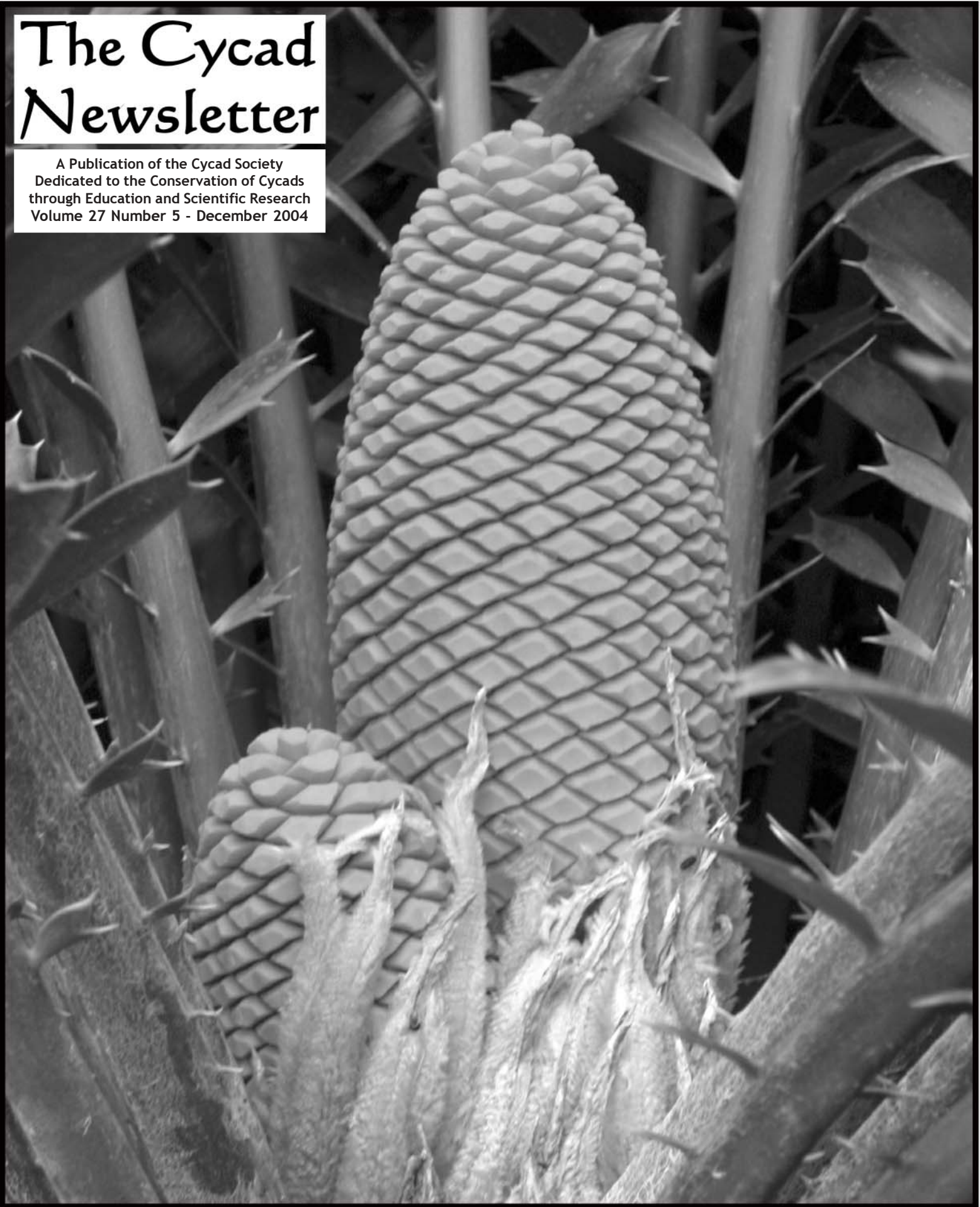


# The Cycad Newsletter

A Publication of the Cycad Society  
Dedicated to the Conservation of Cycads  
through Education and Scientific Research  
Volume 27 Number 5 - December 2004



## In This Issue:

Insect Pollinators of Cycads ..... 3  
CITES and Cycad Conservation ..... 8

Seeds of Hope ..... 10  
2004 Alphabetical List of Members ..... 15  
2004 Membership Address List ..... 17



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Since 1977

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#### COVERS :

Front: *Encephalartos ferox microstrobilate* plant with emerging strobili.

