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## THE PROPAGATION OF CYCADS—A GAME FOR YOUNG PEOPLE?

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**Abstract.** Cycads deserve to be more widely used in Florida gardens, but have always been expensive and difficult to find. Nurserymen do not like them as a crop since they are slow growing and have a reputation for being difficult to propagate. Seed set in most species can be improved by hand pollination using either fresh or stored pollen. The seed of some species needs a period of storage before it is ready to plant; others can be planted immediately and germination is often enhanced by scarification or cutting the seed coat. Gibberellic acid has also proved beneficial in shortening germination time. Other methods of stock increase include division, and cutting the stem into pieces which are then treated to regenerate roots and shoots. Nitrogen and potassium fertilization have been found to speed up growth.

A few cycads have been widely used in Florida gardens for a number of years including 2 species of *Cycas* as specimen plants and the Florida zamia or coontie as a ground cover. They have been valued for their ease of culture and low maintenance needs, and, in the case of coontie, for its tolerance of rocky soil and dry conditions.

In recent years, other cycads have become available which have proved to be just as valuable and decorative. They are frequently seen in private gardens and public plantings but have never realized their full potential as landscape material due to their cost. They are slow to propagate and there are restrictions on their collection and importation from the wild, so that nurseries have found it difficult to grow them for sale at a price competitive with other plants in general use.

Propagation is usually by seed, but vegetative methods are also successful.

### Growing from Seed

Cycads are dioecious with the pollen and ovules formed on scales making up cone-like structure in most genera. The exception is the genus *Cycas* in which the female plants form the ovules on loosely aggregated "seed leaves". Cones in the male plants are much more typical. The pollen from cones on male plants is carried mostly by the wind to fertilize the ovules in cones on the female plants and form the embryos of the seeds. Thus, the development of seeds with viable embryos depends on two things; having pollen produced in male cones in a location from which air

movement can transfer it to the females, and having it produced at a time when the female cones are receptive. This happens often enough in the wild that cycads have survived as a group for about 300 million years but in gardens the populations are often too small for these conditions to be met. Norstog & Stevenson (6) report evidence that insects may be helpful or even essential to pollen transfer in some species and are now testing their observations on this. In some genera the seeds will enlarge whether or not they contain a viable embryo but, of course, will not germinate to give a seedling. The percentage of viable seeds in collections from wild populations is often low.

Pollen can be harvested from male cones and transferred to a female. It can also be stored for a year or more until a receptive female cone is available. The scales of the male cone open slightly when the pollen is ready to be shed. About 4 to 7 days after the scale separation begins, the cone may be cut and wrapped loosely in smooth surfaced paper. During the next 2 or 3 weeks, the pollen will be shed and may be shaken loose from the cone. It is ready to use immediately or may be screened free of debris and stored in a tightly-capped, clean, dry jar at a few degrees above freezing (the temperature found in the fresh food section of a refrigerator).

The female cone shows a similar growth of the central axis and separation of the scales when it is receptive to pollen. In many species, this is accompanied by the formation of a sticky gel that glistens in the small opening between the scales. Later, as this gel dries, it shrinks back between the scales, carrying with it pollen that has been caught on its sticky surface. The pollen may be carried to the entrance to the ovule or may begin to grow in the gel before reaching the ovule which soon begins to swell. The gel seals the entrance to the ovule and the opening between the scales is closed so that after this time pollination can no longer occur. The time when the scales of a particular part of a cone are receptive may be only a few days but in a large cone, such as those of the genus *Encephalartos*, the progressive development of scales along the axis may give a period of a few weeks when some part of the cone is receptive. In other genera such as *Dioon*, it seems probable that only certain scales collect the pollen, and then only for a limited period, so that timing is more critical. In the genus *Cycas*, where the "seed leaves" form a loose mass rather than a cone, the ovules are fully exposed. They appear to be receptive for several days after they reach the size of a small olive.

Most artificial pollination is done by simply dusting the pollen between receptive scales but Oostuhsen (7) describes more elaborate techniques that have given good results which include cutting the top off the female cone and packing the spaces between the scales with a mixture of pollen and sand.

The actual fertilization of the egg may not occur for

several days to several months after pollen transfer: during this time a pollen tube grows into the ovule and forms motile male gametes. The female gamete completes its development and, after fusion, the fertilized egg begins the processes of division and development that will form the embryo.

The remainder of the ovule develops rather faster than the embryo, forming a more or less fleshy outer coat around a leathery or hard shell which, in turn, encloses the embryo and a store of food. Several months later, the cone breaks down to release the seeds, but the embryo may still not have completed its development at this time. Hendricks (5) suggests storing the seed in a cool (60-75°F), dry place for 1 to 9 months after they are collected from the cone. The New World Genera *Zamia*, *Ceratozamia* and *Dioon* complete their embryo development within a few weeks of cone breakdown while the Asian and African genera may take the much longer time.

