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CYCADS[1]

"Cycads"—the "Sago-palms" of popular parlance—is a name used to designate a small group of plants quite definitely isolated and sharply differentiated from all other groups of existing plants; "Sago-palms," because their pithy stems yield a starch somewhat similar to the sago, which is obtained from the stems of several kinds of true palms, which, however, belong to quite a different part of the plant kingdom.

Cycads appeared during the Triassic period of Mesozoic time. They replaced the cycad-ferns which flourished in Paleozoic time, and represented a step higher in the vegetable scale. Their development and increase continued up to the Cretaceous period, when their climax in abundance and almost universal distribution was reached.

The geologic record, as at present interpreted, indicates nearly three hundred fossil species of this group, which are classed in about thirty-five genera. These remains are preserved as stems, leaves, flowers, and fruits. They are found wherever geologic explorations have been made—from the equator to the poles. The evidently generally salubrious climate of those geologic times was conducive to a vast growth of this newly developed, so to speak, type of vegetation. In fact, these plants became so dominant that the term "Age of Cycads" has been applied to the Mesozoic Age. One is inclined to consider the assemblage of fossil remains referred to above a mere fraction of the cycad flora of those remote ages, for without doubt, the majority of the forms were denied a

[1] Abstract of a lecture and demonstration given in Conservatory Range 2 of The New York Botanical Garden on Saturday afternoon, January 23, 1926.

permanent record as fossils in the earth's strata. The following schedule will show the position of cycads in geologic time.

Neozoic	Quaternary	CYCADS reduced to about 80 species
	Tertiary	Higher flowering plants abound
Mesozoic	Cretaceous	CYCADS DECLINE
		Higher flowering plants appear
	Jurassic	AGE OF CYCADS
	Triassic	
Paleozoic	Carboniferous	CYCAD-FERNS, Ancestors of Cycads abound
		Ferns and fern allies appear
	Devonian	Land plants appear
	Silurian	Seaweeds develop
	Cambrian	Seaweeds appear
Proterozoic	Proterozoic	No evidence of plant life
Eozoic	Eozoic	No definite evidence of life

A cycad plant consists of a stem, either subterranean or aërial, which bears a crown of branching feather-like leaves, in all resembling a tree fern in habit. Ultimately, clusters of flowers and seeds grow from the axils of the leaves. The stem is very pithy and typically simple, but in the case of subterranean ones it is frequently branched. The leaf is pinnately compound, that is, it consists of a stalk (midrib) with the leaflets distichously arranged on either side, except that of *Bowenia*, which is bipinnate.

The leaflets show three types of venation. In the first type the secondary veins run from the midvein to the margin of the leaflet, after the manner of most of our ferns and of the cycad-ferns from which our present day cycads may have been derived. This is illustrated by the leaves of the genus *Stangeria* only. In the second type no definite midvein is present, but several simple or branched "parallel" veins run from the base of the leaflet to the apex,—illustrated by the leaves of the genera *Zamia* and *Dioön*. In the third type the leaflet has a strong midvein, which may represent the several veins of type number two, collected into one bundle. There are no lateral veinlets. The tissue between the midvein and the margin is uniform and thallus-like. This we find illustrated by the leaves of the genus *Cycas*.

The inflorescence and the fructification of cycads are interesting. The staminate and pistillate organs consist of leaves more or less modified so that they hold the pollen-sacs and the ovules, and ultimately the ripened seeds. The staminate organ is the more uniformly modified. The leaflets have become changed into more or less peltate scales spirally arranged about the leaf-axis, thus forming a cone-like structure. The pollen-sacs are borne in groups on parts of these scales, except on the exposed surface. The pollen is exceptional—as with Ginkgo—among flowering plants in that it develops motile sperm-cells after germination. The ovulate organ is less constant in its cone-like character than is the staminate. In some of the genera it is a cone of imbricated peltate scales which bear the ovules and the seeds on the inside of the apical expansion. In other genera the ovules and seeds are borne on the edges of the midrib of the less modified leaf, either in the axils of reduced leaflets or in place of the leaflets. The seeds are nut-like or berry-like, and sometimes highly colored.