Back: Scanning electron micrograph of a *Zamia* pollen grain (cover photos by Bart Schutzman).

## Special Issue of the Cycad Newsletter Volume 27 No. 5 - December, 2004



The Cycad Society  
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### The Cycad Society 2005 Grant Application Guidelines



The Cycad Society  
Since 1977

The Cycad Society (TCS) is now accepting grant proposals that support TCS's mission in the areas of cycad conservation, research, horticulture, or education. TCS has one grantmaking cycle per year, with grants ranging from USD\$500 to USD\$2,500. Amount and number of grants funded each year are based on the number of applications received, the amount requested by each application, the subject and objectives of the application, and available funding. We hope, based on submissions, to approve at least one grant application each year.

Application requirements, deadlines, and contact information are presented on TCS's website ([www.cycad.org](http://www.cycad.org)). Applicants must be current TCS Members during the year of their grant application submission. Current TCS Directors cannot submit grant applications.

### JOIN THE 2005 MBC/ FNGLA SEEDBANK PROGRAM

We are now accepting members for the 2005 Montgomery Botanical Center (MBC) and Florida Nurserymen, Growers and Landscape Association (FNGLA) Seedbank Program. This will be the seventh year of this successful collaboration between MBC and FNGLA.

Since its conception in 1998 the MBC seedbank has distributed over four million seeds through FNGLA. During 2004 the Seedbank Program documented and shipped over 837,461 seeds representing 130 taxa of palms, cycads and dicots. Seeds are distributed every two weeks throughout the year.

For the 2005 Seedbank Program, 33 shares are available at \$1500.00 per share to a maximum of 24 members (one share would receive approximately 25,000 seeds in a year). Out of town members must have a FedEx or UPS account. Please make your checks payable to FNGLA and write "Seedbank" and the number of shares on the memo line. You may purchase one, two, or three shares while they last. Checks must be mailed to FNGLA before January 10, 2005 (Dade Chapter FNGLA, 18710 S.W. 288 ST. Room 38 Homestead, FL 33030).

For information or questions about the 2005 MBC/FNGLA Seedbank Program, please contact Judy Kay, Seedbank Coordinator, Montgomery Botanical Center: (305)788-5386, email [Kayj@fiu.edu](mailto:Kayj@fiu.edu), fax (305)661-5984.

# Insect Pollinators of Cycads

A report from a Cycad Pollination Workshop held in Thailand, 2002  
with a protocol for collecting and studying cycad pollinators

Jeff Chemnick\*, Rolf Oberprieler, John Donaldson, Irene Terry, Roy Osborne, Willie Tang & Paul Forster

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During the 6<sup>th</sup> International Conference on Cycad Biology, held from July 27 to August 4 2002 at Nong Nooch Tropical Garden in Thailand, an informal Cycad Pollination Workshop was convened to discuss the current state of knowledge of cycad pollination, identify the major and most critical outstanding issues regarding our understanding of this phenomenon, and coordinate efforts to address such issues. Perhaps one of the most exciting frontiers in cycad biology today is the investigation of insect-cycad relationships, especially with respect to pollination. Long thought to be wind pollinated, several detailed studies over the last twenty years have demonstrated clearly that insects, rather than the wind, are the agents responsible for cycad pollination. To date, both beetles (often weevils) and thrips have been identified as the pollinators in several genera including *Zamia*, *Encephalartos*, *Dioon* and *Macrozamia*.

Many in attendance at the Cycad 2002 Conference at Nong Nooch Tropical Garden in Thailand agreed that the presentations involving insect-cycad relationships were among the best and most interesting of the conference. In part to coordinate the efforts of entomologists and cycad biologists working on insect-cycad associations around the globe and in part to publicize such efforts, a meeting of interested parties took place at the conference. The ensuing enthusiasm resulted in the formation of the "Cycad Insect Pollinator Working Group" (CIPWG) consisting of 8 individuals whose work is either chiefly or peripherally concerned with insect-cycad relationships. The decision was made for the group to act as a clearinghouse for specimens, field data, and projects.

