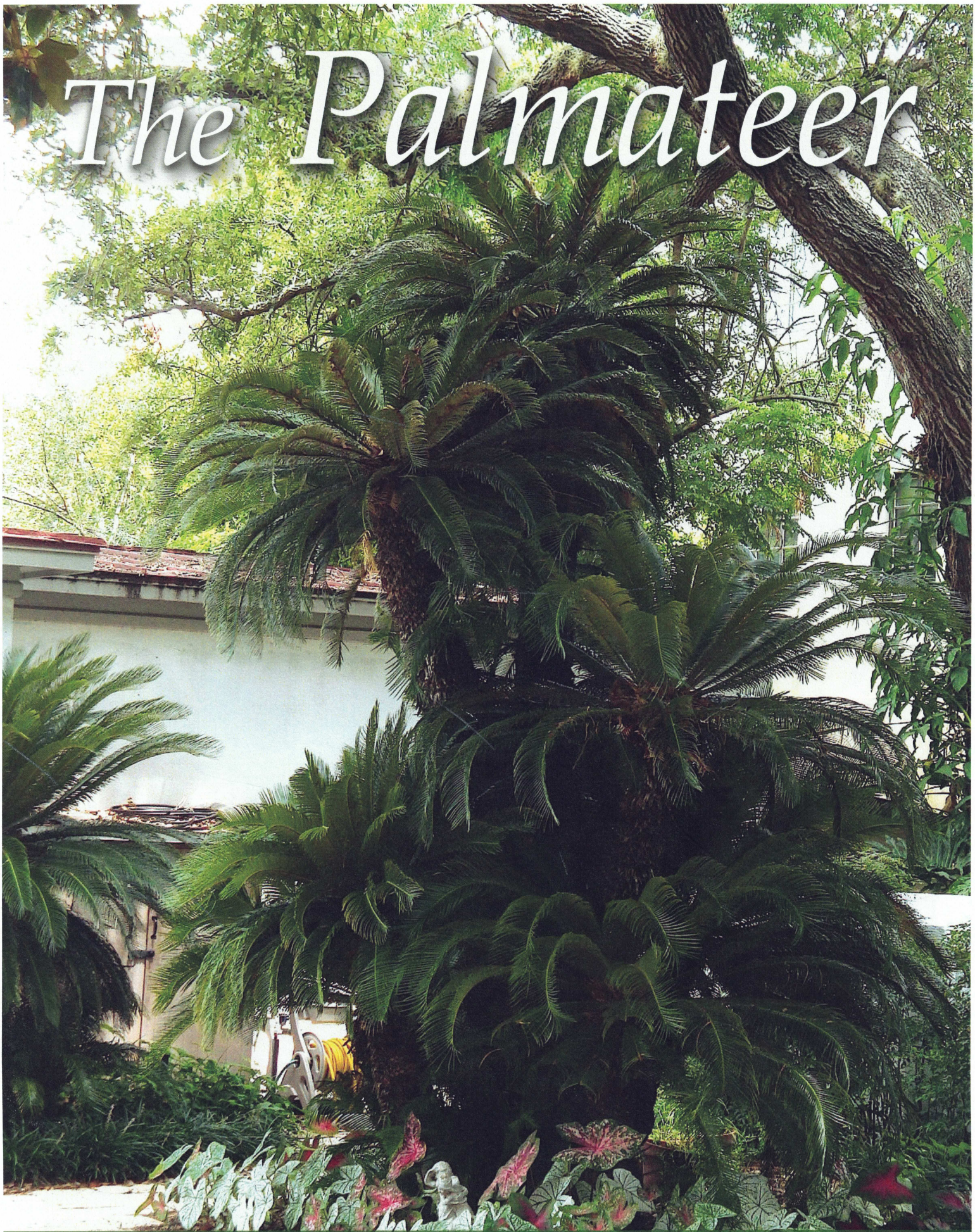
The Palmateer



Central Florida Palm & Cycad Society • Fall, 2010 • Volume 30, Number 3

The Palmateer

Central Florida Palm & Cycad Society

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Contents

5 **New Members**

5 **President's Message**

6 **Cycads at the Polasek** • *Randal Knight*

10 **Shades of Dioon** • *Chuck Grieneisen*

13 **Growing *Dioon edule* in Central Florida** • *Tom Broome*

14 **Optimized Cycad Seed Germination** • *Tom Broome*

17 **Ultimate Cycad Seed Germination** • *Tom Broome*

20 **Growing *Stangeria eriopus*** • *Chuck Grieneisen*

22 **Cycad Pollinators Shifting to New Species** • *William Tang*

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Layout/Production: Bob Johnson

Front cover: *This ancient, majestic cycad (Cycas revoluta) lives up to it's common name 'King Sago' - growing in St. Augustine, Florida (Photo by Bob Johnson).*

Inside front cover: *Female cones of Encephalartos ferox growing at the Polasek Museum Garden in Winter Park, Florida - see article on page 6 (Photo by Bob Johnson).*

Back cover and right: *Coning Encephalartos trispinosus growing in Scott Ward's Indialantic garden - a rare event, few "blue" Encephalartos have ever coned in Florida (photo by Scott Ward).*

Central Florida Palm & Cycad Society

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The **Central Florida Palm & Cycad Society** is an affiliate of the **International Palm Society** and **The Cycad Society**. CFPACS is a nonprofit, nonpartisan organization dedicated to scientific and educational projects related to the study of palms and cycads, their propagation, culture, conservation, care, and development. We assist in the preservation of palms and cycads for future generations as well as promote and maintain public interest in palms and cycads.

CFPACS serves the following counties: *Alachua, Brevard, Citrus, DeSoto, Flagler, Hardee, Hernando, Highlands, Hillsborough, Indian River, Lake, Levy, Manatee, Marion, Okeechobee, Orange, Osceola, Pasco, Pinellas, Polk, Putnam, Sarasota, Seminole, St. Lucie, Sumter and Volusia.* We also welcome palm and cycad enthusiasts from beyond Central Florida to become members.

