A TAXONOMIC MONOGRAPH

OF THE CYCADS

By

Charles J. Chamberlain

The University of Chicago

Edited, Completed, and Revised by

Arthur W. Haupt

The University of California

Los Angeles

PREFACE

The plan and purpose of the present work were set forth by the author in a preliminary announcement, submitted a few weeks before his death to Chronica Botanica, and published in the December, 1943, issue (vol. 7, pp. 438–440) together with a short biographical sketch. Some of the ideas expressed in this announcement are restated herewith in the introduction. In preparing the monograph for publication, the editor has endeavored, so far as possible, to carry out the author's aims and to complete the work in much the same way as he would have done. This has been difficult because of the condition of the unfinished manuscript and of a lack of directions for its completion.

Dr. Chamberlain had made a detailed study of many species of cycads, both in the field and under cultivation. He had assembled copious notes, dried specimens, material preserved in liquid, and many photographs. He had finished writing the descriptions of practically all the species of which he possessed a first-hand knowledge. Because this work was done carefully, over a period of almost forty years, the editor has accepted most of the author's statements without feeling that they should be corroborated by an extensive reexamination of specimens.

Some of the considerable number of species not studied by Dr. Chamberlain in the field, greenhouse, or botanical garden, he had described from data published by authors whom he knew and in whom he placed a great deal of confidence. Other species, mostly belonging to Cycas, Encephalartos, and Zamia, he had not described at all. The editor has written descriptions of these species, basing them on data available in the literature and supple-

mented, wherever possible, by additional facts obtained from the examination of specimens. The original descriptions of practically all these species have been consulted. Exceptionally, the original descriptions are so complete that they are quoted with almost no changes. As a rule, however, they are very incomplete, having been based on mere fragments sent in by collectors in distant places. In fact, the original descriptions are frequently so inadequate, that it is not possible to recognize the species being described. Because of insufficient data, some of the descriptions in the monograph are brief, but their inclusion will at least make possible the identification of species which, it is hoped, will later be described in greater detail by botanists having access to abundant living material.

The editor has prepared the diagnosis of the family, all generic descriptions, the analytical keys, and the citations to the literature. He has been compelled to rewrite all descriptions of species prepared by the author, not to alter statements, but to arrange them in a logical sequence and to make the descriptions consistent throughout in terminology, style, and other respects. Wherever additional facts could be added, this was done. The introduction is almost entirely in the author's words, but the section on relationships and distribution was written by the editor. The ideas here expressed, however, are those with which the author doubtless would have been in agreement. The general account of vegetative organs is a condensation and reorganization of several chapters which Dr. Chamberlain had written for a later work. The section dealing with cones and sporophylls has been added by the editor.

Although the author's views on nomenclature were somewhat unorthodox, his choice of names, with few exceptions, has been preserved. Encephalartos caffer, the name which he insisted on applying to a species which should be designated E. longifolius, is rejected entirely and not applied to E. brachyphyllus, as is done by certain other authors. This change is made in an effort to straighten out a very confusing situation. E. longifolius is the species called E. caffer in all the author's other writings.

Dr. Chamberlain had indicated only a few of the illustrations which he had planned to use in the monograph. But from his collection of hundreds of photographic prints and thousands of negatives, it was possible to select and to prepare the many illustrations appearing throughout the book. Wherever possible, illustrations not previously published by the author have been selected. Although most of them have been prepared from photographs made by the author, those known to have been furnished by others are acknowledged in the accompanying legends. Wherever such acknowledgment may be lacking, the editor was unable to learn the source of the illustration.

The editor has undertaken to finish and prepare for publication Dr. Chamberlain's manuscript in order to preserve and make available the results of his extensive studies. It may be said to represent a fairly comprehensive account of the known cycads of the world. Future research may be expected to establish the identity of a number of species now regarded as doubtful and others that are still undiscovered. Such investigations cannot be carried on merely by an examination of fragmentary herbarium specimens, usually representing parts of leaves, and of dried cones and seeds. They must be based on extensive observations of living plants in the field. It

is hoped that the present monograph will be useful, both to the general student who wishes to become familiar with the known species of cycads, and to the investigator who will have an opportunity of making additional contributions to our knowledge of this ancient and interesting family of plants.

University of California
Los Angeles 24, Calif.

Arthur W. Haupt

January, 1946

CONTENTS

Theodor Just ?

Synopsis of Living and Fossil Cycadaceae

Cycadaceae: represent the surviving line of Nathorst's Cycadophyta.

Usually treated as a single family, occasionally divided into two: Cycadaceae--Zamiaceae.

Last systematic treatment: Schuster (1932) in Pflanzenreich.

Last general summary: Arnold (1953) Origin and Relationships of the Cycads. (Phytomorpholo

Summary of economic uses and poisonous properties given by Thieret (1958).

Small family: extra-ordinary interest, far from being well known, new spp. still being described; unpublished plates in Brussels, and Liebmann's plates in Copenhagen. Much fossil material unworked or coming to light.

Chicago ms.: manuscript notes by the late C. J. Chamberlain, organized and edited by Haupt; nomenclature critically reviewed by the late E. D. Merrill. Rev. by T.J. & Summary of fossil Cycadaceae, by T.J.

Status of various genera uneven, Encephalartos monographed last,(Henderson 1945).

Field work: immense amount remains to be done; Melville's instructions (1957) for collecting cycads should be most useful. No botanist saw them all in the field, Chamberlain made various expeditions to Mexico, South Africa, etc. and probably saw only half of the species in the field.

Nomenclatural problems numerous: Melville (1959) corrected one (Bowenia).

General information and summary given by Gaussen (1944), pp. 94-95: tabular summary of morphological (15 + 18) and anatomical (25 + 15) characters and chromosome numbers; followed by chart of evolution of cycadophytes.

Greatest progress: foliage of living and fossil cycads or cycadophyte affinity studied; epidermal and cuticular structures investigated by Nathorst (1902-1909), Thomas and Bancroft (1913), Thomas (1930), Florin (1931, 1933), and Harris (1932). Impact on classification of gymnosperms unequalled.

Anatomical details: shoot apex (Johnson 1945, Foster 194.), ovulate sporophylls, leaf bundles in +Cycas circinalis (Boureau 1944), wood of living cycads (Greguss 1955), venation types in cycad leaves (Foster, unpublished, three major types).