The seed should be cleaned before being planted or stored for this period of embryo maturation since the outer fleshy coat is a substrate for fungal growth which can spread inwards to involve the whole seed. The flesh softens with a 24 hour soak in water which makes it easier to cut or grate it away from the harder inner coat.

At planting time, it pays to separate the light seeds from the remainder by floating them in water. Some of the "floaters" may still be maturing an embryo, but most will not be viable and will rot after planting with the chance of spreading fungi and bacteria to the other seeds. Seeds of some species of *Cycas* have air trapped in spongy tissue and for these the flotation test is of no value.

A number of studies have shown the value of scarifying the seed coat either by cutting, grinding, acid treatment, or even complete removal (3, 5, 9, 11), and a soaking before planting in vitamin B<sub>1</sub> (5%) or gibberellic acid (1000 ppm) has also given good results (3, 5). The seeds may be sown in containers or ground beds using a mix that is free draining and well-aerated, but which will not allow the seeds to dry out. Alternatively, they may be kept in a moist chamber until the root begins to push open the end of the seed coat before being planted. Shallow planting with the seeds flat is best and the usual recommendation is to have only about 1/3 of the seed in the ground. This is not as critical for some species as for others, but it is always necessary to guard against rot caused by keeping the newly germinated seed too wet. A temperature of 80-90°F is best for germination.

The emergence of the root from the seed may begin in a few days in mature Florida *Zamia* seed that has been scarified and soaked, but may delay for several months in other cycads. The effect of scarification and other treatments is usually to make germination more uniform in addition to hastening the process.

The root continues to elongate after emerging from the seed and turns down into the soil. From close to the seed, between the 2 cotyledons which never emerge fully from the seed, the first leaf grows upward and is followed at intervals by others which gradually take on the form typical of the mature leaf. The time of first leaf emergence and the rate of new leaf formation depends on the species, but gradually more than 1 leaf is formed at a time until the production becomes synchronized to give a new flush of growth or a complete rosette of leaves once or a few times a year or even only once every several years.

In the types with the fastest growth, such as the Florida *Zamia*, this whole process takes up to 15 months from the time when cones are first seen to the maturation of their seeds, and a further 3 to 4 years to give a plant with 12-18 leaves in a gallon container.

*Cycas circinnalis* takes 2 years from pollination to the stage of germination where the root is turning down and the first signs of an emerging leaf appear. It is then a further 2 years to get a good saleable plant in a 3 gallon container.

One or 2 *Encephalartos* match these rates or at least speed up their growth once they have reached a certain size, but, in general, propagation by seed is a matter requiring great patience.

### Vegetative Propagation

Cycads do not have buds in the axils of their leaves as is the case with most flowering plants, but do have areas of undifferentiated cells in the stem which, under the proper stimulation, can give rise to root and shoot initials. In the genus *Cycas* bulbils commonly form on the stems of mature plants from pockets of tissue in leaf bases that persist on the trunk after the leaves fall (10). These bulbils take on the same form as the terminal bud and can be removed carefully with a sharp knife to be rooted when they reach 8 to 12 leaf size. Set into a free draining mix in partial shade, success rate is usually high and will give a plant of good size and form within a year.

Bulbils are not formed spontaneously in other genera although plants with multiple heads are often found, presumably as the result of earlier damage to the plant. In a growing stem, there is actively dividing tissue in the cork cambium just below the surface and in the ring of vascular cambium that lies deeper in the stem. These areas are the ones that are most likely to be converted into root or shoot initials and the stimulus for this often comes from damage to the stem.

When digging plants from the wild (where this is allowed), problems may be experienced with rotting that begins at a wound. The stem is rich in starch and, thus, an ideal substrate for decay organisms. The chances of rot at the base are minimized if it is trimmed with a very sharp knife so that the fibres are cut off cleanly and not bruised or torn. Many collectors feel that dipping the entire stem in a water slurry of chlorothalonil 75% or Ethazol plus methylthiophanate is also a useful precaution against rot. The treated stems are still very likely to be damaged by too much water so are usually set in coarse sand or an extremely free draining mix and watered only enough to prevent desiccation. Types with above-ground trunks are put a few inches into the mix, those that grow with the stems buried are set at their original depth.