CFPACS Membership Dues for 2010:

US Members (1-year): $15

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Please send dues to:

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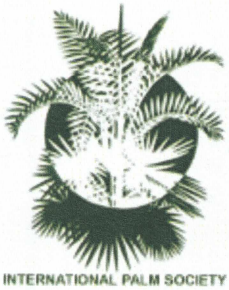
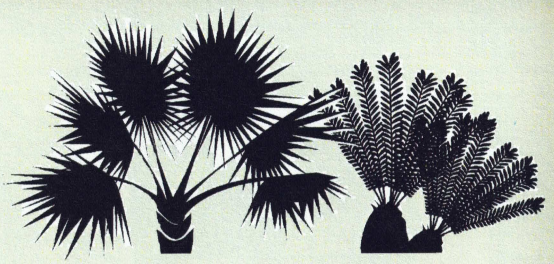


About the International Palm Society: IPS membership dues are $45 a year. Membership includes a subscription to *Palms*, the quarterly journal of the IPS. For further information on the IPS, please visit their web site: www.palms.org

About The Cycad Society: TCS membership dues are $35 a year. Membership includes a subscription to *The Cycad Newsletter*, the quarterly journal of TCS, and access to The Cycad Society seed bank. For further information on the TCS, please visit their web site: www.cycad.org

New Members

We extend a **warm welcome** to our newest members.
We are **glad** that you are a part of CFPACS!



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President's Message

Bob Johnson

The Central Florida Palm and Cycad Society officially brings together enthusiasts for two very different families of plants. I say "officially" because most of us grow a wide variety of plants in addition to palms and cycads. It has been quite some time since we published anything on cycads in *The Palmateer.* With this "all cycad" issue we make up for that. Many of our members grow both palms and cycads, so I know that the information contained in this issue will be welcome and useful to many. If you have not yet added cycads to your garden, I encourage you to consider doing so. Cycads are great companion plants to palms - they look like they are supposed to go together. Two of the most widely planted cycads in our area are even (incorrectly) referred to as "palms" by the general public - the sago "palm" *(Cycas revoluta)* and the cardboard "palm" *(Zamia furfuracea).* This captivating family of plants has survived on the earth since the time of the dinosaurs. Nearly all of them are endangered or threatened species today. By growing and propagating cycads you can aid in the preservations of these prehistoric plants for generations to come - literally, since they will likely outlive you by hundreds of years.

Another reason to grow cycads is that many of them are very cold tolerant and can take the freezes that occur in central Florida. Even if they are frost damaged, most of them will come back, pushing out a new flush of leaves in the spring. As this issue goes to press, most of central Florida has experienced a freeze and another one is on the way - and it is not even winter yet! Although these freezes are part of our climate here in central Florida, they are still disappointing as they limit what palms we can grow in the ground. Not so much with cycads. Outside of the truly tropical cycad species, there are many that can add an exotic tropical look to our gardens and will laugh in the face of our freezes. You might want to plant some cycads next spring!

Cycads at the Polasek

Article by Randal Knight
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The Polasek Museum and Sculpture Garden in Winter Park, Florida was the retirement home of Albin Polasek, internationally known sculptur and former head of the sculpture department at the Chicago Art Institute. He retired to Winter Park in 1950 and built his home and garden. While he was still living, Polasek created the Albin Polasek Foundation. After his death in 1965, his home became a museum to display some 200 pieces of his art work. The mission of the Albin Polasek Foundation, along with the mission of the museum is to promote the legacy of internationally known sculptor, Albin Polasek, and to encourage study, appreciation and the furtherance of representational art. The outdoor gardens date to 1949. The three-acre garden is a pastoral oasis within the city of Winter Park. It is also a historic landscape on Lake Osceola with many of the plantings originally placed by Albin Polasek and his family. The garden is open to the public with free admission. Plantings include many unusual plants that accentuate Polasek's impressive sculptures.

The garden features collections of six different families of plants: Aroids, Begonias, Bromeliads, Cycads, Ferns and Orchids. The Central Florida Palm and Cycad Society helped to greatly the cycad collection through a matching grant awarded in 2009. How exciting it was to see three men carefully examining our small collection of cycads and palms. I later learned that the men were Bob Johnson, Chuck Grieneisen and Brian Warner of the Central Florid Palm and Cycad Society. They were considering the possibility of a grant from CFPACS to help the Polasek develop our cycad collection for the public to enjoy.

Above - The Polasek Musiem and Gardens are on a main thoroughfare in Winter Park. Through a CFPACS grant, over 20 new cycad species have been added to the museum garden's collection (photos by Bob Johnson).

Left - Zamia vasquezii, the fern cycad (photo by Gail Peck).

Right- Encephalrtos ferox, Zamia floridana and Zamia furfuracea thriving in the full sun bed (photo by Gail Peck).

After the CFPACS grant was in place, all three men have dedicated themselves to insure that cycads appropriate for our climate were selected and placed in the right location in the garden. In addition to the CFPACS grant, several cycads and palms were donated to the garden through their efforts. As a result of their dedication, a complete overhaul of the garden has taken place to properly provide the right amount of sun and shade as the cycads and palms require.

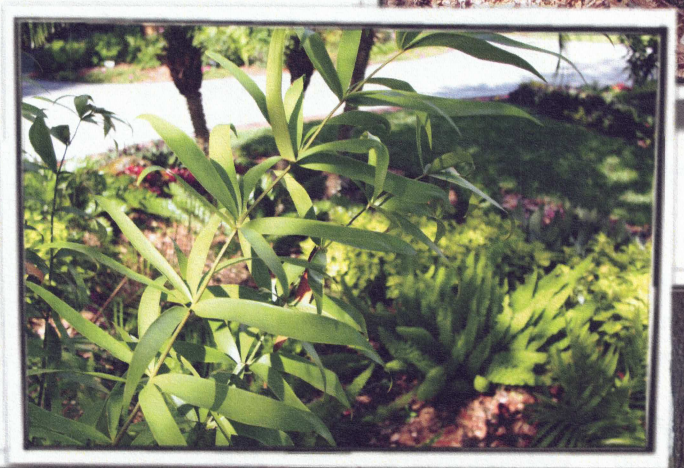
The original cycad planting at the Polasek contained a six foot female specimen of *Encephalartos ferox* with 3 large seed cones produced on a regular basis. Guests are attracted to this showy display and photograph the plant regularly. Many of the cycads planted with the help of the CFPACS grant are plants not typically seen in many central Florida gardens. Our guests are intrigued by the beauty and variety represented by these fascinating plants.