Pollination: "Variations of Temperature in Male Cones of Encephalartos Altensteinii Lehm.", reported by A. Jacot-Guillarmod (Rhodes University, Grahamstown), 1959, Jour. So. African Botany, vol. 25: 93-59. Cones cut off and measured in situ. Gaussen (only other reference to this phenomenon) described it as fererish rise. J.-G. found dirunal rhythm and a connection between rise of temperature and shedding of pollen. Laboratory measurements show rise of 17°C and plants in open field show 10°C on windy days. Pollen is shed in afternoon, Three spp, of weevils common on such cones, and one tenebrionid beetle. A dimorphic weevil was common on female cones of E. horridus, but only when a gelatinous exudate appeared; otherwise few were present. Center of cone represents warmest third. Cones mature from late March to early May. Cones 17 in. long (average), other spp. 24 in. long. Distinctive, not particularly unpleasant, smell, present in E. Altensteinii and E. villosus, none in E. Lehmannii.

Populations: stands of various spp. in Australia (Carl Wilson).

E. Eugene-Maraisii Verdoorn (1945), Transvaal, 6 localities, all within short distances of one another; on one fram two plants are known, one a female, the other immature, "It would appear that they are relics of a new localised and almost extinct species."

Microcycas calocoma: Province Pinar del Rio, western tip of Cuba, represented by about 500 individuals, 3 lowland groups, 8 montane; A. S. Foster and Manuel R. San Pedro (1942). Mucrosporangiate trees taller then megaspor., 30 ft. to crown, female trees to 28 in. in diam.

Hybridization experiments carried on by Chamberlain in Chicago. Elsewhere now?

Experimental studies in evolution: unknown.

Taxonomy: Schuster treats 9 genera, 65 spp.; Chamberlain-Haupt, 9 genera, 98 spp.

Genus	Schuster	Chamberl.-Haupt	Type species
Cycas	8 spp., 3 sect.	19 spp.	C. circinalis
Stangeria	1 sp., 1 var.	1 sp.	S. paradoxa
Bowenia	1 sp., 1 var.	2 spp.	B. spectabilis
Dioon	3 spp.	5 spp.	D. edule
Macrozamia	9 spp., 3 sect.	16 spp.	M. spiralis
Encephalartos	14 spp., 3 sect.	19 spp.	E. longifolius
Microcycas	1 sp.	1 sp.	M. calocoma
Ceratozamia	2 spp.	6 spp.	C. mexicana
Zamia	26 spp., 3 sect.	29 spp.	Z. pumila

Cycas: A. Messeri (1927): "The species of Cycas are so nearly alike that they should be considered varieties of the same species." Based on anatomical characters of leaflets.

Stangeria: no change.

Bowenia: B. serrulata, var. of spectabilis, raised to species by Chamberlain (1912), Melville (1959) corrected nomenclature.

Dioon Dohenyi E. A. Howard (1933), Guatemala, not in Chamberlain-Haupt ms. Nomen nudum?

Macrozamia: no change.

Encephalartos: nine new spp. and 2 new vars.; E. Eugene-Maraisii Verdoorn (1945), Transvaal; E. lembomboensis Verdoorn (1949) Swaziland; E. ngoyanus Verdoorn (1949), E. eximias, Verdoorn (1954), Cape Province; E. natalensis Dyer & Verdoorn (1951), Natal; E. arenarius Dyer (1956), Cape Province; E. tegulaneus Melville (1957), Zululand; E. bubulinns Melville (1957), E. marunguensis Devred (1958), Belgian Congo Henderson (1945) recognized 22 spp., no difference in their pollen; 18 with names, others wihout. -- Melville (1957, 1958) points out that male cones have fewer taxonomic characters than to female cones; treated nine spp. from Central Africa, 2 being new. Detailed descriptions of cone characters.

Microcycas: most detailed field obeservations by A. S. Foster & M. R. San Pedro (1942).

Ceratozamia:matudai Lundell (1939), southern Mexico.

Zamia: other genus with novaltie s.

Z. Guggenheimiana Carrabia, Cuba (1941).

Z. jirijirimensis Schultes (1953), Amazonia.

Z. madida Schultes(1958) ?, Amazonia.

Undescribed, large tree sp., vegetative stages known, no cones.

Z. Allison-Armourii Millspaugh (1912 ?)

Fossil Members: listed in Schuster, Florin, Gaussen, and Arnold; none complete.

Paleozoic: mostly doubtful:

Stems: Cycadoxylon, Ptychoxylon, Permian.

Leaves: Dioonites, Permian of China.--Pterophyllum, Upper Carboniferous, France, cuticle is Nilssonia-like; Plagiozamites, Sphenozamites.

Additional doubtful forms in Schuster.

Pollen: Carboniferous, France, Dounbinger 1957 (Ann. Assoc. Géol. du Nord).

Entylissa, Permian, Naumova.

Mesozoic: best known fossils belong here.

1) Dioonitocarpidium pennaeforme, Triassic, western Germany; D. keuperianum D. liliensterni, Triassic, Austria, Megasporophylls, up to 8 in. long, 2 or more seeds near base.

2) Bjuvia simplex: Rhaetic of Sweden, consists of Macrotaeniopteris gigantea (leaves) and Palaeocycas integer (megasporophylls).

These two fossils are Cycad-like.

3) Androstrobus, A. manis and A. wonnacotti, Jurassic, Yorkshire coast of Englan male fructifications, like male cones of living cycads. Microsphorophylls look most like those of Encephalartos.

4) Beania, several spp., Jurassic female fructifications, same locality as A. B. gracilis, loose spike, 4 inches long, 2 seeds per peltate sporophyll, A. manis and B. gracilis are conspecific (ffde epidermal structures). Associated with Nilssonia-like leaves. Both genera belong to Zamia allia..

Both types of cycads are about of equal geological age.

5) Encygmatostrobus Dokturowskyi, Jurassic, Amurland, Kryshtofovich (1915).
Cones. Cycadales ? Never entered the literature other than original publ.

6) Almargemia, Cretaceous, Portugal, sterile pinnate leaves, 4 in. long, 2 1/2 wide;
Probably belongs to Zamioideae.

7) Leaf genera: pinnate Nilssonia types, associated with Androstrobus and Beania, Ctenis, Pseudoctenis (including Pseudopterophyllum), Doratophyllum, and the giant, long obovate, entire Macrotaeniopteris.
Pleiotrichium commelinoides Weyland & Greifeld, western Germany, most like Doratophyllum. Fragments, hairs most like those of Commelinaceae.

Tertiary material:

8) Macrozamia hopeites, Cookson (1953), leaf fragments, Oligocene brown coal, Bacchus Marsh, Victoria, Australia. Only Tertiary cycad, whose epidermal structure was studied like that of Mesozoic cycads. Resembles closely M. hopei, tallest living cycad, northernmost representative (near Cairns, 16 - 18 °S). M. hopeites occurs 38°S.
Impression material summarized by Hollick.

