He discovered that beetles were indeed visiting them.



A. Bannister/NHPA

Some like it hot: cycad cones heat up to give off a minty smell which attracts insects

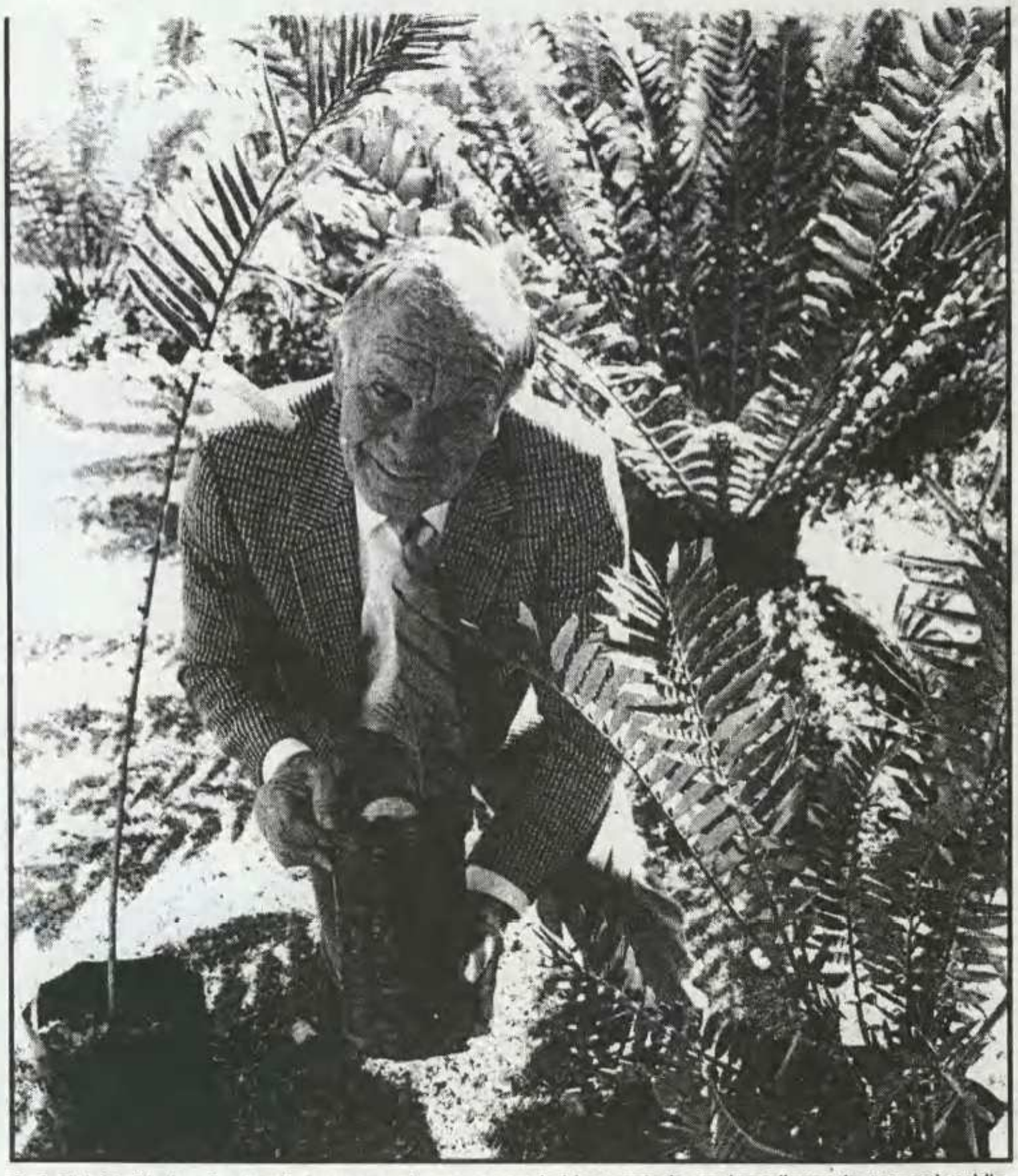
To see whether the beetles were responsible for pollination, Tang put cones in cages which shut out either the wind or the beetles. He found that the cones were pollinated only when the beetles could get at them. In fact, the cones heated up only in the late afternoon and evening when the beetles were active. They gave off a sweet minty smell and oozed a nourishing, nectar-like liquid which contained sugars and amino acids. The beetles liked the cones so much that they often spent time copulating there (*American Journal of Botany*, vol 74, p 90).