The CIPWG workshops were held in the afternoons of 31 July and 2 August and attended by the following: Alvaro Calonje (Carrera, Colombia), Jeff Chemnick (Lotusland, Santa Barbara, USA), John Donaldson (National Botanical Institute, South Africa), Paul Forster (Queensland Herbarium, Australia), Tim Gregory (Montgomery Botanical Center, Miami, USA), Rolf Oberprieler (CSIRO Entomology, Australia), Roy Osborne (Burlington, Australia), Willie Tang (Fair-

child Tropical Garden, USA), Irene Terry (University of Utah, USA) and Andrew Vovides (Instituto de Ecologia, Mexico).

Various needs and goals were identified and discussed. Primary among these was the need to make a concerted global effort to study diverse pollination systems from as many representatives from each cycad genus and species as possible and establish a standard technique for collecting, labeling, preserving and shipping insect specimens to appropriate destinations. Another objective is conservation-related. Pollinators need to be identified in threatened and declining cycad species to better plan and prioritize conservation efforts. The need for publicity was also recognized. It is the hope of the group that anyone doing fieldwork on wild cycad populations will contribute significant data to this important effort. Readers who are currently or plan to be doing such fieldwork are encouraged to contact one of the principle investigators listed below for more information. This area of cycad science is still on the ground floor and as such, almost anyone who finds cycad cones in the wild has the opportunity to contribute meaningfully to expand the body of knowledge in these areas.

Studies of insect-cycad (pollinator) relationships, which are both vitally important and data deficient areas, are one of the keys to understanding cycad evolution, extinction and distribution. Research undertaken to date indicates that there is a strong mutualistic relationship between cycads and their specific pollinators, inasmuch that the cycad cannot reproduce without the pollinator. Further, the insect's life cycle is intimately tied to that of the cycad. This suggests that, if we are to be serious about cycad conservation, we need to consider aspects of insect conservation as well.

The Workshop resolved to prepare this document summarizing its conclusions and recommendations, with the aim of distributing it among the cycad research community and fostering wide cooperation in addressing the major issues that remain to be solved in cycad pollination. The document is particularly intended to identify areas of critically-needed scientific research and to facili-

tate research organizations and funding bodies addressing these in a coordinated and effective manner.

Six major issues were identified and discussed:

## 1. Collection of cycad-associated insects, particularly pollinators

We identified a general lack of communication and collaboration between botanists, entomologists and pollination ecologists with regard to collecting insects on cycads in different parts of the world. We recognized that cycad botanists and horticulturists, who generally have the best opportunities of visiting remote cycad populations during pollination, often possess insufficient knowledge about cycad insects; their sites and times of occurrence on cycads, suitable collecting and preservation methods, and the contact information of pollination ecologists, insect taxonomists and appropriate repositories for insect specimens.

We resolved to draw up a protocol that will guide all students of cycads in the collecting, preserving and forwarding of insects and similar animals as they may encounter during their visits to cycad populations. This protocol is given as Appendix 1.

## 2. Pollinator surveys

The Workshop undertook a rapid virtual tour around the world of cycads and identified hotspots of cycad diversity where there is a total or substantial lack of knowledge about pollinators. Detailed surveys of potential pollinators and other insect associates in these areas are a clear priority, although the following list is not comprehensive and nearly all areas with cycads stand to benefit from further sampling of their insect faunas.

**Australasia:** Northern Australia, New Guinea, Fiji and other Pacific islands, Indonesia, Malaysia, Thailand, Myanmar, Vietnam, China, Philippines and Taiwan.  
**Africa:** Mozambique, D. R. Congo, Tanzania, Kenya, Uganda, Sudan and Nigeria.  
**America:** Mexico, Guatemala, Honduras, Costa Rica, Panama, Columbia, Venezuela, Bolivia, Ecuador and Peru.

Reasonably comprehensive surveys have thus far only been conducted in south-eastern Australia, parts of Thailand, South Africa, Zimbabwe and parts of Mexico; further surveys are presently underway in Australia and Cuba.

