

# Optimizing Cycad Seed Germination

edited by Maurice Levin, from an original article by Tom Broome

To optimize cycad seed germination it is important to understand how cycad seeds develop and the physics involved with seeds. Once you understand the basics, you can fine-tune your germinating procedures to work best with your own growing conditions. This article discusses seed development, seed storage, and various planting techniques. This article also discusses what techniques have work best in two different growing environments, Florida and California.

When a female cone becomes receptive, the ovules in the cone 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. Cycad pollen, which consists of motile sperm cells, will then be stored in pollen chambers inside the seed 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. At first, the embryo can be seen in the middle of the seed and will grow until it emerges from the same point at which 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 a cycad seed sprouts the compressed suspensor can be seen exiting the seed. Figure 1 shows an immature seed with the suspensor and the immature embryo. Figure 2a shows an immature seed, and figure 2b shows a seed that is sprouting with a full size embryo.

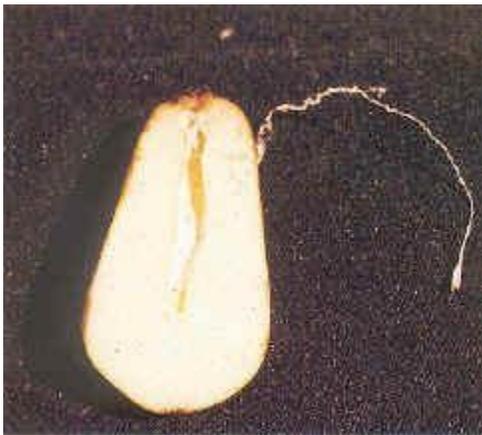


Figure 1. Immature *Encephalartos* seed showing coiled suspensor.

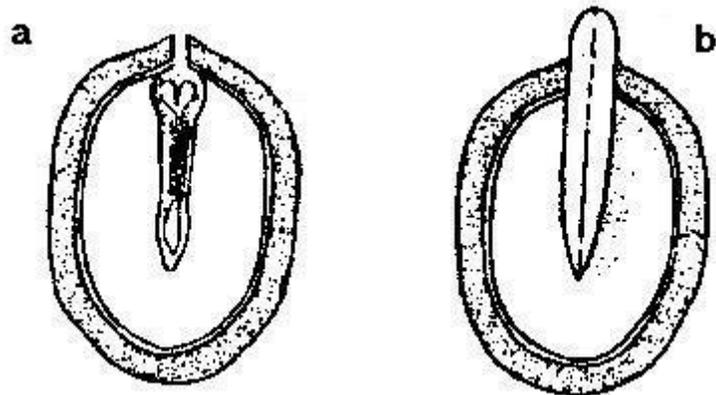


Figure 2. Progressive development of an *Encephalartos* embryo.

**Table 1. Typical hold period for cycad seeds.**

Genus	Typical holding period
<i>Bowenia</i>	1 to 3 months
<i>Ceratozamia</i>	3 to 6 months
<i>Cycas</i>	4 to 12 months
<i>Dioon</i>	0 to 2 months
<i>Encephalartos</i>	6 -9 months
<i>Lepidozamia</i>	3-12 months
<i>Macrozamia</i>	3 months
<i>Microcycas</i>	1 to 2 months
<i>Stangeria</i>	1 to 3 months
<i>Zamia</i>	0 to 2 months

When a female cone falls off the parent plant, the embryos in its seeds may not yet be full size. Cycads can hold the cones from six months up to 18 months depending on the genus and even the species within a genus (Table 1). Generally, most embryos become mature within 12 months from when they are initially pollinated, however there are also several exceptions to the rule. Southern *Macrozamia*s can sprout as early as 9 months after pollination, and some *Dioons* and *Zamia*s can 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. **Table I** below shows approximate times that seeds should be held before planting. There are some species that have very erratic embryo development. Certain *Encephalartos* and *Cycas* species may 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. This extra period gives time for fungus and insects to attack the seed as well. It is a good idea to cut open one seed lengthwise down the middle to observe embryo development. In most cases, you will save more plants by destroying one seed, compared to how many seeds will die from being planted too early. Figures 3-5 show examples of seeds from three different genera.



Figure 3. *Ceratozamia* seeds. The seed on the left is a very immature seed; sowing time is about 3 months. The seed on the right is half mature showing a small embryo and a compacted suspensor; sowing time is about a month to 6 weeks.



Figure 4. *Dioon edule* seed that is ready to sprout, with full sized embryo.



Figure 5. *Zamia variegata* seed with full sized embryo; on the top of the left side, you can see the compressed suspensor.

Proper seed storage 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 sarcotesta (outer fleshy layer) on. I have found that the same seeds will start going bad after three months of storage if they are cleaned first. The sarcotesta 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 type of seed, 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 too wet. The nylon bags work great for this process.

Once you are ready to germinate your seeds, you should remove the sarcotesta first if it hasn't been done already. After they are clean, I will soak them 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 100 F 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 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 (called the chalazal end). 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 either a single 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 chalazal 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 using 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 (Fig. 6). 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.

Figure 6. *Dioon edule* seeds planted with sprouting end up and some already pushed down. Note the newly sprouted seeds with lighter colored radicles that have not been pushed down.