9) Cycadopites and Dioonipites, pollen from Eocene Green River formation (U.S.).
C. follicularis, Paleocene, FortUnion series. Cycadopites resembles grains of Cycas. Dioonipites resembles those of D. spinulosum, but is it cycadaceous

Phylogeny: review of various views in Arnold. Mention here Greguss and Gaussen.
Triassic: both lines (Cycadoideae and Zamioideae) about equally old. Origin no doubt Paleozoic. Some living members very old, others actively speciating. Van der Hammen mentioned only dichotomous rootlets of Dioon edule as an example of dichotomous branching when presenting evidence for Prof. Lam's views on phyllosporous and stahhyosporous groups
Three main lines according to Greguss: monopodial, dichotomous, and verticillate. See charts on slides for quick review.

INTRODUCTION

In a proposed work dealing largely with the structure, development and phylogeny of the cycads, with some attention to them as they occur in the field, in tropical botanical gardens, and in conservatories, no taxonomy was included in the original plan. However, even in describing morphological details, the form under investigation must have a name. For the taxonomist, that name is extremely important; but for the morphologist, it is a minor matter, his principal interest being the identity of the material.

Since many descriptions in the cycad family are incomplete and since there is much confusion regarding nomenclature, it seems best, before proceeding with the principal work on morphology and phylogeny, to make a taxonomic survey. Although not a taxonomist, I may state as an excuse for such a survey that I have studied, in the field, all the genera and more than half of the species, especially in Mexico, Cuba, Puerto Rico, Florida, Australia and Africa. Some of the rest I have studied in botanical gardens and conservatories; a few, only on herbarium sheets. Anyone who would identify a difficult cycad, especially a Zamia, from a herbarium sheet, would easily name the species of Crataegus at sight.

Hooker wrote a great work on Welwitschia. Strict taxonomy demanded that the name be Tumboa. Later, Pearson made a detailed study of histological features of the plant, retaining Hooker's name, Welwitschia. With all the important literature under that name, it seemed trivial to insist on Tumboa. The fact that

Welwitschia was restored later under nomina conservanda hardly interests a morphologist. We shall write Stangeria paradoxa and shall continue to write Dioon, instead of the misspelled Dion of the original description. When a name has become established in the literature, we shall retain it even if strict taxonomy requires some forgotten name.

In these cases there is no doubt about the identity of the plants, although tastes differ in selecting names; but when different names have been given to the same plant, and different plants have been given the same name, there is confusion. Still greater confusion arises when the plants are described and named from scraps sent to some distant taxonomist. In the case of the Cuban Microcycas, the incomplete description, together with the geographical range, is sufficient to identify the plant. The inappropriate name shows that the taxonomist never saw the plant in its native habitat, for it is one of the largest of all cycads and does not look like Cycas; but it will always be called Microcycas.

In those cases which lead the taxonomist into his maze of sub-genera, sub-species, varieties and forms, morphologists have little interest. We recognize that in horticulture, especially in hybridizing, an enormous number of forms may be produced, and for these it is convenient to have names. In cycads, on account of their scattered geographical distribution, it is doubtful whether there are any natural hybrids, although it is easy to hybridize them artificially. I have secured scores of

cycad hybrids, including two generic crosses, and have collected as many as 500 cones from F_1 plants in a single season. These hybrids will be mentioned only in a general way and will not be included in the keys. In the field, I have seen numerous plants of Bowenia serrulata and Macrozamia miquelii with leaves interlocked, but a thorough search failed to show any evidence of crossing. In Florida, Zamia floridana and Z. pumila are sometimes close enough together for crossing; and in Cuba, species of Zamia may be close enough; and many species of Zamia cross readily in the greenhouse. It seems safe to conclude that, in the field, crossing does not occur, except possibly in Zamia.

In most cycads, young plants look different from old ones. From a typical plant of Encephalartos altensteinii, Professor George Rattray sent two carefully selected leaves to Kew and two to Berlin. At both places, as he had anticipated, one leaf was identified as E. altensteinii and the other as E. longifolius. When I visited East London, Union of South Africa, Professor Rattray took me out to see this plant. At a distance of 5 m., it looked like a typical specimen of E. altensteinii; but it was easy to select leaves for herbarium sheets of E. longifolius. In E. altensteinii, the leaflets are spiny until the trunk reaches a height of a meter or more, when they become less and less spiny and, in old plants, one can usually find a leaf without a single spiny leaflet. For the taxonomist that leaf is E. longifolius; for the morphologist, it is still E. altensteinii.

In a young plant of Dioon spinulosum the leaf has a naked petiole, often 70 cm. long and sometimes nearly a meter in length, with the lowest pair of leaflets almost as long as those higher up; while in older plants the leaflets in the lower third of the leaf become smaller and smaller until, at the base of the leaf, they are reduced to mere spines and there is scarcely any naked petiole. From herbarium sheets, it would be easy to make two species.

In many species the margin of the leaflet changes with the age of the plant, being distinctly spiny in young plants and becoming entire as the plant grows older. The spiny character may be retained until the plant is more than 100 years old and then gradually disappear. In Dioon edule the spines are likely to disappear before the plant is 30 years old. In any case, buds from older plants in which the leaflets have become entire, revert to the spiny condition. However, in Dioon purpusii and D. madrense, which look like D. edule, the spiny condition is permanent, not even the size or number of spines being changed. The margin of the leaflet is usually mentioned as a specific character, and in Ceratozamia the entire margin is so universal that it is even a good generic character. In Dioon spinulosum nearly all plants have almost all their leaflets spiny; but, on a plant with nearly all the leaflets entire, one can find a few leaflets with one or two small spines. Taxonomists call such a specimen D. pectinatum; we call it D. spinulosum. In D. edule the leaflet of the mature plant is entire; in D.

purpusii and in all other species described or merely labeled, there are varying degrees of spininess. Unless the spiny leaflet is associated with other characters, all these plants, except Dioon madrense, D. pinoi and D. spinulosum, might be included at least temporarily under D. purpusii. In Bowenia the spiny or entire margin of the leaflet is so constant that it is a good specific character. A thorough field study of numerous individuals should be made before adding a new species to any genus of cycads, especially a new species based upon the leaflet.

The petiole and rachis of the leaf are often described as round or flattened or grooved above. The character is of little value unless it is stated (and it never is) whether the description is from living or dried material. For example, in living material of Stangeria paradoxa, the petiole in transverse section is oval near the base, higher up rounded below and somewhat flattened on the upper face. In dried material, the whole petiole is distinctly grooved above. The rachis, which in living material is rounded below and flat or depressed above, remains rounded below, but above has a groove half the diameter of the rachis.