The Age of Cycads has long been past. During the Cretaceous period, which followed the periods (Triassic and Jurassic) of their maximum development, this type of vegetation not only lost ground in point of numbers of kinds, but also in the breadth of geographic range. They were forced to begin a retreat from the polar regions. Unfavorable climatic conditions and changes in the earth's surface hastened and finally brought about their extermination in the higher latitudes of both northern and southern hemispheres. For example, in the northern hemisphere in the Tertiary period the cycads had retreated southward as far as southern Europe, where they were represented, as far as the evidence goes, by a single species of *Encephalartos*, and southern North America, where the representatives were species of *Zamia* and *Dioön*.

To complete the devastation, the rigors of the great Ice Age at the beginning of the Quaternary period pushed this ancient group still further south, even to near the latitude of the Tropic of Cancer. The range of the genus *Encephalartos* shrank into the confines of Africa, and *Zamia* retired to the Florida peninsula, while *Dioön* retreated across the Rio Grande into Mexico. How much ground, if any, these cycads regained, since the retreat of the ice we do not know. Apparently they did not return far into their former domains, although enough vigor remains in their blood to withstand a colder climate than exists within their present ranges, as is indicated by their being successfully cultivated in the open northward of the natural northern limit of the geographic ranges, the maximum distance depending upon local climatic conditions.

From a world-wide geographic range and the maximum number of genera and species cited above, the total existing cycad population and its geographic distribution may be summarized as follows:

About sixteen species of *Cycas*, in eastern Asia to Australia and Indo-Pacific.
About fifteen species of *Macrozamia* in Australia.
A single species of *Bowenia* in Australia.
About fifteen species of *Encephalartos* in Africa.
A single species of *Stangeria* in Africa.
About thirty species of *Zamia*, in tropic and subtropic America.
About eight species of *Ceratozamia* in Mexico.
About three species of *Dioön* in Mexico.
A single species of *Microcycas*, in Cuba.

In other words the geologic strata have given up nearly four times as many fossil genera and species as are represented in the

FIGURE 1. In Royal Palm Hammock, Dade County, Florida.—Several colonies of *Zamia silvicola* occur on the hammock floor in the dense shade. The leaves and leaflets are spreading. The ancestors may have been carried there by flood water, by animals, or by the Florida aborigines who made this island a rendezvous, if not a permanent settlement site.

living flora. This number, although large, is very likely only a fraction of the geologic maximum. This is evidence that the cycads are a vanishing type of vegetation.

Curiously enough, the present-day cycads simulate the modern palms in their geographic distribution. Their distribution in geologic times also coincided, for the palms were once universally distributed over the land surface of the earth. In North America the limiting latitude of the cycads lacks only about five degrees of that of the palms. In the eastern hemisphere about the same discrepancy exists in the Europe-Africa region; while in the East the ranges of the two groups extend northward into southern Japan and southward into Australia.

The early travelers in the East and in the West were not slow to observe the cycads, and to bring them back to their native lands. Botanical descriptions and illustrations of them began to appear in the sixteenth and seventeenth centuries. Thus, their botanical history began shortly after distant travel was undertaken by Europeans. The modern botanical nomenclature began with the formal publication of the genus *Cycas* by Linnaeus in 1753. Ten years later he established the genus *Zamia*. Thus in the eighteenth century the types of the largest genera of cycads were fixed, the one in the eastern hemisphere, the other in the western, and the regions of both diametrically opposite. More than a half century elapsed before additional cycad groups were proposed. As a result of explorations in more remote regions, new cycads were brought to light, and were added to botanical literature in chronological sequence as follows: *Encephalortos,* 1834 (Africa); *Macrozamia,* 1841 (Australia); *Dioön,* 1843 (Mexico); *Ceratozamia,* 1846 (Australia); *Stangeria,* 1853 (Africa); *Bowenia,* 1863 (Australia); *Microcycas,* 1868 (Cuba).

Cycads are closely associated with the history of mankind. They have and do appeal to him physically, aesthetically, and spiritually. In this way they also very closely parallel the palms.

The stems of cycads furnish a flour or starch which has been used by man from prehistoric times. In countries where the growth is abundant it forms a staple food, where imported it usually constitutes a luxury. It is also used to starch fabrics.

Taking examples from our own country, we know, according to the records of Hernando de Escalante Fontanada, a captive in

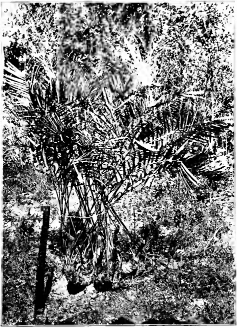

FIGURE 2. On Robert's Island in the Everglades west of Little River, Dade County, Florida.—Here the *Zamia silvicola* grew in partial shade. The leaves and leaflets are rigid and largely erect. The ancestors may have been taken there by the Florida aborigines, who used the island as a place of residence, as is evidenced by the many-stemmed live-oaks.