What makes this behaviour of cycads extraordinary is that the generation of heat as a means of attracting insects was thought to be unique to the more advanced flowering plants, such as *Victoria* water lilies and aroid lilies. Like cycads, these plants use heat to vaporise "perfumes" which attract insects to pollinate the flowers.

The discovery of insect pollination in plants so far removed in evolution from the flowering plants was a great surprise. But there were more shocks to come. Tang found that cycads generate heat by using the same type of chemical reactions as flowers.

As the cones gave off heat, their starch and fat content fell rapidly. Aroid lilies such as the tropical voodoo lily function in the same way, burning up so much starch and fat that their blooms shrink. Heating is expensive in terms of energy, so the aroid lilies, like cycads, heat up just as the flowers are ready for pollination. This is triggered by a surge of salicylic acid through the bloom.

No one knows whether salicylic acid also synchronises the cycads' heating. But Tang, Hanna Skubatz and Bastiaan Meeuse also found that the cycads' temperature tended to oscillate every few minutes, possibly to conserve their energy supplies (*Journal of Experimental Botany*, vol 44, p 489).



Prof. Nat Grobbelaar is steeds verras oor 'n sogenaamde blaar-metode om broodbome te vermenigvuldig. Die boom regs met die welige blare is een van die eerste bome wat hy gekweek het deur net die blaar van 'n broodboom te plant.

Foto: CHRISTIAAN KOTZE

Blaar kan dié broodbome in toekoms red

Martie Snyman

DIE blaar van 'n broodboomspesie wat "toevallig" 'n paar jaar gelede geplant is, kan in die toekoms 'n toenemende rol speel om skaars broodboomspesies van uitwissing te red.

Prof. Nat Grobbelaar, emeritusprofessor van die departement van plantkunde aan die Universiteit van Pretoria en president van die Broodboom-vereniging van Suid-Afrika, het aanvanklik gedink sy vrou, Hanneke, is "laf" om 'n broodboom se blaar in die grond te druk en te verwag dit moet groei.

Die blaar het egter meer fut gehad as wat hy gedink het en vandag is dit 'n volwaardige broodboom.

'n Week nadat sy vrou die blaar met die blaarvoet geplant het, het dit nog steeds lewend gelyk. Hulle het dié "vreemde verskynsel" dopgehou en ná sowat 'n jaar het nuwe blare verskyn.

Prof. Grobbelaar het sedertdien met verskeie broodboomspesies geëksperimenteer en reeds met die meeste daarvan sukses behaal. Volgens hom lyk dit of die blaar ten minste drie jaar neem voordat dit in 'n volwaardige plant ontwikkel.

Daar is verskeie ander plante, soos turksvye, wat ook deur 'n blaar of vegetatiewe voorplanting vermenigvuldig kan word. Vir broodbome is dit egter 'n uitsondering en sover hy weet is dié blaar-metode nog nooit elders "ontdek" nie.

Die verrassende van die blaarmetode is dat die blaar so op eie houtjie groei, sonder enige hormoon- of ander behandelings.

Dit kan lei tot interressante navorsingsprojekte. Met die regte hormoonbehandeling kan broodbome, veral skaars soorte, vinniger vermeerder word, het hy gesê.