The color of the fleshy coat of the seed is always mentioned if the taxonomist has seen it. When a cone of Dioon edule, D. spinulosum, or Ceratozamia mexicana with ripe seeds is opened, the outer fleshy layer is white; but when exposed to the air, it soon becomes cream-colored. Seeds of Macrozamia reidlei have a crimson outer fleshy layer which changes to a dark blood-red color,

with hardly any orange. The most usual color in the whole family is some shade of red, with more or less orange. That there are changes in color should be borne in mind when the seed coat is described as white, cream-colored, yellow, scarlet, orange-red, brownish, or some other color.

Examples could be multiplied. If all diagnoses had been written in the field, from abundant material, most of the uncertainty would have been avoided.

From herbarium specimens or from scraps sent from the field to persons who never saw the plants in their native habitats, or saw only a few greenhouse specimens, it is easy to make several species where there should be only one. After wandering among hundreds of plants of Zamia floridana or Z. latifoliolata, or through thickets of Macrozamia spiralis, or through Bowenia serrulata so abundant as to be a conspicuous part of the forest floor, one has little confidence in the sub-genera, sub-species, varieties and forms of the herbarium taxonomist.

The veteran Australian botanist, F. M. Bailey, tramped over the cycad region of Queensland for more than forty years. He knew every species, from seedling to old age, and he knew what differences in size and form can be caused by light and shade, by wet and dry conditions, and by other ecological factors. Besides, he was a close observer of fluctuating variations as one sees them in the field. Consequently, in his simple key to the Queensland cycads, there are none of the sub-species, varieties or forms, so characteristic of herbarium-sheet taxonomy.

As one wanders through a patch of Macrozamia spiralis at Avoca, near Sydney, Australia, with plants so crowded that progress is difficult, with some individuals so close to the ocean that the salt spray bathes their leaves, while others, protected by rocks, receive only occasional rains, and with all ages from seedling to maturity, one could easily select material for sub-species, varieties, and forms. On a rock, with only 10 or 15 cm. of soil, this species may form a trunk half a meter high; while, a few yards away in deep soil, the stem may be entirely covered.

In some places in the Chavarrillo region in Mexico, plants of Dioon edule are in more or less definite groups, with older plants at the center and younger ones at the outside. The youngest plants have spiny leaflets, while those of the larger plants are entire. The large plants have longer leaves with more leaflets and more leaves in a crown. To the man in the field, there is only one species and he might reasonably guess that the entire group may have come, originally, from the seeds of a single cone. A similar grouping is conspicuous in Zamia latifoliolata in northeastern Puerto Rico, and it is probably common where plants are abundant.

Dioon spinulosum, in the tropical rainy forest region 70 to 120 kilometers south of Veracruz, Mexico, the only region in which I studied it, grows in an almost impenetrable tangle of shrubs and vines. It also grows in the dense, but more open forest of tall trees, and it is likewise at home on great rocks, growing out from inaccessible clefts. Among the tall trees, it reaches

a height of more than 15 m., with a slender trunk and leaves 4 m. in length. On the rocks, the trunk is stouter, seldom more than 7 m. high, and the leaves are shorter.

In the greenhouse, I believe several of the described species of Ceratozamia could be grown from seeds of a single cone of C. mexicana, by planting some in the ground and the rest in pots of various sizes, and by manipulating light, heat, and moisture.

What is a species? From a field study of cycads, we should regard a species as a norm (not the type of the taxonomist, which may be only a variant from the norm), which has small fluctuating variations even under the same conditions. We are not concerned with sub-species, varieties and forms, because, as we regard it, a species in the cycads is broad enough to include these minor categories.

We have no doubt that one species may originate from another. When some variation or mutation has become established, so that plants can be recognized generation after generation, we should treat such an assemblage as a species. Although logically the variant might be a new species at the beginning; if the variation should disappear at the next generation, the description of a new ephemeral species would only burden the literature.

Let us imagine a case. Some seeds of a single cone of Dioon spinulosum are dropped at some distance from the parent plant or group. They germinate, and in time, the coning stage is reached. With only fluctuating variations, most of the plants

will closely resemble the parent. But one of the new plants might have entire leaflets. If it be a female, it is likely to be pollinated by an individual with the usual spinulose leaflets; and if a male, it is likely to pollinate a female with spinulose leaflets. In either case, the variation may not be permanent. If a male and female, within easy distance of each other, should have entire leaflets, and pollination should occur, the entire leaflet character might become established, and we should not hesitate to describe a new species, calling it Dioon integrifolium. The fact that the origin of the new species is known, should be no argument against its validity. Such a mutation probably occurs rather frequently for we have two such plants, raised from seed, in our collection, and we have seen one at Kew, where taxonomists call it D. pectinatum. Probably our plants, nearly all of which have spinulose leaflets, came from the seeds of one cone. If the taxonomist should want more than one character to establish a new species, more could be found in the anatomy of the sporophyte or in the gametophyte. Ceratozamia mexicana can be identified positively by its pollen tube, or by its embryo, although these characters are not listed by taxonomists. Cycas wadei, Dioon edule, Stangeria paradoxa, and others can be identified by the stony layer of the seed. In our collection, besides plants of Dioon spinulosum with entire leaflets, there is a plant in which the new crowns, for several weeks, have a rich purple color, instead of the usual yellowish green, before reaching the dark green color of the mature leaf.

Notwithstanding the entire leaflets and the purple color, we label these plants Dioon spinulosum.

In Encephalartos there are species around E. horridus which are probably rather closely related, and another group around E. villosus; in Macrozamia, there seems to be a similar grouping about M. spiralis, and in Cycas, a group around C. circinalis. In Zamia there is such confusion that a workable key will never be made until some botanist with a good knowledge of taxonomy, morphology, ecology, and genetics, makes a thorough study of its numerous species in the field.

Such groupings often have been made the basis for arrangement of species, but since the groupings are generally made around a single character, an artificial sequence may be used until more knowledge accumulates.

The size of the leaf and the number of leaves in a crown vary with the age of the plant and with ecological conditions. In general, cycads in a good conservatory are larger and finer than plants of the same age in the field. Stangeria with six leaves in a crown is rare in the field, but not so rare in a conservatory or tropical botanical garden.

The size of the cone is equally variable. When a plant produces only one cone, the cone is larger than when there are two or three. A female cone of Encephalartos longifolius, in St. George's Park, Port Elizabeth, South Africa, weighed 42 kilos, while three cones on a plant of the same species in the same park weighed about 23 kilos apiece. In Zamia floridana the number of sporophylls

which might have good seeds varies from about 20 to more than a hundred.