### 3. Pollination studies

The Workshop acknowledged the major advances that have been made in recent years regarding the understanding of cycad pollination systems in various parts of the world. However, we also recognized that very little is known about pollination despite some familiarity with the potential pollinators in several major regional and taxonomic groups of cycads. The following geographic areas and cycad genera were identified as in need of particular attention in this regard:

#### Australasia:

- *Cycas* in Thailand (weevils and languriid beetles are strongly implicated but their precise role in pollination is unproven)
- *Cycas* in China (languriid beetles are implicated but their role in pollination is unproven)
- *Cycas* in New Guinea and Pacific islands (weevils are implicated in several areas but their role in pollination is unproven; no pollinator candidates are known from many Pacific islands)

#### Africa:

- *Stangeria* in South Africa (the only cycad genus with no known insect pollinator candidates, a knowledge of pollination being critical for conservation)
- the *Encephalartos manikensis* complex in Zimbabwe (weevils are known but do not appear to belong to a proven pollinator genus; this information is critical for conservation)
- *Encephalartos hildebrandtii* and other common species in East Africa (weevils, including a pollinator genus known from the area but pollination systems are unknown)
- *Encephalartos barteri* in Nigeria and Ghana (the western-most *Encephalartos* species and of sufficient population size to potentially harbor pollinators, but none known so far)
- *Encephalartos latifrons* in South Africa where weevil pollinators appear to be extinct. Will weevils from related species colonize *E. latifrons*?

#### America:

- *Ceratozamia*, *Dioon* and *Zamia* (especially *Z. paucijuga*) in Mexico (several potential pollinators are known but the

detailed pollination systems are as yet unstudied)

- *Zamia* in Costa Rica and Panama (especially *Z. fairchildiana*) (some potential pollinators are known but as yet no weevils - and pollination systems are unstudied)

- *Zamia/Chigua* in Colombia and Ecuador (suspected to be beetle-pollinated but no candidates collected thus far)

### 4. Pollinator taxonomy

We now have sufficient evidence to conclude that most cycads are essentially cantharophilous (beetle-pollinated). The main groups of pollinators appear to be weevils (superfamily Curculionoidea, the families Belidae and Curculionidae) and xenosceline erotylids (formerly Languriidae). The taxonomy of the weevils is largely being addressed, though hampered by lack of time and funding, whereas that of the erotylids are very poorly known and in urgent need of attention. The following is a summary of the current state of affairs in this regard:

§ Allocorynini weevils in America (genera *Rhopalotria* and *Parallocorynus*). These are under study by Prof. Charles O'Brien (Florida A&M University) but work is progressing slowly due to O'Brien's retirement and other projects. Concerted collecting efforts in Central America and funding would facilitate the completion of this project. This work would be well suited as a Ph.D. or postdoc project under Prof. O'Brien's supervision.

§ Amorhocerini in Africa (genera *Porthetes* and *Amorhocerus*). These are under study by Dr. Rolf Oberprieler (CSIRO, Canberra). Completion of such work has been delayed due to other duties and research priorities but currently in progress.

§ *Tranes* group in Australia. Preliminary sorting of species has been done by R. Oberprieler; taxonomic and phylogenetic study is included in a recent research grant application.

§ *Tychiodes* group in Australia and southeast Asia. Preliminary study has been done by Tang, Oberprieler & Yang (1999). Some more material has been collected since, but more extensive collecting is required throughout the region. This work is well suited for Ph.D. or postdoc studies under Oberprieler's supervision.

§ Erotylids in America, Africa and Australasia. Isolated descriptions of two Costa Rican species by J. Pakaluk (1988) and a South African species by P. Wegrzynowicz (2000) and preliminary study of Thailand/Chinese fauna by Tang, Oberprieler & Yang (1999) have been published. Comprehensive study of entire group is feasible as a Ph.D. or postdoc project based in Canberra with supervision by Dr. S.A. Slipinski (supervisor of Wegrzynowicz's 2001 Ph.D. thesis on erotylid taxonomy).

It is apparent from this synopsis that considerable progress can be made to resolve the taxonomic problems pertaining to the main cycad pollinator groups with some concerted efforts and funding, particularly with support of the suggested student projects.