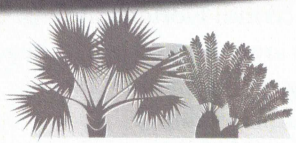
With the help of CFPACS, the garden now has nine cycad genera *(Bowenia, Ceratozamia, Cycas, Dioon, Lepidozamia, Macrozamia, Zamia)* representing 26 different species. All of the cycads survived the extended cold weather in early 2010 with only minor damage on 2 species. Our small *Bowenia serrulata* had three leaves when planted in 2009 and has the same three leaves today. The *Zamia loddigesii* was 24 "tall when planted in 2009, had some damage to the leaves this past winter and the new flush produced leaves that are now only 18" in height. Those are the only two cycads that were affected by the cold weather and have not bounced back with vigor. Most of the other 20 or so cycad species have flushed new leaves and are thriving vigorously.

The gardens are located on the south side of Lake Osceola, a favorable micro climate which gives a few degrees protection from the cold. There was minimal frost damage on

the property and a very few tropical plants were lost to the cold weather in 2010. The cycads are thriving and are among the most trouble free plants in the garden. To protect our *Cycas* species from scale damage, we use coffee grounds every three months during hot weather. With the help of cycad expert Tom Broome from Lakeland, we were able to refine our cultural program with minor adjustments. We use the Cycad Special fertilizer he formulated for his nursery. We did notice a manganese deficiency on our *Encephalartos villosus* but corrected that problem with the addition of manganese. I am seeing some yellowing on our *Ceratozamia kuesteriana* growing nearby and feel sure that can be corrected with a light application of magnesium and iron.

We are so pleased with our Cycad collection. Our aim is to educate our visitors and present these ancient and unusual plants that inhibited the earth two to three hundred million years ago. We hope to encourage the use of this endangered group of plants in the landscape of homes, parks and businesses to help protect them from extinction.





Top - Zamia sp. "Jamaican Giant' (photo by Bob Johnson).

Right and lover right - Ceratozamia hildae (photos by Gail Peck) .

Below - New leaf on Chambeyronia macrocarpa - yes, a few donated palms made their way into the Polasek along with the cycads (photo by Bob Johnson).

Above - Cycas panzihuanensis

Left - Dioon merolae

Below - Shade bed containing Ceratozamia, Cycas and Ceratozamia species

(photos by Gail Peck)

Shades of *Dioon*

photos by Chuck Grieneisen

New leaf flushes of the variable *Dioon edule* come in a myriad of hues.

Growing *Dioon edule* in Central Florida

Article by Tom Broome

Of all the cycad species that can be grown in central Florida, *Dioon edule* is probably the hardiest and easiest to grow. I have never seen this species with insect problems, and it is very tolerant of a variety of soil conditions, *Dioon edule* is also one of the longer living cycads, a single stem can live to be 1500 years old, and will attain a stem height of 10 feet.

Dioon edule is an average sized plant that will normally have a six-foot spread. In many ways, it is very similar to the king sago, or *Cycas revoluta*. The leaves are a little lighter green, and are more rigid than the king sago. I have found it to be one of the most frost hardy species in my collection. During the freeze of 1989, I had 17F at my nursery. All of my king sagos were either defoliated or showed leaf damage. None of my *Dioon edule* plants had even the first sign of tip burn. From what I have been told, this species will get leaf burn at 14F, and trunk damage when experiencing temperatures in the single digits. This species comes from Mexico with a habitat ranging from just south of Texas to Veracruz in central Mexico. Because of this, there are several variants as far as leaf types, and cold hardiness. The tolerance of low temperatures will vary depending on which variant you have, but all should be considered very cold hardy. As far as leaf types are concerned, they can have leaflets that are spread apart, close together, or *continued on page 23*

Optimizing Cycad Seed Germination

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In order to optimize cycad seed germination it is important to understand cycad seed development and the physics involved with seeds. Once you understand the basics, you can fine-tune your planting procedures to work best with your particular growing conditions. I will discuss seed development, seed storage, and various planting techniques. I will also relay what techniques have worked best for me in my growing conditions here in Florida.

When a female cone becomes receptive, the ovules in the cone will secrete a sticky drop of liquid. As the day progresses the liquid dries up and is pulled into the ovule. If pollen has been in contact with the drop, the pollen is pulled in as well. The pollen, which are actually motile sperm cells, will be stored in pollen chambers until it is time to fertilize the ovule. This can take as long as four months to occur. At the time of release, the sperm cells swim down a tube and fertilize the ovule. The embryo grows at this point and will take several more months to become full size. The embryo at first can be seen in the middle of the seed and will grow until it emerges from the same point that the pollen entered months before. A seed with an immature embryo will have a small embryo in the center with a hollow tube running from the embryo to the point of exit. An umbilical cord type structure called a suspensor connects the embryo and the exit point. As the embryo grows the suspensor is compressed. Many times when the seed sprouts the compressed suspensor can be seen exiting the seed.

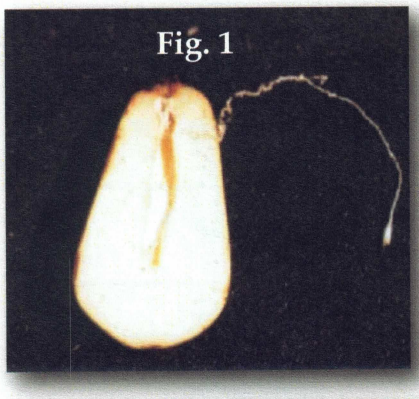
At the time that the cone falls off the plant the embryo may or may not be full size. Cycads will hold the cones from six months up to 18 months depending on the genus and even the species within a genus. As a general rule, most embryos will become mature approximately 12 months after the initial pollination occurs, however there are also several exceptions to the rule. Southern *Macrozamias* can sprout as early as 9 months after pollination, and some *Dioons* and *Zamias* will take as long as 18 months before they even fall from the plant. One of the secrets to cycad seed germination is knowing how long a seed needs to be held after it falls from the mother plant. The chart below shows approximate times that seeds should be held before planting. There are some species that have very erratic embryo development. I have found that certain *Encephalartos* and *Cycas* species will start sprouting at a certain time and other seeds from the same seed batch will continue to sprout over a year or even two years time.