If no one would describe a new species of cycads without adequate material and a thorough field study there would not be so much uncertainty in making determinations and such categories as subspecies, varieties, and forms would disappear.

In view of these facts, we shall pay no attention to subspecies, varieties or forms, and shall follow the descriptions and use the names given by men like F. M. Bailey. While, in some cases, another name might be more acceptable to the professional taxonomist, there should be no doubt as to the identity of the plant under consideration. [Where the name of a plant like <u>Stangeria paradoxa</u> has become fixed in the literature, we shall continue to use that name, following the practice of Pearson, who used <u>Welwitschia</u>, although technical taxonomy required <u>Tumboa</u>.]

This is not true for Welwitschia is the officially conserved generic name!

A very unscientific statement. In taxonomic determinations it is entirely immaterial which name be used!
[illegible]

Relationships and Distribution

The gymnosperms embrace two great phyla, the Cycadophytes and Coniferophytes, both with a geologic history extending far back into the Paleozoic. Because both groups were highly developed and very abundant in the Carboniferous, they must have originated much earlier. These two great lines of descent have undergone a parallel evolutionary development for over three hundred million years. The fossil record does not reveal which group is the older or even whether the two groups had a common ancestry. In fact, the oldest available material, of Upper Devonian age, shows the two lines about as sharply separated as they are today. However, the many fern-like features of the Cycadophytes, especially of the Paleozoic members, strongly indicate that they were derived from an ancient fern stock, while the many structural resemblances between the two gymnosperm phyla imply that either the Coniferophytes were derived from the Cycadophytes very early, or that both arose independently from a common filicinean ancestry.

During the Paleozoic the Cycadophytes were represented by the Cycadofilicales, and the Coniferophytes by the Cordaitales. Both orders, dominant then, are extinct today. During the Mesozoic the Bennettitales and Cycadales, both probably derived independently from the Cycadofilicales, carried on the Cycadophyte line, while the Ginkgoales and Coniferales, both probably descended from the Cordaitales, continued the Coniferophyte line. Of these four Mesozoic orders, the Bennettitales became extinct before the close of the era, but the others have persisted. The Cycadales are represented today by nine genera and about one hundred species, the Ginkgoales by a single species (Ginkgo biloba), and the Coniferales by about forty genera and over five hundred species. Another modern

order of gymnosperms, the Gnetales, comprise three genera and about sixty-five species. Although their affinities may be with the Coniferales, they occupy a very isolated systematic position and are practically unknown as fossils.

The Cycadophytes are comparatively small plants with pinnate leaves and unbranched or slightly branched stems having a large pith, scanty zone of wood, and large cortex. The Coniferophytes, on the other hand, are comparatively large plants with simple leaves and profusely branched stems having a small pith, abundant wood, and scanty cortex. Fern-like characters, retained by the Cycadophytes from their filicinean ancestors, include the general habit, vascular anatomy, form and venation of the leaves, occurrence of microsporangia in sori, structure of the microsporangia, and multiciliate sperms.

In the Cycadofilicales the sporophylls are much like the vegetative leaves and are not collected into cones. In the Bennettitales cones that are mostly bisporangiate are borne in large numbers, generally laterally along the stem. The microsporophylls are somewhat leaf-like and loosely clustered below the megasporophylls, which are much reduced, not at all leaf-like, and compactly organized. In the Cycadales monosporangiate cones are borne in small numbers and in an apparently terminal position on the stem. Both the microsporophylls and megasporophylls are much reduced. All except the megasporophylls of Cycas are organized into a more or less compact cone.

In the Mesozoic the Cycadales were world wide in distribution. Now they are confined to tropical and subtropical regions, and even there most of them occur in scanty patches in out-of-the-way places, hard to find after the general locality is reached. The order is represented by a single family, the Cycadaceae,

Of its nine genera, four are restricted to the Western Hemisphere and five to the Eastern Hemisphere. The occidental genera are Zamia, Microcycas, Ceratozamia, and Dioon. All of these occur north of the equator except a few species of Zamia. The oriental genera are Cycas, Bowenia, Macrozamia, Stangeria, and Encephalartos. All of these are found south of the equator except some species of Cycas and Encephalartos. The principal cycad regions of the world are southern Mexico, the West Indies, Australia, and South Africa.

Zamia, the largest genus, ranges from Florida to Chile. It has nearly one-third of all the species in the family. About thirty of the species already described appear to be valid, but the identity of the others is doubtful. Only a few have been thoroughly studied in the field. Microcycas, which is monotypic, is confined to western Cuba. Ceratozamia and Dioon are both endemic to southern Mexico. Ceratozamia appears to have six valid species and Dioon five; perhaps one or two more may later be recognized. Cycas, occurring from Japan to Australia and Madagascar, may have at least twenty species, but some are not very well marked. Bowenia and Macrozamia are confined to Australia. Bowenia has only two species. Macrozamia has about sixteen, most of them easily recognized; more may later be discovered in the vast central region of Australia. Stangeria is monotypic and confined to South Africa. Encephalartos, in its well-studied South African range, has thirteen species, while in tropical Africa there are six or seven more.

The Stem

The stem of cycads may be either aerial and columnar (arborescent) or subterranean and tuberous. An arborescent stem is characteristic of all species of Cycas, Dioon, Microcycas, and Ceratozamia. In Macrozamia and Encephalartos the stem is aerial in some species and subterrenean in others. In Zamia a tuberous underground stem occurs in most of the species, an aerial one being found in only a few. Both Stangeria and Bowenia have a tuberous subterranean stem. The tallest cycads are Macrozamia hopei, reaching a height of 18 m., and Dioon spinulosum, reaching 16 m. Microcycas calocoma becomes nearly 10 m. tall, while Encephalartos laurentianus, with a prostrate stem, attains a length of 15 m. Most arborescent cycads are much smaller, few species exceeding 3m. and many being less than 2 m. in height. The smallest of all cycads is Zamia pygmaea, with a stem less than 25 cm. long and only 2-3 cm. in diameter.

Typically, cycads have an unbranched stem, but wherever they are abundant, one can usually find an occasional branching plant. Often the branching is obviously the result of injury. At van Staadens, near Port Elizabeth, Union of South Africa, are many plants of Encephalartos longifolius like the one shown in Fig. 1. The soft terminal part of the stem had been cut off, perhaps a hundred years ago, to make Kaffir bread, a practice which gave the genus its common name, Bread Palm, and its scientific name, Encephalartos.