### 5. Funding

The Workshop identified a lack of funding as one of the most critical obstacles to advancing our knowledge of cycad pollination. This applies to targeted surveys of cycad populations for pollinators and other associated insects and, even more importantly, to taxonomic and ecological studies of the pollinators and their host associations. The general dearth of taxonomic knowledge of cycad pollinators was highlighted as one of the matters in most urgent need of attention. This stems partly from a shortage of insect taxonomists able to undertake descriptive and phylogenetic studies of cycad insects, but even more so from a general lack of support by scientific institutions that employ such taxonomists to have them engage in research on cycads and their ecology. It was pointed out that most research institutions nowadays require their scientists to generate external revenue, and that projects unable to do so invariably end up at the bottom of the scientists' and institutions' priority lists. Scientific institutions are often willing to co-invest scientists' salaries and indirect research costs into worthy scientific projects when some external funding for them is available. Taxonomic and ecological studies of cycad pollinators may thus become more feasible if financial support to cover direct costs (e.g. field work) becomes available.

We identified major potential sources of funding. A number of private foundations and organizations such as botanical gardens generously and effectively support cycad cultivation and conservation worldwide. Perhaps such institutions could be approached to help fund taxonomic and pollination studies as well. National research funding bodies

exist in most developed countries to support research by universities and similar institutions. However, they are becoming increasingly competitive, tend to focus on major scientific, collaborative projects and sometimes exclude scientists from outside their national borders. While taxonomic and ecological studies of cycad pollinators in isolation from larger scientific-evolutionary questions stand little chance of securing funding from these bodies, there are opportunities for including such studies in broader research agendas and projects that can attract the necessary funding. A couple of such initiatives were named as already currently underway, but we identified a significant potential for expanding this arena.

### 6. Legal issues

The Workshop discussed the issue of permits and other legal requirements surrounding the collecting and exporting of native fauna and flora. Legislation regulating these activities is being introduced increasingly around the world and needs to be considered and respected in all collecting activities regarding cycads and their insects. Unlike cycads, cycad-associated insects are not listed on any CITES appendix and can be collected and exported subject only to local conservation and legislation. Generally, collecting permits are issued by conservation authorities and applications range from mere technicalities to bureaucratic nightmares requiring the tedious registration of rigid research projects. A general requirement of nearly all collecting permits is that voucher specimens are to be deposited in a recognized local or overseas research institution or museum collection. Such institutions may have official international exchange programs for scientific material and can assist with the exportation of specimens. They will often help with permit applications or registration of research projects as well. It is advisable to coordinate collecting activities with such institutions where feasible. Recent increases in transportation security



Closeup of male weevil isolated from *Dioon merolae*.

might restrict the contents and containers of specimens being shipped, especially by air. Care to ensure compliance with all regulations should be taken.

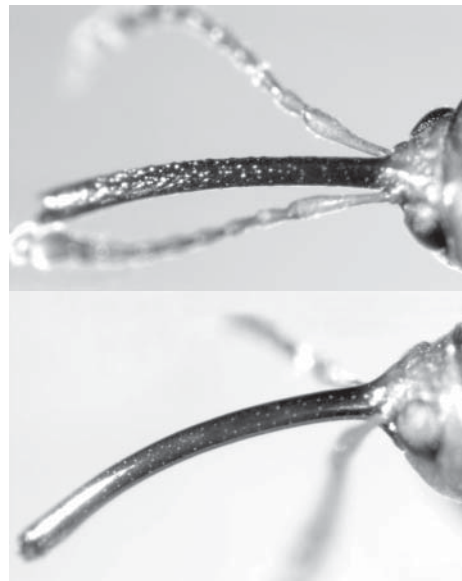
### 7. Spokesman

The need for a central database and group spokesman was recognized. Happily, John Donaldson has agreed to assume these duties.

### Appendix 1: Protocol for collecting, preserving and forwarding cycad insects

**Sites on plant.** Most cycad insects live in the **cones**, either crawling around between the sporophylls or living within them (particularly the larvae), or tunneling inside the rachis (axis). More insects live in male rather than female cones, but both sexes of cones should be inspected. The larger sporophylls of female cones often show no external sign of harboring an insect inside and need to be carefully cut open. In the absence of cones, cycad insects often hide deep among the densely packed **cataphylls** in the plant's crown. Others live on or inside cycad **trunks** and subterranean **caudices** and are often detectable only by soft or decaying tissue on the surface. **Leaf feeders** usually eat away at the edges of cycad fronds and may be very conspicuous if aposematic (unpalatable to predators) or hide during the day and feed only at night. **Sap-suckers** such as aphids and scale insects are sessile on all leaf, petiole and rachis surfaces.