Alle spesies reageer nie ewe goed op die blaar-metode nie. Sommige spesies neem langer om volwaardige plante uit die geïsoleerde blaar te vorm, terwyl ander glad nie groei nie.

Volgens prof. Grobbelaar is daar ook in die buiteland 'n sogenaamde proefbuis-tegniek om broodbome te kweek. Navorsing in Amerika het getoon sekere broodboomspesies reageer goed op die sogenaamde weefselkultuur-tegniek of proefbuis-metode.

Dit behels dat 'n stukkie plantweefsel onder steriele omstandighede in 'n proefbuis behandel en gevoed word om uiteindelik 'n volwaardige broodboom te kweek.

Die blaar-tegniek kan veral aangewend word in gevalle waar dit moeilik is om plante deur saad voort te bring, soos by die *Encephalartos woodii*, 'n spesie waarvan nog net een boom ooit in die natuur gevind is.

The Cycad Collection

A new publication from the Durban Botanic Gardens which makes for fascinating reading

Text by ROBYN SIMPSON

THE CYCAD collection at the Durban Botanic Gardens ranks among the top 10 cycad gardens in the world. A book entitled *The Cycad Collection*, recently published by the Botanic Gardens, gives a fascinating glimpse into the history of the Gardens, its cycad collection – which comprises nearly 400 specimens in 51 different species – and data on the cultivation and conservation of these ancient plants.

The book was written by cycad expert Dr Roy Osborne of the University of Natal with assistance from members of the Durban Parks Department and other cycad enthusiasts.

Dr Osborne writes that cycads are members of the botanical order Cycadales, the surviving plants of a cone-bearing (Gymnosperm) group which thrived in the Mesozoic era and reached their peak in the Jurassic Period, some 160 million years ago.

Cycads have an enormous appeal because of their antiquity as well as the size, shape and symmetry of the trunks and foliage which have considerable decorative appeal to the landscape gardener. Their slow growth rate and the comparative scarcity of most species has resulted in a value which, as Dr Osborne says, "has been inflated by rumour, media publicity and a 'status symbol' identity". For a number of reasons, these precious plants are now seriously under threat.

The proceeds from this book will go to the recently formed Durban Botanic Gardens Trust Fund set up to promote the development and conservation of the Gardens.

The Gardens began nearly one-and-a-half centuries ago when the Natal Agricultural and Horticultural Society was founded on April 18, 1848, with a grant of 20,5 hectares of land at the foot of Durban's Berea. The first curator was Mark McKen, who emigrated from Scotland in 1851 to "propagate and distribute plants of economic importance to the Colony of Natal".

Curator John Medley Wood not only developed the Gardens into the finest botanic gardens in Africa, but also found the last known specimen of the cycad *Encephalartos woodii* 'Sander' while on a collecting trip in Zululand. Today, two trunks from this specimen can be seen growing on the Old Conservatory terrace at the gardens.

Illustrated with good photographs and written in an easy-to-read, scientifically accurate style, this book is an invaluable guide to the cycads of the Gardens as well as being the perfect introduction to these fascinating plants.

The book is available from the Durban Botanic Gardens' Information Kiosk or by contacting the Curator's offices at (031) 211303, Fax: (031) 217382.

Photograph courtesy of the DURBAN PARKS DEPARTMENT

The* Encephalartos woodii *'Sander' at the Durban Botanic Gardens, named after the curator John Medley Wood who discovered the last remaining specimen near Natal's Ngoye Forest in 1895. Today there are numerous specimens in cultivation derived from this single male specimen. Scientists are currently investigating whether they can create a female of the species by a sex-change treatment using hormonal or environmental shock manipulations together with tissue culture techniques.