Young plants frequently arise from the base of an old one, especially if the old plant has a leaning stem, as in Dioon edule. The large crown of leaves on a cycad about a meter in height offers such resistance to the wind that the stem may lean or even be blown down. Any slight crack at the base may result in the formation of a bud which develops into a branch. When formed close to the soil, such buds become rooted and established as independent plants when the old plant dies. The most conspicuous cases of branching are seen in plants of Cycas revoluta growing in temple grounds or on old estates (Fig. 2). Here branching has been induced by making cuts in the stem, a method still employed by nurserymen, who pot the resulting buds. Sometimes branches become hundreds of years old and must be supported by props. Branching is very common in subterranean stems. When growing in stony ground, the stems are often cut or scratched, and a bud arising from the wound becomes a branch (Fig. 3).

An entirely different type of branching may appear in another way. When a cone breaks down, some of the seeds may be held in a kind of basket formed by the crown of leaves. Here they sometimes germinate and the seedlings grow down into the soft tissues of the stem apex (Fig. 4). At Chavarrillo, Mexico, I saw a plant of Dioon edule with thirty-five buds at the top forming a circle that replaced the normal crown of leaves. Five of the buds had four to ten green leaves; the others were still covered by bud scales. At least some, and perhaps all, of the thirty-five buds were seedlings.

Other plants in the vicinity showed three to five crowns, some of which were almost certainly a result of the germination of seeds at the stem apex. In Zamia floridana seedlings often grow down into the tissues of the stem apex and produce what appear to be branches. Such a young plant, becoming established and looking like a true branch, might bear a male cone, while the older plant might be female. The finder of such a specimen might claim that cycads are sometimes monoecious.

Another type of branching, which is internal and may never reveal itself externally, takes place regularly when a terminal cone is produced. When a cycad produces its first cone, the apical meristem is used up, but a new meristem is soon formed at the base of the peduncle (Fig. 5). This develops leaves and pushes the cone aside. Although really a lateral branch, it continues the growth of the main stem. When another cone is produced, the process is repeated, but externally the stem still seems to be unbranched. However, a longitudinal section of the stem shows a series of cone domes, each of which was terminated by a cone (Fig. 6). If two meristems should appear at the base of the peduncle, as they probably sometimes do, one might remain vegetative for several years and build up a branch; while the other, producing a cone, would form a new meristem. Although externally alike, one branch would show a cone dome, while the other would not.

In the female plant of Cycas, the original meristem continues throughout the life of the individual, producing successive crowns of foliage leaves, scale leaves, and sporophylls (Fig. 7). A

longitudinal section of the stem does not show any cone domes. The male plant has terminal cones and a longitudinal section shows a cone dome for every cone the plant has produced except the first one.

Where several cones are produced, the stem may or may not contain cone domes. Zamia has a complicated system of cone domes, and when a new meristem appears at the base of each peduncle, a profusely branched stem results. A plant of Zamia latifoliolata in our collection has produced as many as 60 male cones at one time. Even externally, it is much branched. A dissection of the stem would doubtless reveal a complicated anatomy that would probably be of the cone-dome type, with more than one meristem appearing at the base of a peduncle.

Encephalartos friderici-guilielmi frequently has a circle of cones appearing in the axils of leaves (Fig. 8). The cones are lateral structures, the terminal meristem continuing the growth of the stem. Cone domes are absent. In Macrozamia moorei male cones are usually numerous, with 10 to 20 not rare and sometimes as many as 100 being present (Fig. 9). These cones are strictly lateral, arising from the leaf axils. A tangential section of the stem resembles a section of the extinct Cycadeoidea, of the order Bennettitales. Ovulate cones are not so numerous, usually only two or three being present, but in one plant eight were counted, all fully grown and weighing about 15 kilos each. Both male and female plants of Macrozamia moorei have no cone domes.

In Stangeria and Bowenia, which have subterranean stems, an abscission layer develops at the base of the petiole and cuts off

the leaf cleanly, leaving only an inconspicuous scar that finally becomes unrecognizable. In other cycads with subterranean stems, as in most species of Zamia and in some species of Encephalartos and Macrozamia, an abscission layer does not appear so early. Instead, the leaf dies, the leaflets are shed, and the rachis and petiole disorganize. In Zamia an abscission layer is formed after several years, the base of the petiole then breaking off cleanly. Consequently, the top of the stem is covered with a temporary armor of leaf bases. After the leaf is cut off, the scar may be visible for a long time (Fig. 10), but usually soon disappears, leaving the stem as smooth as in Stangeria or Bowenia, and a normal phellogen is continuous around the entire cortex. Those species of Encephalartos and Macrozamia having subterranean stems, or stems raised only slightly above the ground, have an armor less conspicuous than in arboreal types but one that may persist throughout the life of the plant.

Cycads with aerial trunks have a conspicuous armor of persistent leaf bases. Dioon edule affords a good example (Fig. 11). In its first year the young crown of leaves is obliquely erect; in its second year it becomes depressed, so that the leaves are almost horizontal; in its third year the leaflets fall off; during the next two or three years, the rachis and petiole disorganize and only 8 or 10 cm. of the petiole remain. Finally an abscission layer forms, not at the base of the petiole but farther out, so that 2 or 3 cm. of the base of the petiole remain as a permanent armor. The end of the remaining part is suberized. Even trunks a thousand years old

are completely covered by these petiole bases, which are more or less diamond-shaped as seen from the surface. In such an old trunk, the diameter near the top is usually greater than at the base, for there is almost no increase in the width of the xylem of the stele. On the other hand, there is often a decrease in the diameter of the trunk, for one abscission layer after another forms at the outer ends of the leaf bases, cutting off thin flakes that finally reduce the diameter of the trunk. In extremely old trunks of Encephalartos latifrons this process goes on until no trace of the armor remains.

In trunks of rapid growth - rapid for cycads - a distinct alternation of large and small leaf bases occurs. The large bases, forming a rib, belong to foliage leaves, while the small ones, forming the depression between two ribs, belong to the bud scales. Microcycas calocoma and Dioon spinulosum furnish good illustrations of such ribbing (Fig. 12). The successive cork cambiums are much more vigorous in the bases of the foliage leaves, which form the ribs. Consequently, the ribs become reduced, and at a distance of a couple of meters from the top, the trunk becomes even, with no distinction between ribs and depressions. In very old trunks the abscissions continue until they not only remove the armor but invade the cortex, so that the diameter of the trunk is noticeably less at the bottom than at the top (Fig. 13).