**Number of specimens.** For identification and taxonomic research, a series of at



Closeup of probosces of male (top) and female (bottom) weevils isolated from *Dioon argenteum*.

least 20 specimens per sample is desirable. This should include both sexes in about equal numbers, and 10 males and 10 females per sample is generally adequate

**Life stages.** Where available, immature stages (larvae, nymphs, pupae) should also be collected, about 10 specimens of each.

**Collection.** Cycad insects are best picked up with a pair of fine forceps. The soft and blunt, spring-steel forceps available in entomological supply shops are best as they allow a firm grip without crushing the insect. A more effective apparatus is an aspirator or "pooter", with which small insects are sucked up into a glass or plastic vial or tube. It consists of two lengths of open plastic tubing, approximately 8 mm in diameter, inserted tightly through holes in the lid of the vial for a short length. Sucking air from the end of one tube while placing the end of the other over the insect will suck it up into the vial. A piece of tissue paper in the vial is useful to keep the insects apart from each other and clean.



Three views of Male (top) and female (bottom) weevils isolated from *Dioon argenteum*.

**Preservation.** The universal preservative for cycad insects (except for butterflies and moths) is 70% ethanol. Insects can be dropped alive into small vials with this alcohol, although soft-bodied larvae achieve better long-term preservation and color retention when cooked briefly in near-boiling water before immersion into ethanol. Preservation in ethanol is also suitable for long-term storage and for shipment in small quantities.

If ethanol is not available, adult cycad insects can be killed by freezing or gentle heating (exposure to sun in a closed container) and then stored in a dry state in small, ventilated containers (match boxes are ideal) between layers of tissue paper. In humid conditions, small quantities of a fungicide such as phenol, thymol or chlorocresol must be added to prevent mould and rotting of the specimens. Immature stages and soft-bodied insects cannot be stored in this way. When ethanol is unavailable, strong, clear spirits such as vodka or gin may be used as short-term alternatives, but their ethanol content is too low to achieve proper and permanent preservation. Isopropyl alcohol at 70% concentration has also been used extensively.

**Data and labels.** All samples of cycad insects must be accompanied by a small label with essential collection data. These include, as the minimum, the locality where the insects were collected (country, nearest town, GPS coordinates and elevation if available), the date, host plant and collector's name. Information about the sex, organ and condition of the host plant is also very useful, e.g. "from male cone", "tunneling in decaying female sporophyll", "in cortex/pith of dead trunk", "feeding on new fronds at night", etc. Labels should be written in pencil and placed inside the vial. Its also a good idea to include a collection number that can be linked to field notes.

**Observations and notes.** If conditions permit, any observations on the behavior of the insects should be recorded. It should be noted that not all insects found in apparent association with cycad cones are pollinators. Of interest are notes such as whether they were carrying pollen, feeding on a particular organ or tissue, mating on or inside the cones, emerging/flying at a particular time of day, visiting male or female cones, etc. Notes on the cycad population are also informative, i.e. how large and dense the population was, how large and old the plants were on average (mature plants only, large numbers

of seedlings present, etc.), the approximate number of cones present (of both sexes), under which conditions the plants were growing (open grassland, dense forest, etc.), and other relevant prevalent features (i.e. whether the area had been burnt or disturbed, suffered a recent drought, etc.).

**Shipment of specimens.** On return from a collecting trip, the specimens are best submitted to a museum or research institution as soon as possible. Vials with

small amounts of ethanol can generally be mailed when enclosed and padded in tight-sealing plastic bags to prevent breakage and leakage, but local regulations regarding transport of flammable liquids should be checked. Where relevant, documents regarding exportation permission should be completed fully and attached to the parcel, clearly labeling it as containing fragile specimens for scientific study with no commercial value.