Bottom heat is very helpful in stimulating rooting which usually occurs from a number of sites around the vascular cambium ring. In most cases, the leaves present when the plant is dug are cut off before rooting is attempted, but Conover et al. (2) report better rooting in *Zamia* imported from the Dominican Republic when the leaves were left intact. In any case, once roots have a strong start, new leaves are usually formed in numbers that soon approach those present when the plant was dug.

Legal constraints on digging cycads from the wild mean that this relatively rapid way of obtaining a landscape size plant will be less and less available in the future. What can be done, however, is to harvest plants from your own landscape plantings by cutting off the top part of the stem and rooting it. It would take considerable courage to do this for a rare specimen, but a groundcover planting of *Zamia* could be harvested selectively with little effect on the appearance. The root and stem portions left in the ground would rapidly regenerate a new shoot system, probably with multiple heads so that the long term appearance would be greatly improved.

The ability to initiate root and shoot apices at a number

of places in the stem also suggests a method of rapid multiplication. In an experiment using the Florida zamia (1), plants were cut into a series of 2 cm thick sections. These, together with the root and stem remnant and the stem apex with its leaves, were planted in sand in the way already described for rooting dug plants. After 4 months, 68% of those treated with fungicide and 60% of those not treated had developed roots. In another year, all these had 1 to 6 shoots, each with 1 to 3 leaves, and were full, although rather stunted, specimens.

When the stem of a mature plant is rooted, a number of roots are initiated giving a strong root system. Dehgan and Johnson (4) have cut off the roots of seedlings of zamia and with a variety of treatments have grown back many more roots, which have the potential of giving much faster seedling growth. Response to nitrogen and potassium fertilization of seedlings and larger plants is also appreciable (8).

Does cycad propagation really deserve the reputation for difficulty and slowness which it has acquired? The answer must be yes, at present, with respect to seed propagation and growing from stem pieces and, with the restrictions on collecting, the question is largely academic as far as establishing plants from the wild is concerned.

Work in progress in a number of places may improve the situation, however. Cycads are proving to be tricky in tissue culture, but the experimental work which will eventually disclose the balance of plant growth substances that control differentiation, root growth, leaf initiation and cone formation is already suggesting chemical materials to use in the manipulation of the growth of whole plants. Gibberellic acid soaking of seeds to enhance germination is already in use, and researchers at the University of Florida are working with growth substances to increase the number and quality of roots in seedlings, to speed up early growth and to bring on flushes of leaf growth at

more frequent intervals. These techniques together with a better understanding of the plants' fertilizer needs, are giving saleable plants of zamia from seed in about half the time that it used to take.

As the experimental work gives a better understanding of how cycads grow, it may well be that our perception of them as a slow growing group will change. Nurseries will see them as a profitable item and our landscape will benefit from having these interesting and useful plants readily available.

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### SCREENING OLEANDER CULTIVARS FOR RESISTANCE TO WITCHES' BROOM<sup>1,2,3,4</sup>

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**Abstract.** Selection of resistant cultivars is the most economical approach to the control of witches' broom, the most serious disease of oleander (*Nerium oleander*) in the south Florida landscape. The fungus which causes the disease, *Sphaeropsis tumefaciens*, was isolated from naturally infected oleander and grown on autoclaved, 5- to 10-mm-diameter oleander stems for 4 to 6 weeks under continuous fluorescent lighting. The fungus-colonized bark was fragmented in sterile deionized water with a blender, and the

resulting slurry was swabbed onto the apices of young oleander plants. Fifteen plants each of 18 cultivars were inoculated in November 1980 and in March and July 1981. Plants showing symptoms were recorded biweekly through August 1981. None of the cultivars was immune to the fungus, but the cultivars, Hardy Pink and Isle of Capri, had few symptoms until July while symptoms in other cultivars were abundant in May.

Oleanders (*Nerium oleander* L.) have become popular landscape plants because they are colorful, fast growing, and require little maintenance. The most important limitation to their success in Florida is the witches' broom disease. West (4) recognized the disease in 1937, and Ridings and Marlatt (1) later showed that the disease was caused by the fungus, *Sphaeropsis tumefaciens* Hedges. At present the only known control for the disease is pruning (1), but this practice is not always practical or effective in heavily infected plants or in large plantings. Chemical control is not practical because of a lack of information on appropriate chemicals and the timing of applications.

A serious epidemic of the disease has developed during the past 2 years and has increased the need for selection of

<sup>1</sup>Florida Agricultural Experiment Station Journal Series No. 3511.

<sup>2</sup>Ms. C. Hall Thomas and Ms. S. Williams contributed technical assistance for these studies.

<sup>3</sup>Use of trade names in this report does not imply endorsement of the products named or criticism of similar ones not named.

<sup>4</sup>For English conversions of metric units, see the table provided at the beginning of these Proceedings.