In Dioon edule one might imagine an obscure ribbing; but here the buds scales are hardly recognizable except near the tip. Each of the big groups which might be mistaken for ribs is made up of the bases of foliage leaves and consists, not of the bases of one

crown but of several crowns, perhaps as many as twelve. When a plant produces a crown of leaves every other year and a cone every other year, or even every year, it becomes exhausted and goes into a dormant state, looking dead and producing neither leaves nor cones for several years. A fire may sweep through the patch and thus initiate a dormant stage or an animal may initiate it by eating a young crown. When the plant comes out of the dormant state, an unusually large number of bud scales makes a slight constriction. The number of such constrictions on a stem doubtless denotes the number of times the plant has become dormant. In Dioon edule a growth ring resembling an annual ring is formed as the plant comes out of the dormant state. Such a growth ring, in this species, may be formed every 20 or 30 years. The dormant periods are too irregular to make the rings of much value in estimating the age of a plant.

In Dioon spinulosum the successive abscission layers in the leaf bases are so frequent that, at the bases of plants 6 or 7 m. high, there is not only no distinction between ribs and depressions, except in the upper part of the trunk, but even the diamond-shaped markings are obliterated. Thus any estimate of the age of the plant on this basis is extremely indefinite. In this species the width of the xylem of the stele increases considerably, the diameter of the stem being greater at the bottom than at the top. Except during dormant periods, a crown is formed every other year, and with every new crown a growth ring appears in the wood. In trunks 10 m. high the ribs are easily recognizable in the upper 3 m. Consequently, the age of this upper part, making no allowance for possible dormant

periods, is just twice the number of ribs. A plant of D. spinulosum 16 m. high would probably not be half as old as one of D. edule 1 m. high. In the lower part of such trunks, where leaf bases or ribs are indistinguishable, one might make a guess from the growth rings, making the number of years twice the number of rings.

Some records of very old cycads are available. In the grounds of the temple of Gokokuji, at Takaido, Japan, is a plant of Cycas revoluta that is known to have been growing in the same place for over 650 years, and it was probably 100 years old when transplanted from the field. One of the largest specimens of C. revoluta in Japan is in the temple grounds of Shokuji, at Hiji-Cho, Oita Prefecture. The stem is 9.15 m. tall and 1.75 m. in diameter. It has 90 branches and the area covered by them is about 100 square meters. The age is said to be about 500 years.

At Chavarrillo, Mexico, large plants of Dioon edule produce a crown of about 20 leaves every other year, an average of 10 a year. Some specimens not more than 1.5 m. in height have 10,000 leaf bases, indicating an age of about 1,000 years (Fig. 14). Such an estimate is conservative because a plant is not likely to produce 20 leaves in a crown until it is nearly 100 years old; also no account is taken of dormant periods. In conservatories both Dioon edule and D. spinulosum may retain their leaves for 2, 3, or 4 years, or even longer, or crowns may appear two years in succession, the duration being so irregular that the method of determining the age of field specimens is of little value when applied to plants in cultivation.

Transverse sections of adult cycad trunks show two distinct types of vascular structure, the monoxylic and the polyxylic, the former having a single zone of wood and the latter two or more zones separated by parenchyma (Fig. 15). Most cycads have the monoxylic type of stem. In Cycas all species which have been examined are polyxylic, while in Macrozamia and Encephalartos some species are monoxylic and some polyxylic. In Cycas revoluta and C. media plants 1.5 m. in height seldom show more than 3 or 4 zones. The greatest display of zones which has come to our attention is in Cycas pectinata. A piece of stem 20 cm. in diameter, collected by Sir Joseph Hooker in 1848, in the Great Rungeet Valley, Sikkim, shows 14 zones, all rather narrow but very distinct. (Fig. 16) The zones are formed at irregular intervals of, probably, many years, and may indicate the number of times the plant has had a prolonged dormant period.

In adult plants of Zamia floridana having a stem diameter of 8 cm., the xylem zone is about 2 mm. wide and the phloem zone the same. In exceptionally large specimens with a diameter of 12 cm., the xylem zone is about 3 mm. wide and the phloem zone about 2 mm. Growth rings are absent. It is evident that growth of the woody cylinder is very slow. A plant of Ceratozamia mexicana near Jalapa, Mexico, with a trunk 30 cm. high and 15 cm. in diameter, had a zone of xylem only 3 mm. wide. A plant of Microcycas calocoma near Consolación del sur, Cuba, was about 2.5 m. high and about 20 cm. in diameter at 50 cm. above the ground. The diameter of the pith at this level was 10 cm., the width of the xylem zone 1.5 cm., the phloem 1 cm., the cortex 2.2 cm., and the armor 0.5-1 cm.

A plant of Dioon edule at Chavarrillo, Mexico, with a trunk about 60 cm. high and 21 cm. in diameter, had a pith 8.7 cm. in diameter, a xylem zone 5mm. wide, phloem zone 5 mm., cortex 2 cm., and zone of leaf bases 3.6 cm. A specimen about 1 m. in height but with no greater diameter had a pith 6.9 cm. in thickness, a xylem zone 15 mm. wide, phloem zone 8 mm., cortex 3.2 cm., and zone of leaf bases 1.5 cm. Dioon spinulosum has the widest zone of xylem ever recorded for any cycad. A specimen at Tierra Blanca, Mexico, with a stem 6 m. high and 33 cm. in diameter, had a pith 8 cm. in diameter, a xylem zone 10 cm. wide, phloem zone 1.4 cm., cortex 2.5 cm., and armor 0.5-1 cm. (Fig. 17).

Leaves

The leaves of cycads are produced in crowns, except that in Stangeria, which often has only one leaf and rarely more than two or three in a season, the term crown is not very appropriate. But even in Stangeria, whose leaves often live two or three years, particularly in gardens and conservatories, the foliar display might be called a crown. The leaves of all cycads do not appear simultaneously but in succession along a low spiral. Consequently, the leaves in a crown are of such different lengths that the oldest may be several times as long as the youngest (Fig. 18). In some species of Macrozamia, such as M. moorei and M. miquelii, the crown may contain as many as 100 leaves, but in most cycads the number is much less, seldom exceeding 20 or 30, and often being fewer than 15.

The duration of the crown varies with the species and with conditions. The young crown is erect until the leaves reach at least half their mature length (Fig 19). At Chavarrillo, Mexico, where Dioon edule is very abundant, crowns are produced every other year. During the first year the crown is bright green and the leaves extend obliquely upward. During the second year, partly because of the presence of a small grayish lichen, the leaves are not so bright and become horizontal or even droop slightly. During the third year the leaflets fall off, the petiole and rachis hang down and decay, beginning with the tip, and still later an abscission layer appears 2 or 3 cm. from the cortex, making a clean cut that leaves the base of the petiole on the trunk (Fig. 14).