Appendix 2		<u>CYCAD/INSECT DATA SHEET</u>														
SUBMITTED BY (Name): _____					Date: _____											
CYCAD SPECIES: _____																
Accession number for cycad collection (if a herbarium voucher was collected): _____																
LOCALITY INFORMATION:																
Description in words: _____																
COORDINATES: _____																
SOURCE: <input type="checkbox"/> GPS <input type="checkbox"/> Map <input type="checkbox"/> Map type: _____																
HABITAT INFORMATION																
Vegetation type:																
Forest	Savanna	Shrubland	Grassland	Rocky areas*	Coastal dunes	Coastal cliffs										
* cliffs, outcrops																
Condition of vegetation:																
Intact	Low disturbance	high disturbance	Transformed	Fragmented												
Cause of disturbance																
Agriculture	Grazing	Forestry	Harvesting	Housing	Other:											
CYCAD POPULATION INFORMATION																
ITEM	PLEASE TICK ONE BLOCK IN EACH ROW					NOTES										
Population numbers*	1-10	11-100	100-1000	>1000	Actual no.?											
Seedlings present	None	Occasional	Numerous													
Population profile	Mostly adults	Mostly juveniles	Evenly spread	Can't tell												
Plants in cone	<10%	10-50%	>50%													
Plants with male cones	1-10	11-100	>100													
Plants with female cones	1-10	11-100	>100													
Coning stage	Before pollination	At pollen shed	After pollination	Unknown												
* excluding seedlings																
POLLINATOR INFORMATION																
INSECT INFORMATION					HOST PLANT INFORMATION											
Accession no. (use a different number for insects that look different or occur in different parts of the plant)					Adult insect (A) or larva	Pollen present	Male plant	Female plant	On cone	Within sporophyll	Within cone axis	On or in stem	In crown	On young leaves	On old leaves	In leaf rachis

## Appendix 3

### Names and addresses of research institutions with insect collections where cycad insects can be deposited

Extract from R. Osborne & T. Walters. 2003. In search of the true tree: guidelines for classification. Chapter 15 in T. Walters and R. Osborne (eds). *Cycad Classification: Concepts and Recommendations*. CAB International, Wallingford, Oxon, UK.

#### SCHEDULE 15.5: INSECT COLLECTIONS WITH SIGNIFICANT

#### CYCAD-ASSOCIATED SPECIMENS

##### ALBANY MUSEUM

Somerset Street, Grahamstown 6139, South Africa. Website: <http://www.ru.ac.za/departments/am>  
Contact person: F.W. Gess, [f.gess@ru.ac.za](mailto:f.gess@ru.ac.za)

##### AUSTRALIAN NATIONAL INSECT COLLECTION

CSIRO Entomology, GPO Box 1700, Canberra, ACT 2601, Australia. Website: <http://www.ento.csiro.au/research/natres/natres.html> Contact person: Rolf Oberprieler, [rolf.oberprieler@ento.csiro.au](mailto:rolf.oberprieler@ento.csiro.au)

##### CHARLES W. O'BRIEN (PRIVATE) COLLECTION

Florida A & M University, Tallahassee Florida 32307-4100, USA. Contact person: Charles O'Brien, [charles.obrien@fam.edu](mailto:charles.obrien@fam.edu) or [biocontrol@netally.com](mailto:biocontrol@netally.com)

##### IZIKO MUSEUMS OF CAPE TOWN (SOUTH AFRICAN MUSEUM)

PO Box 61, Cape Town 8000, South Africa. Website: <http://www.nhm.org/~lorquin/evans/a2collections.html> Contact person: Simon van Noort, [svannoort@samuseum.ac.za](mailto:svannoort@samuseum.ac.za)

##### NATIONAL COLLECTION OF INSECTS

Plant Protection Research Institute, Private Bag X134, Pretoria 0001, South Africa. Website: <http://www.sciref.org/netc/netc1-2/dit2c.htm> Contact person: Riaan Stals, [vrehrs@plant5.eric.za](mailto:vrehrs@plant5.eric.za)

##### THE NATURAL HISTORY MUSEUM

Department of Entomology, Cromwell Road, London SW7 5BD, United Kingdom. Website: <http://www.nhm.ac> Contact person: Chris Lyal, [c.lyal@nhm.ac.uk](mailto:c.lyal@nhm.ac.uk)