Many times if a seed is planted before it is ready to sprout it may absorb too much moisture, expand and appear as if it is going to sprout, and then die. Depending on the growing conditions used, this extra period gives time for fungus, and insects to attack the seed as well. Whether you produced the seed yourself, or if you purchased the seed from someone else, it is a very good idea to cut one of the seeds open lengthwise down the middle to observe the development of the embryo. In most cases, you will save more plants by destroying one seed, compared to how many seeds will die from being planted too early.

Proper storage of seeds is the next important aspect of getting a high germination rate. This is the point where most good seeds can become bad seeds. Cycad seeds need a certain amount of moisture at this time to continue developing properly. If a seed does not get this moisture in some way the soft inside can separate from the hard outside shell. Most of us by now have heard about rattlers and floaters. When the inside of the seed starts to dry up, it gets smaller which forms an air pocket and this is why a seed will float in water or rattle when shaken. If a seed has just started to rattle it is still possible to save the seed by soaking it in water for a day or two. If the seed has been kept for a long period of time without any hydration it can be too late to save it. I never throw away rattlers or floaters and have had hundreds of them germinate over the years. I usually plant them separately, because if they are bad, the bad seeds will spread fungus

very fast once they are planted in a community tray or pot.

Cycad seeds can be stored in many ways. Some should be cleaned before they are stored and some are better off stored with the seed coat on. The smaller the seed the better the chance of the seed drying out on the inside. I store all my *Zamia* and *Cycas* seeds with the fruit on. Without any special care, I have stored *Zamia floridana* seed for up to seven months with the fruit on. I have found that the same seeds will start going bad after three months of storage if they are cleaned first. The fruity seed coat is an amazing thing. It keeps the seed just moist enough to keep the seed fresh, but it also inhibits the seed from germinating until it is removed. I always store my seeds in a cool place. I never store them in a closed container or plastic bag because this seems to give fungus a good chance to attack the seeds. I keep my seeds in open containers, or when I have very large amounts of a certain seeds, I use nylon mesh bags. I soak the seeds I have cleaned every two weeks for a couple of hours, and then let them dry again. This keeps them moist enough so they don't go bad, but on the other hand, they don't get to wet. The nylon bags work great for this process.



Once you are ready to germinate your seeds you should remove the seed coat first if it hasn't been done already. After they are clean, I will soak the seeds for two days in water. This really seems to help them get started. Cycad seeds are very capable of absorbing moisture, and there is absolutely no need to scarify or crack the seeds. A seed that has a full sized embryo will readily germinate once there is enough moisture, and the temperature in the growing area is high enough. Once I soak the seeds, I will usually dip them in a fungicide before I plant them. I prefer to use *Daconil*, but there are other fungicides that will work just as well.

There are many techniques that people use to germinate their seeds. The most important things to remember are that you want your medium to be as sterile as possible, you want your seeds to be moist but not wet, and you want your growing area to be warm enough to stimulate germination.

The "bag" method is very popular, especially for people who need to germinate their seeds indoors, or when the temperatures are too cold outside to stimulate germination. Seeds are placed in a plastic bag filled with a sterile medium like perlite or vermiculite. The medium should be slightly moist but not wet. The bag is then placed near a heat source. The temperature should not exceed 100F just to make sure the seeds don't get damaged. The seeds should be checked every few days to make sure that they don't get fungus, and to remove any seeds that have sprouted.

I usually place my seeds on top of builder's sand, and then lightly cover them with perlite. I will lightly water the area a couple of times a week. I know of people in South Africa who plant the seeds on top of sand and cover them with a moist burlap bag. Another method is

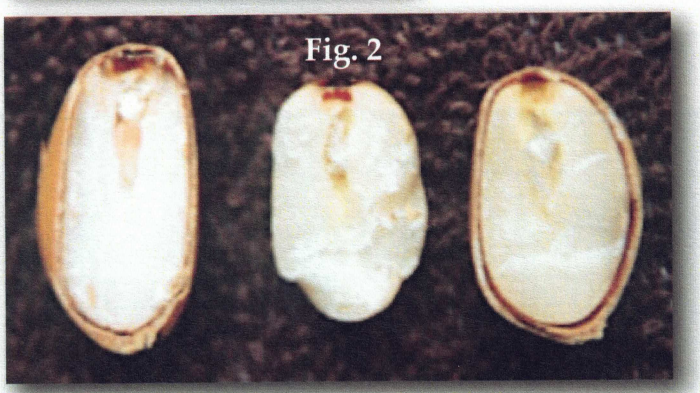
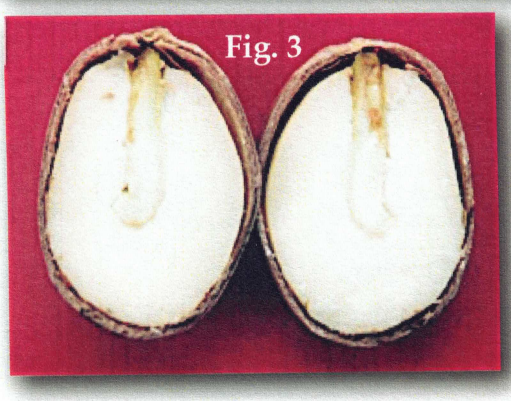


Figure 1 - Encephalartos seed with very immature embryo showing suspensor and embryo at end. Planting time could be as long as 4 to 6 months.