DONATIONS RECEIVED / DONASIES ONTVANG

JANUARY/JANUARIE 1993 TO/TOT SEPTEMBER 1993

THE FOLLOWING DONATIONS TO THE CYCAD SOCIETY OF SOUTH AFRICA ARE ACKNOWLEDGED WITH THANKS:
DIE VOLGENDE DONASIES AAN DIE BROODBOOM VERENIGING VAN SUID-AFRIKA WORD MET DANK ERKEN:

Number Nommer	NAME/NAAM	Amount Bedrag	Number Nommer	NAME/NAAM	Amount Bedrag
223	N.J. Kachelhoffer	R100.00	203	A.S.J. van der Walt	R19.00
1144	A.M.P. van den Heede	100.00	237	J.M. Nell	19.00
1324	M. Lovatt	100.00	433	W.G.C. Henning	19.00
598	J. Caudry	79.00	616	E.W. Buhr	19.00
847	J.W. Walters	69.00	696	L.G. Westermeyer	19.00
1079	P.J. Gelderbloem	69.00	710	J.N. de Bruin	19.00
1117	C. Strang	69.00	748	B.H. Niemand	19.00
1543	P. de Kooker	69.00	776	J. Besseling	19.00
112	J.H. du Plessis	50.00	793	W.A. Everett	19.00
1186	G.G.C.H. Delhove	50.00	853	P.W.B. Kruger	19.00
1507	R.J. Cohen	50.00	923	J.A. de Beer	19.00
1632	F.J. Fuglister	50.00	947	J.J. Booysen	19.00
1196	M.J. de Bruyn	46.50	991	C.M. van der Linde	19.00
1060	V. Wilson	46.00	1002	J.M. Janse van Rensburg	19.00
1245	W.B. Bayer	44.00	1019	J.J. Ras	19.00
1323	F.P. Pieterse	38.00	1035	M.C. Cian	19.00
487	A.H. Knouwds	35.00	1081	D.J. Nel	19.00
1434	J. Clemitson	35.00	1197	N. Reinach	19.00
719	P.A. van Niekerk	30.00	1253	K.B. Robinson	19.00
1190	H.P.J. Fouche	30.00	1258	L. van Rooy	19.00
1180	G. Holzman	29.08	1272	W.H. Louw	19.00
1047	J.M. Begley	29.00	1335	T. Gould	19.00
1271	H.X.N. du Toit	29.00	1428	L. du Rand	19.00
1275	G.A. Meyer	29.00	1462	A.J. Kable	19.00
81	H.C. Kennedy	26.50	1470	M. Nasser	19.00
242	D.J. Cochrane-Murray	26.50	1478	M.J. van den Berg	19.00
681	F.F.C. Venter	26.50	1505	Everdon Landgoed	19.00
1236	R.C. Steyn	26.50	1514	P.D. Niehaus	19.00
518	P.A. Schellevis	26.00	1514	P. Niehaus	19.00
844	J. Camey	26.00	1531	I.J. Joubert	19.00
1262	C. York	26.00	1547	J.H. de Jager	19.00
487	A. Knouwds	25.00	1581	J.J. Prinsloo	19.00
1524	C. Dixon	25.00	1600	R. Harris	19.00
47	S.W. Wentzel	24.00	1604	K. Schilz	19.00
59	Y.H. Phipson	20.00	1614	C.F.H. Gneiting	19.00
992	B.E.J. Spicer	20.00	1631	H.J. van den Berg	19.00
1366	P.L.F. Verwey	20.00	1639	K. Nair	19.00
1374	K.N. de Kock	20.00	1642	H.H. Fouche	19.00
1448	L. Molloy	20.00	1652	M. van Sittert	19.00
1540	I.W. Ferreira	20.00	1653	A.J. Dunn	19.00
1547	J.H. de Jager	20.00	299	A.J.H. Jonker	16.50
1624	J. Heyneke	20.00	817	C.S. Erasmus	16.50
159	J.D. Loubser	19.00	1112	M.J. Rautenbach	16.50
168	N. Munro	19.00	1489	J.D. Pryer	16.00