## Appendix 4

### Brief biosketches of the principal investigators

**John Donaldson:** John has a Ph.D. in Zoology/ Entomology and first became interested in cycad pollination during his doctoral project when he worked on the evolution of interactions between cycad weevils (species of *Antliarhinus*) and species of *Encephalartos*. After his Ph.D., John studied the pollination biology of *Encephalartos cycadifolius* and *E. villosus* and demonstrated that beetles were the principal pollinators in both species. John's research also showed that different groups of beetles are involved in pollination of these two cycad species. Since then, John has become interested in the diversification, specialization and extinction of cycad-pollinator interactions and has studied pollinators throughout southern and eastern Africa. He has also worked with Irene Terry's team on pollination of *Macrozamia* in Australia. Although now heavily involved in research management, John continues to work on cycad pollination. Email: [Donaldson@nbict.nbi.ac.za](mailto:Donaldson@nbict.nbi.ac.za)

**Paul Forster:** Paul is a systematic botanist at the Queensland Herbarium, Environmental Protection Agency, Brisbane Botanic Gardens, Mt Coot-tha Road, Toowong, Queensland 4060, Australia, where he is also Curator responsible for cycads. He is currently involved in the systematics of *Macrozamia* (Zamiaceae) in eastern Australia and is also preparing Recovery Plans for six endangered species of Queensland cycads. He has also been involved with the *Macrozamia* pollen research team. Email: [paul.forster@epa.qld.gov.au](mailto:paul.forster@epa.qld.gov.au)

**Rolf Oberprieler:** (Research Scientist (Zimmerman Fellow), CSIRO Entomology, Canberra, Australia). Rolf's research field is the systematics and evolutionary biology of weevils (Coleoptera: Curculionoidea). One of the focal points of this research over the last decade has been the systematics of weevils associated with cycads, mainly of the African fauna but also involving some preliminary research on the Asian and Australian cycad weevils. Current research includes systematic revisions of the African Amorphocerini and Antliarhinini and the Australian *Tranes* group, with an emphasis on patterns of host specificity, phylogenetic relationships and evolutionary radiations. A question of particular interest has been whether cycad

associations in weevils are ancient and reflect ancestral life styles, as is widely claimed in the literature. Rolf's research past and present shows that this is not true, but that seven different groups of weevils have colonized cycads independently and seemingly in all cases involving host shifts from more derived plants, perhaps always angiosperms. It furthermore appears that weevils have been instrumental in the evolution of entomophily (insect pollination) in cycads and that this has resulted in recent speciation in both the plants and their weevil pollinators. Email: [Rolf.Oberprieler@csiro.au](mailto:Rolf.Oberprieler@csiro.au)

**William Tang:** Willie works as an entomologist for the U.S. Dept. of Agriculture and has been a Research Associate with Fairchild Tropical Garden (a volunteer position) since 1989. Although he has contributed cycad articles on a wide variety of topics to *The Cycad Newsletter* and *Encephalartos* over the years, his main research interest is insect pollination in cycads. He conducted the first pollination exclusion experiment on a wild population of cycads in 1984 as a graduate student, on the native Florida *Zamia*; this was the first conclusive evidence of insect pollination in a wild cycad. (The late Knut Norstog was the first to demonstrate insect pollination, but in a group of cultivated *Zamia furfuracea*.) Willie has conducted work on the behavior of cycad pollinating beetles and has also produced a series of pioneering studies on the physiology and chemistry of heat and odor production in cycad cones, essential processes that cycads use to entice and control their insect pollinators. Besides basic observations and experiments he is interested in the theory of how insect pollination works in cycads and how and when it evolved. Email: [William.Tang@aphis.usda.gov](mailto:William.Tang@aphis.usda.gov)

**Irene Terry:** Irene and several colleagues have been studying the specialist pollinators of several *Macrozamia* species in Australia. They have discovered some new species of pollinator, including a new *Cycadotherips* on *Macrozamia macdonnellii*, have identified a potential pollinator of *M. moorei*, and have conducted tests confirming that *Tranes* is a pollinator of several *Macrozamia* species. The group is also trying to characterize specific cone traits that are associated with their pollinators. They hope that these studies will reveal more about the evolution of these pollination systems. Email: [terry@biology.utah.edu](mailto:terry@biology.utah.edu)