Figure 2 - Ceratozamia seeds- left is half mature showing embryo and compacted suspensor. Plant time about a month to 6 weeks. The two on right is one seed that is very immature. The suspensor can be seen on the left side, the right only shows the other half with nothing important to be seen. Plant time about 3 months.



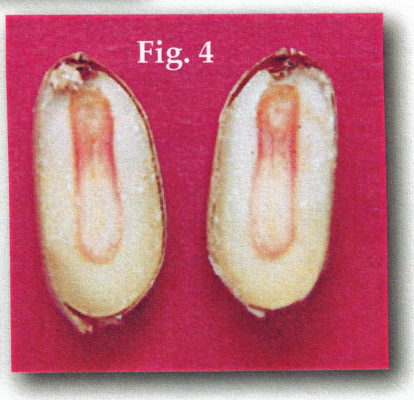


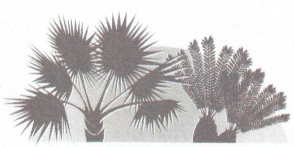
Figure 3 - Dioon edule seed that is ready to sprout with full sized embryo.

Figure 4 - Zamia variegata seed with full sized embryo and on the top of the left side, you can see the compressed suspensor.

to plant them with the sand and perlite, but cover the growing area with plastic so that the moisture does not escape. This keeps you from having to water as often and will avoid the possibility of keep the growing area too wet.

In the past I have not had a great deal of luck germinating *Encephalartos* seeds with my method using the sand and the perlite. I found that I was keeping the seeds too moist and had too many seeds rotting before they sprouted. This is very important when certain seeds may take up to an extra year to germinate. My newest method is to place the seeds half way into the moist sand. There are two ends of a cycad seed. There is the end where the seed will sprout from and the end where the seed was attached to the cone. This end will usually have some sort of scar on it. The pattern of scars will vary depending on the genus and even the species in some cases. The sprouting end will usually have only one spot on the end, a raised area, or as with *Encephalartos* seeds, a series of cracks that act as a hatch when the seed sprouts. I have found that placing the attachment end down into the medium keeps the seed moist enough to make sure they don't go bad. This also means that the sprouting end is out of the medium and makes it very hard for fungus to enter the seed like it would if it was placed in the medium. I have doubled my germination rate on *Encephalartos* seeds using this method as opposed to my previous method using the sand and the perlite. Once the seed sprouts, I will then push the sprouted end in the sand and let the radicle push down into the medium. All methods can work well, but results will vary depending on moisture content, sterility of the growing area, and the temperature. I personally don't use any additional heat source, and rely on the natural temperature outside.

Cycads are rare enough as it is to waste perfectly good seeds by improper storage and poor germination techniques. Thousands of cycad seeds go bad every year because they were not stored properly, or were planted incorrectly. By optimizing cycad seed germination we will be on our way to making these endangered plants more common.



Genus	Typical Holding Period
Bowenia	1-3 months
Ceratozamia	3-6 months
Cycas	4-12 months
Dioon	0-2 months
Encephalartos	usually 6 months
Lepidozamia	3 months
Macrozamia	3 months
Microcycas	1-2 months
Stangeria	1-3 months
Zamia	0-2 months

Figure 5 - Dioon edule seeds planted with sprouting end up and some already pushed down. Note the newly sprouted seeds with lighter radicles that have not been pushed down (photo by Tom Broome).

Ultimate Cycad Seed Germination

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Several years ago I purchased some *Encephalartos ferox* seeds from a person here in Florida that was brokering the seeds for someone else. When I got them, all of the seeds either rattled and/or floated. I cut some of the seeds open to see what I was dealing with, and what I found was that the seeds with the testa removed were about half the size they were supposed to be. It was hard and dry and looked like they had been kept dry for several months. *Encephalartos* seeds are supposed to be held for several months (usually 6) before the embryos are full size and ready to plant, but these had been held much longer than that. After cutting some of the seeds open, I found full size embryos in them and a few had even tried to sprout within the seed. I didn't want to throw away these seeds, like most people would have done, so I thought I would experiment with them. I had nothing to lose.

I wasn't sure where to begin, but I knew that no matter what I did, these seeds could not germinate on their own. The inside of the seed needs to be close to full size so that if the seed starts to sprout, the new shoot can put pressure on the hatch at the end of the seed, and break through to the outside. The only way I could think of taking care of this was to remove the shell and plant the inside part of the seeds. I cut the shell at an angle, as opposed to straight in, so I could cut away the shell without hitting the inside of the seeds and damaging them. After removing all the shells, I soaked the inside of the seed in a weak bleach solution for less than a minute, and planted them in containers filled with white sand that I had sterilized. It was a lot of work, but it paid off. I got more than half the seeds to sprout and become plants, where most people would have thrown them all away.

After having good luck with these seeds, I wondered what would happen if I did the same thing with some good seeds that had been taking a long time to germinate. I had a few *Encephalartos trispinosus* seeds that had been sitting in sand pots for more than a year and a half without any results. One of the key problems withgerminating many *Encephalartos* seeds is that there needs to be the right amount of heat and moisture to stimulate the new sprout to activate, and push through the hatch of the seed. From my own observations over the years, I haven't seen very many *Encephalartos* seeds germinate until the outside temperatures get into the mid 90's, which means it is close to 100F inside the greenhouse. On top of that, the seeds need a certain amount of moisture to help them start. Not so much that they rot, but just enough to stimulate them. I obviously had not given these seeds the proper treatment. As seen in **figure 1**, I cut the seeds at an angle so that I didn't nick the inside material. It was more important to make sure of my angle compared to the *E. ferox* seeds because the insides of the seeds were still full size and could get damaged very easily. A little bit at a time, I cut parts of the shell off until they were free of the shell material. I treated these the same way as the *ferox* seeds and planted them in a small container. After less than 24 hours, the first two seeds had sprouted, as seen in **figure 2**. Within 3 days, 3 of the seed sprouted. The last seed never sprouted and after cutting it open, I found out it never had an embryo. I was amazed. Seeds that had not sprouted in a year and a half all sprouted in 3 days just by removing the shell. To me, this was a great way to get seeds that are hard to germinate to sprout in a fast and uniform manner. The only draw back was that everything needed to be fairly sterile because the insides of the seeds are very susceptible to fungus.