Number Nommer	NAME/NAAM	Amount Bedrag	Number Nommer	NAME/NAAM	Amount Bedrag
823	P.S. Knox-Dames	R14.50	1380	P. Wentzel	R9.00
265	A.A. Tarr	14.00	1380	P. Wentzel	9.00
271	I. Freeman	14.00	1423	J.J.G. Nel	9.00
1227	H.M. Besseling	14.00	1525	R.P. Richardson	9.00
224	R.J. Campbell	11.50	1528	S.J. Naudé	9.00
1608	S.C. Jacobs	11.50	1548	R.J. du Preez	9.00
311	C.M. Schimmer	10.00	1551	F.T. Odendaal	9.00
477	J.H. Scriba	10.00	1588	A.L. Ochse	9.00
1056	C.L. Visser	10.00	146	I.J.H. Jordaan	7.50
1061	R. Kruger	10.00	285	C.H. Bleksley	7.50
1237	M.A. Hepplewhite	10.00	645	W.J. Lotter	7.50
1503	J. Niewoudt	10.00	832	C.G. Rademeyer	7.00
1521	K. Stander	10.00	276	T.J.R. Botha	6.50
1536	I.E. du Plessis	10.00	424	C.F. Schmidt	6.50
1564	J.S. du Toit	10.00	523	P.P. Myburgh	6.50
1603	T.G. Opperman	10.00	525	P.H. Gore	6.50
1611	S. Ferreira	10.00	964	P.G. de Villiers	6.50
43	V.L. Pringle	9.00	1206	S.D. Coetzee	6.50
66	O.J. Minnie	9.00	1282	S.J.H. Britz	6.50
139	J. Swanepoel	9.00	1433	C. Leslie	6.50
166	G.C. Prinsloo	9.00	1481	A.J. Snyman	6.50
304	A.L. Topham	9.00	1628	L.C. Eksteen	6.50
359	E.W. Bronkhorst	9.00	834	G.K. Edland	6.00
399	K. Bischofberger	9.00	1446	R. Schmid	6.00
427	K.H. Palmer	9.00	1502	K. Wiegner	6.00
448	F.H. Wessels	9.00	1596	G. Storbeck	6.00
452	C.V. de Kock	9.00	1549	M.P. Humphries	5.00
545	M. Kruger	9.00	1562	J. Venter	5.00
569	L.D. van Rooyen	9.00	115	E. Herman	4.00
578	R.F.H. Bester	9.00	539	D.J. de Bruyn	4.00
601	G.B. Hart	9.00	595	B. Bursey	4.00
893	P.D. Badenhorst	9.00	734	R.J. Platford	*4.00*
969	B.L. Matthee	9.00	816	T.J. van der Merwe	*4.00*
971	K.P. du Toit	9.00	916	M.B. Bruwer	4.00
1026	Y. Barnard	9.00	1066	B. Henderson	4.00
1039	D.F. McKinlay	9.00	1126	H.R. van der Westhuizen	4.00
1140	S.R. Kruger	9.00	1130	A.J.J. Boshoff	4.00
1166	C.G. Lightley	9.00	1172	J. Allers	4.00
1178	M. Harris	9.00	1212	H. Baboohal	4.00
1194	H.D. Niemand	9.00	1285	J. Vorster	4.00
1222	S. Riordan	9.00	1358	J.H. Kofman	4.00
1228	C. Chistopulo	9.00	1431	S. le Roux	4.00
1240	J.H. Lombard	9.00	1442	J.J. le Roux	4.00
1257	L. Slotow	9.00	1476	J.A. Armstrong	4.00
1257	*L. Slotow*	*9.00*	*1589*	*S.J. Kahn*	*4.00*
1268	E.J. Myburgh	9.00	1403	P.W. Doddemeade	3.00
1280	A.M. Draper	9.00	1526	I.J. van den Berg	1.50
1283	C.H. van der Merwe	9.00	1566	M. Cole	1.00
1338	C. Stokes	9.00	1572	H. Rohnkvist	1.00
				TOTAL/TOTAAL	**R3309.58**