Florida for seventeen years in the sixteenth century, that the Florida aborigines—an isolated group of the American Indian, now extinct—"made bread of roots [*Zamia*], which is their common food the greater part of the year." Commenting on this statement it has been recorded that "The flour, prepared from the root, is called by the Spaniards Kun-ti hat-ki, 'white bread,' to distinguish it from the red bread, from the China briar-root, which they call Kun-ti tscha-ti." Referring to the use of this cycad by the Seminole Indians, Dr. William Baldwin recorded that "I had the gratification to find the 'Wild Sago'," or Coontia,[2] of the Seminoles. . . . At supper, I had the pleasure to eat the bread prepared from the large tuberous root [stem] of this plant. In the late time of difficulty many negroes, and others, were prevented from perishing from hunger by having recourse to it; . . .[3]

Although the odds are evidently against the cycad and it is without doubt a vanishing type of plant, the natural growth in Florida, which furnished flour to the aborigines and to the Seminoles, and in a transition period—the seventies of the last century—to the Cubans for starching their linen,[4] now furnishes the white man with "Arrowroot crackers," for many of our arrowroot crackers are made, at least in part, from "Florida arrowroot," which is one of the names for the flour made from the native cycads of Florida.[5] Cycads play a large part in horticulture.

[2] Bow-legs, the grandson of Bartram's "Long Warrior," says, that "Coontia" signifies Bread Plant.

[3] For a history of *Zamia* in Florida see, "Seminole Bread——The Conti." —Journal of The New York Botanical Garden **22**: 121–137. 1921.

[4] The manufacture, and export, of Coontie-starch was the main occupation and source of revenue of the pioneers of southern peninsular Florida.

[5] There are four species of *Zamia* in Florida: one of them is also native in Cuba; the other three are, apparently, endemic in Florida. The following is described here for the first time.

Zamia silvicola Small, sp. nov. Leaves 1 m. long or less; leaflets 12–17 cm. long, the blades linear, often broadly so, 1–1.5 cm. wide, 14–20-veined, flat, obscurely toothed at the apex: staminate cone cylindric or slightly tapering upward, 8–16 cm. long: mature ovulate cone ellipsoid-cylindric, mostly 9–14 cm. long: nut-like part of seed broadly obovoid, 18–20 mm. long, decidedly flattened, minutely pointed at both ends.—Humus, rich sandy soil, aboriginal village sites, and shell mounds, peninsular Florida.—The most robust Zamia in Florida, often abundant on the upper west-

They are easily grown and are very decorative objects. In warm regions species of *Cycas* and *Zamia* are used in out-of-door plantings. In conservatories in the cooler latitudes all the genera may often be found in a thriving condition and perfectly adapted, apparently, to their artificial habitats. In this way, again the cycads parallel the palms; and likewise, both primitive people and some of our contemporaries in their spiritual cravings consider the cycad a symbol, both of Life and of Death.

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FURTHER NOTES ON THE FLOWERS AND SEEDS OF SWEET POTATOES

As ordinarily grown, sweet potatoes are most decidedly sterile in respect to the production of capsules and seeds. The two main conditions responsible for this unfruitfulness are (1) the habit of non-blooming, especially throughout the more northern areas of their culture, and (2) the failure, even when blooming profusely, to set seed either to self-pollination or to pollination between plants of the same clonal variety. It should be noted that the various plants of the variety are all propagated from branches of one original seedling and that hence pollination between plants of the variety is the same as pollination between flowers on a single plant.

In a number of instances, however, seeds of sweet potatoes have been obtained and the breeding for new varieties from seed has been possible. The summary of these cases and the data bearing on the blooming and seeding habits of sweet potatoes were assembled from published records and from a rather extensive correspondence and published in considerable detail.[1] Since this report appeared further data have come to hand and also fruit and seeds have been obtained in controlled pollinations

ern coast, and locally in hammocks southward in the peninsula. Plants on the shell mounds often have branching stems. This hammock inhabitant differs from the pineland-inhabiting species —*Zamia integrifolia*—in the more numerously veined, wider, and more remote leaflets, and the flattened nut-like part of the seed.

[1] The Flowers and Seed of Sweet Potatoes. Journal of The New York Botanical Garden 25: 153–168. June, 1924.