Around the same time, Greg Holzman had been working with cutting the ends of seeds with a knife to get them to sprout. At least this would be a way to reduce the risk of fungus attack. The only draw back I could think of would be that if you had seeds standing on their ends with a hole in them, water could get in the holes and rot the seeds. After a few experiments, I have come up with a fast and efficient way to treat these seeds.

First of all, you want to start with seeds that have full sized embryos. You can either cut a few seeds open to see how far along they are, or treat them once you see the

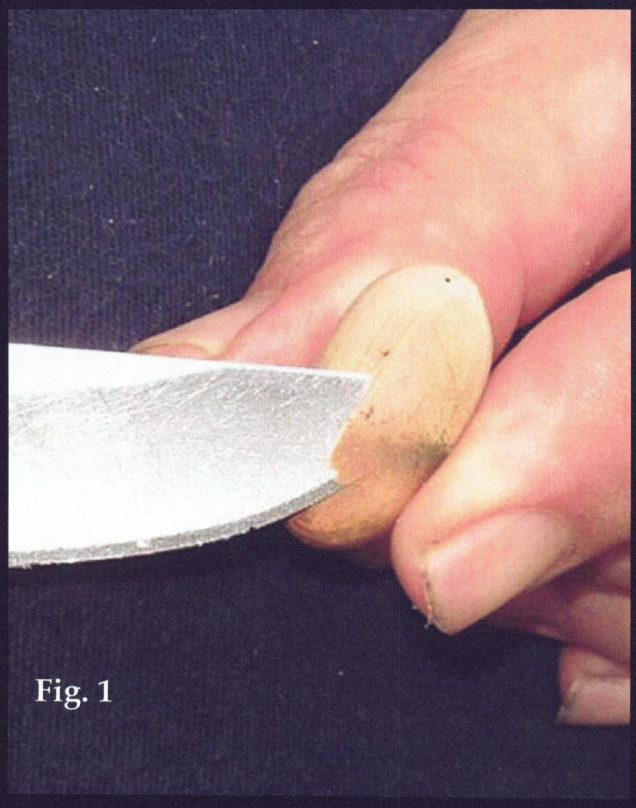

Fig. 1

Fig. 2

Fig. 3

Fig. 4

first few seeds sprout on their own. I take a small grinding attachment and put it on my small hand tool made by Dremel. These tools are relatively inexpensive and are perfect for fine work. As seen in **figure 3**, I grind out a hole at the sprouting end of the seed so that it just barely removes the hard shell, but you don't want to cut into the seed area. This is a very fast method. On average, it only took 10 seconds or less to grind the ends off of each seed. In **figure 4**, you can see down into the seed and see the sprout that wants to come out. I place all the seeds in a 4-inch pot with slightly moist

Sphagnum moss so that the sprouting ends are straight up. This way, the hard shells can absorb enough moisture to stimulate germination, but no water can get into the seed and rot them. I put the small pot in a plastic bag so that it can hold in the humidity, but at the same time, will keep my irrigation from getting into the holes in the seeds before the seeds sprout. **Figure 5** shows the newly ground seeds planted in the *Sphagnum* moss. **Figure 6** shows them in the plastic bag. 24 hours later, I removed this pot to see what had happened and as seen in **figure 7**, 70% of the seeds had already sprouted. In the next couple of days, all but one of the seeds had sprouted, but I found that this seed was also bad, so within 3 days every good seed had sprouted.

I have since used this method on hundreds of *Encephalartos* seeds, as well as *Dioons, Lepidozamias,* and a few other seeds that can be difficult to germinate. This new method changes everything I have ever written about in my previous germination articles and to me is a revelation in cycad seed germination. Cycad seed germination is not the easiest thing to accomplish. The temperatures for germination need to be just right. Many people over the years have used incubators and have put together homemade germination boxes with various heating units. With this method, there is not need for any extra heat. I have achieved 90% germination of *Encephalartos* seeds that were placed in my garage during the middle of the winter. There is no need to regulate the moisture to try and get the seeds to sprout any more. By removing the end of the shell, there is nothing to hold back the sprout. *Cycas thoursii* seeds can take as long as 3 years to sprout, mainly because they have a very thick shell. These seeds can now be germinated in a short period of time. *Lepidozamia* and *Bowenia* seeds have been known for germinating inside the shell, so this would not happen either. One complaint I am always hearing from people about cycad seed germination is that they can take a long time to sprout and it is very inconsistent in it's timing. Now, you can achieve close to 100% germination of the good seeds within a week or less. Most seeds will sprout within the first 24 hours, so uniform and fast germination can be achieved regardless of temperature, or time of year.

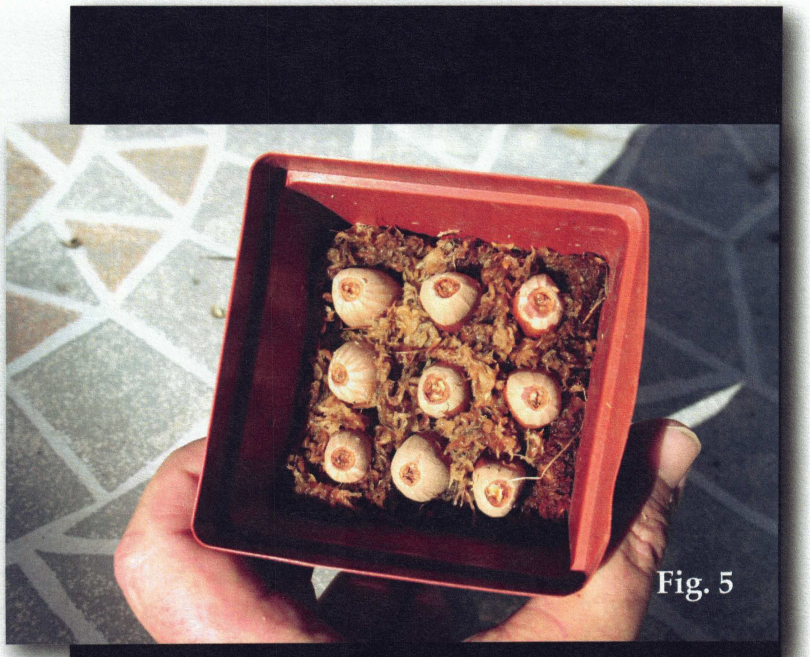
Fig. 5


Fig. 6


Fig. 7

Growing *Stangeria eriopus*

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Stangeria eriopus is one of the most unusual cycads that can be grown well in Florida. When it was first discovered it was thought to be a fern. They only discovered that it was a cycad when it produced a cone. There is only one species in the genus, *Stangeria eriopus*. Most other cycad genera like *Cycas* and *Dioon* have many different species. Although there is only one species, there are two forms of *Stangeria eriopus*, the grassland form and the forest form. The grassland form has smaller leaves, up to 24 inches. If the leaves are longer they are the forest form, which can have leaves leaves up to six feet long.

Growing *Stangeria*

Stangeria likes sandy loam and slightly acidic pH. *Stangeria* grows best in some shade. A half a day of sun is all that I give then. I have never seen them in full sun, but I have seen them growing in deep shade. I have never had any cold damage on *Stangeria.* They have taken 27F with heavy frost and even 25F without any damage. If you only have pure sand for soil I would add some peat or other "topsoil" in with it. I have also had them grow well in a regular "potting mix" in a container. Most other cycads wouldn't like that. My usual mix for *Dioons* and *Encephalartos* is 75% perlite and 25% peat. *Stangeria* does not like that, it doesn't seem to hold enough moisture for them, even if watered every day. To be safe I make a mix of 50% potting mix and 50% perlite. That makes it well draining enough but still holds enough moisture. Seedlings are another matter though, they will rot in just potting mix. I put them in a mix of 50% horticultural charcoal and 50% perlite or in pure sugar sand. The charcoal/perlite mix doesn't seem to be able to be over watered but he sugar sand can be over watered. If the sand stays wet for a week it can kill the seedlings, so I water them just enough that it dries out after a day or two. I leave them in the seedling mix until they get about 1/2 to 3/4 inch diameter. Another unusual thing that I have noticed is that most of them seem to be female (cycads are dioecious, producing male or female plants). Two of them I know of in botanical gardens were both female. I have acquired five large *Stangeria* and four of them have coned female. The other hasn't coned yet. I may just be "lucky" but I haven't had that luck with any other cycads. At this time I need to get a male on loan if I want to pollinate them.

Stangeria Pollination

Some people that have *Stangeria* don't do anything to pollinate them and get good seed production. Most, if not all cycads have insects that pollinate the cones. Our coontie has a weevil, that's why you don't need to pollinate them to get good seed. How does a South African plant pollinate itself here then? At first I thought a collection imported pre-CITES may have imported the beetle needed to pollinate it. Then I heard that a fruit fly may be the pollinator. It makes sense, since I have heard of other populations here that self pollinate. I have also seen what appear to be fruit flies around my female cones at various times. So even if you don't pollinate them, if

Fig. 1

you have a male and female plant that cone at the same time you may get good seed.

I do hand pollinate my *Stangeria*. If you have a male and female cone, I would watch the male cone. The females seem to have a cone on them forever before they get pollinated. The male cone will elongate and shed it's pollen about two months after it fully forms. Most cycad male cones will still produce pollen if it is cut off just after it emerges. *Stangeria* will not do that. The male cone needs to stay on the plant to produce pollen. I check on it once a week after it cones to see if pollen is present. At that time the female cone will have opened up a little on the top and you can look in and see the little seeds. If you just throw pollen in the top you will get only a few good seeds.

A technique Tom Broome taught me years ago is that the female cone will get "loose". Each segment of the cone gets rubbery, and you can bend down each segment and throw some pollen in each segment (figure 2). I always use the dry method, which is just putting dry pollen in. There is a wet method where you mix the pollen with water and squirt it in. I just haven't tried that yet, I am concerned that the water may rot the cone. With the Tom Broome technique I got 14 seeds on one cone this year. *Stangeria* does not produce hundreds of seeds like some cycads.

Once it is pollinated it is another 6-10 months before the cone breaks up and you can collect the seeds. Once the cone breaks up the seeds still need to be held another 3 months before planting. When the cone breaks up the good seeds are about the size of a nickel, the others are about the size of a grain of rice. I leave the seed coat on to prevent the seeds from drying out. Be sure to take the seed coat off before planting. I just plant my seeds in pure sand, making shore they don't dry out. One other thing I learned that may apply to other cycads is that one time I cut the cone off a female plant just after I pollinated it. I did that because it was a small plant and I thought the developing seeds could pull so much energy from the plant that it could die. That happens with some first time coning cycads. I just left the cone in the container and months later it broke apart and it had some mature seeds in it! I planted them and they were good. I have since heard that that is a common practice in South Africa where cycad cone thefts are common.

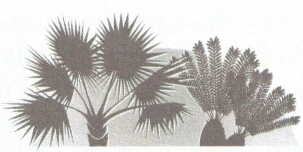

Figure 1 - Stangeria eriopus leaf.

Figure 2 - Putting pollen into a Stangeria female cone (photos by Chuck Grieneisen).

Figure 3 - Stangeria eriopus growing at Leu Grdens, Orlando (photo by Bob Johnson).

Cycad Cone Beetles Shifting to New Species

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In an article in the journal *Encephalartos* (Cycad Society of South Africa) Piet Vorster reported his observations of *Encephalartos* cone beetles visiting cycad cones of other species and genera in his garden. I report some similar observations and research in Florida. in the 1980's and 90's (especially in the early 1980's) I've removed and inspected hundreds of cycad cones from 10 genera of cycads, mainly from Fairchild Tropical Botanical Garden and Montgomery Botanical Center in Miami, for close scrutiny in the lab.

There is a native weevil pollinator, *Rhopalotria slossoni* (zamia beetle), on the native Florida *Zamia* species. I have seen it on one occasion visiting *Zamia vasquezii* (formerly *Z. fisheri*) cones in a nursery setting. *Zamia vasquezii* has a pollination period that overlaps with that of the native *Zamia*. There are a few other cycads species with an early winter coning period. Some *Ceratozamias* will cone during this period, but I have never observed zamia beetles on them.

Of greater interest is the natural pollinator of *Zamia furfuracea*, *Rhopalotria millis*, both of which were introduced into south Florida from Mexico. Norstog and Stevenson (1980) document *R. mollis* in south Florida as early as 1980. *Zamia furfuracea's* pollination period is in summer, beginning here in June and ending by mid September. Knut Norstog and Priscilla Fawcett (1989) have studied the life cycle of this beetle in great detail. Pupae of this beetle remain dormant in the cone debris from the previous pollination season. At the start of the new pollination season some internal clock [see Tang (1997) for further discussion] or environmental cue, such as odor from new cones, stimulate the ability to emerge. They reproduce in male cones, completing several generations in one season. When their host plants finish coning what happens to the adult beetles? The instinct to survive and continue reproducing is very strong. These beetles do not simply drop dead. What are they doing? UV light traps placed out at the end of *Z. furfurcea's* coning season indicate that large numbers of these beetles are still very active and searching for mates and cones to lay eggs in. Even many months after the last cone has passed it's pollination period these beetles have been captured in flight intercept traps (C.W. O'Brian, pers. comm.). These captures indicate that they were still actively flying and probably searching for cones. It is at the end of *Z. furfuracea's* pollination period, when the beetle numbers are high and their natural host plant's cones become scarce, that I observe them from late July through August in female and male *Dioon spinulosum* cones cut open at the pollination phase. This may explain the occasional production of fertile seed in this species at Fairchild Garden and Montgomery Botanical Center when no hand-pollination was performed. This species only opens to pollination at the base of the cone [see Tang (1997) for more details], and wind was unlikely to be causing pollination. In 1995, also at the end of *Z. furfuracea's* pollination season I was amazed to see one morning *Rhopalortria* beetles hovering around the base of female *Encephalartos hildebrantii* cones receptive to pollination! When not hand-pollinated, this species produces fertile seeds at Fairchild Garden and Montgomery Botanical Center on an erratic basis, but its pollinator was a mystery (Tang 1994). These particular cones were not hand-pollinated, and months later when mature, fertility of the seeds was found to be 78 percent! In mid-September 1983 at Fairchild Garden and again in 2000 at the end of August in my garden, with Eddie Williamson present, I observed *R. mollis* beetles on male *E. hildebrantii* cones that were shedding pollen.

These beetles, like most weevils, are primarily nocturnal. They probably locate their host by odor. In 1991 Swedish colleagues and I managed to complete a chemical analysis of male cone odors of *Z. furfuracea* and *Encephalartos altensteinii* (Pellmyr *et al.* 1991). *Encephalartos hildebrantii* has a cone odor similar to that of *E. altensteinii*, suggesting that there is some similarity in the chemical composition of cone odors of these two species. Interestingly, the main chemical constituent of both *Zamia*

furfuracea cone, making up a third of the odor, is linalool, an alcohol with a sweet scent. The *E. altensteinii* cone also has linalool, but in much smaller amounts, making up only 0.8 percent of the total. These two species also share two other chemicals, limonene and trans-ß-Omicine, which are found at levels between 0.3-3.1 percent. Limonene has a resiny or citrus odor to the human nose. If indeed *E. hildebrantii* and *E. altensteinii* have similar cone scents, these odor analysis explain a lot. When its natural hosts become scarce or are no longer available at the end of the pollination season, the *R. mollis* beetles will search out whatever has the closest scent. In Miami, Florida this is probably *E. hildebrantii.*

To my knowledge, no chemical analysis of *Dioon* cone scents have been published, however *Dioon spinulosum* is visited in the wild and apparently pollinated by an as yet undescribed species of *Rhopalotria* beetle (Tang 1997). This suggests that there are similarities between *Dioon spinulosum* and *Z. furfuracea* cone scents as well.

I have not found any larvae of *Rhopalotria* in *Dioon spinulosum* or *Encephalartos hildebrantii* suggesting that this beetle does not successfully complete its life cycle on these other species. Some insect species, such as aphids, have been known to shift from one host to another, especially after they have inadvertently been introduced to a new habitat. During the millions of years of cycad evolution, this kind of host shift of insects from one species to a new species of cycad has undoubtedly happened many times. The main barrier to a successful host shift is probably the chemical defense in cycad tissues. If the insect can adapt itself to the combination of toxic chemicals that are peculiar to each species of cycad, it may be able to colonize and use another cycad species to complete its life cycle. In the process the plant may also benefit by gaining a new pollinator and eventually evolve by natural selection to accommodate the insect. Those individual cycads plants that are less toxic to the new beetle may have more success in reproducing if the new beetle visitor increases its pollination success.

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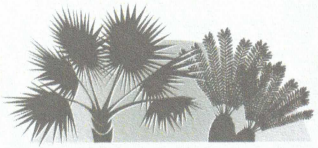

Dioon edule

- continued from page 13

even slightly overlapping. *Dioon edule* can have green, red, silver, and even purple emergent leaves. This means that the leaves will emerge a certain color, and once the leaves harden up, they will change to green. This is common in many cycad species, and the most colorful plants are highly sought after by collectors.

Dioon edule prefers to be grown in full sun, but can tolerate some shade. It is not very fast growing. Even when it is fertilized regularly, you should not expect more than two flushes of leaves per year on the average. Cones become receptive to pollination in our area in either October or November, and seeds are usually ready the next November. Once the cone falls apart, the seeds can usually be planted immediately or with an over ripening period of only one month.

Dioon edule is a good choice for the first time cycad enthusiast and is readily available at CFPACS sales. A plant like this will be something that you can enjoy growing for the rest of your life, as well as handed down to many generations to come.

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