As nearly as could be determined, the production of new crowns seems to be the same in Dioon spinulosum as in D. edule. At Trapps Valley, near Grahamstown, South Africa, Encephalartos altensteinii produces a new crown every year, but E. latifrons does not. Cycas circinalis usually bears a new crown every year, but at Townsville, Queensland, Australia, lying at sea level in a hot and wet region, a plant in the botanical garden is said to produce two crowns a year. This is a ~~very~~ unique case. Probably in no other cycad are the successive crowns more sharply marked than in Encephalartos friderici-guilielmi, where the tomentum is extremely abundant, covering the scale leaves and making the foliage leaves very abundant. In this species a new crown appears every year and remains green for two years.

The vernation in Dioon, Macrozamia, and Encephalartos is perfectly straight (Figs. 18, 19, 20A). In Cycas it is as circinate as in any fern, both in the rachis and leaflets (Fig. 20B). In Zamia, Ceratozamia, and Microcycas the rachis is circinate and the leaflets straight (Fig. 20C). In Stangeria the rachis is distinctly curved, sometimes appearing circinate and sometimes conduplicate, while the leaflets are straight (Fig. 20D). In Bowenia the bipinnate leaf has the tip of the main rachis and side branches curved, but the leaflets are straight.

When a new crown has broken through the bud scales, growth is very rapid. The following measurements were made in the greenhouse, where growth is likely to be faster than in the field. But the rates of growth at various periods in the development of the leaf, and

comparative rates of growth of the different regions, are probably the same as in the field. All the plants measured, except Stangeria and Bowenia, were grown from seed and were not more than 35 years old.

	Number of days	Increase in length	Average rate per day
Dioon spinulosum	6	28 cm.	4.6 cm.
D. edule	6	21 cm.	3.5 cm.
Cycas circinalis	48	146 cm.	3.0 cm.
Ceratozamia mexicana	55	61 cm.	1.1 cm.
Encephalartos villosus	50	110 cm.	2.2 cm.
Stangeria paradoxa	31	88 cm.	2.8 cm.
Bowenia serrulata	30	83 cm.	2.7 cm.

The leaves of all cycads are pinnate except those of Bowenia, which are bipinnate or even tripinnate. They range in length from 5 or 6 cm. in some mature specimens of Zamia pygmaea to as much as 3 m. in Cycas circinalis, Dioon spinulosum, and Macrozamia denisonii. The leaves of Encephalartos villosus sometimes reach a length of 5 m. while E. laurentianus, of tropical Africa, is reported to have leaves reaching 6 m. in length. About 1 m. is a very common length for a cycad leaf and this is reached or surpassed in all the genera and in many of the species.

The pinnate leaves, arranged in crowns, make the cycads look like ferns. Stangeria paradoxa was long thought to be a fern and was included in the tropical genus Lomaria until the discovery of its cones proved it to be a seed plant. Zamia pseudoparasitica looks so much like Polystichum acrostichoides that, without cones, it might be mistaken for that well-known fern. On the other hand, some of the ferns resemble cycads. At a distance of 50 m. the South African Cyathea dregei could easily be mistaken for a cycad. In the tropical

rain forest south of Tuxtepec, Mexico, one must often dismount from his horse for a closer look before he can decide whether a plant is a cycad or a fern. Sometimes it is a Zamia, but usually only a fern. Bowenia, with its bipinnate leaves, is so fern-like in appearance that, without cones, one might pass it by without even suspecting that it is a cycad.

Most cycad leaves are differentiated into a petiole and rachis. In some species the lower leaflets are gradually reduced to spines that often extend to the base of the leaf, so that a distinct petiole seems to be lacking. Such spines, generally occurring in a row along each of the two sides of the petiole, are seen in most species of Cycas, in Dioon spinulosum, and in some species of Encephalartos, such as E. villosus. In many species of Macrozamia the lower leaflets are reduced in size but, with only a few exceptions, are not spine-like. In Ceratozamia, except C. kuesteriana, and in many species of Zamia, the petiole is spiny, but the spines are irregularly scattered and do not intergrade with the leaflets; in fact, they are frequently borne on the rachis as well. In Stangeria, Bowenia, and Microcycas the petiole is entirely without spines of any kind.

In Dioon spinulosum, where in older plants the reduced leaves extend to the base of the petiole as spines, seedlings and young plants, as well as buds from older plants, have very long unarmed petioles and the lower leaflets are nearly as large as those higher up (Fig. 21). Such leaves are called juvenile leaves and many students of phylogeny regard them as evidence in favor of the recapitulation theory. In Ceratozamia, also, the first leaves of the seedling have

unarmed petioles, the spiny condition developing gradually as the plant becomes older. In some species of Cycas, on the other hand, where the leaves of mature plants have few or no spines on the petiole, numerous spines occur on the petioles of young plants. Because the degree of spininess often depends on the age of the plant, too much stress should not be placed upon it, especially since nearly all taxonomic descriptions of cycads have been written by botanists who have never studied the plants in the field.

In nearly all herbarium specimens leaves are cut off above the base, the extreme lower portion being lost. In Zamia stipules are as prominent as in the Rosaceae. In Ceratozamia the stipules are thick and fleshy, forming an important part of the armor that covers the stem; in C. latifolia they develop so early that the growing leaf breaks through the stipule as the root tip of a cycad embryo breaks through the coleorhiza. In this species the stipules are so closely applied to the cortex that the trunk is smooth, making it easy to distinguish C. latifolia from C. mexicana by this feature alone.

Since Zamia and Ceratozamia have highly developed stipules, it seemed desirable to examine representatives of all the other genera. In no others are the stipules as prominent as in Zamia, but in every one there is a distinct widening at the base. In Dioon, while the widening could hardly be called a stipule, there is a wedge-shaped edge from which a dense mat of tomentum extends in a thin layer, making the whole structure resemble a wing. In Microcycas, Stangeria, Macrozamia spiralis, Encephalartos hildebrandtii, and E. latifrons the wings may very well be called stipules; and in

some other species of Macrozamia and Encephalartos the broad thin wing, while not quite as stipular in appearance, is doubtless the same morphologically. In Cycas and Bowenia also, the broad thin wing is morphologically a stipule. In old leaves of some cycads the thin stipule or wing weathers off at the tip and what remains becomes so closely applied to the leaf that it may be overlooked, or if noticed, as in Encephalartos latifrons, may be called a "collar".

It would not be worth while to ask those who collect large leaves to cut them far enough down so as to show the lowest part, for it is difficult to make such a cut and there is danger of damaging the plant. Moreover, in leaves such as those of Macrozamia moorei, the fleshy base is so broad and thick that it does not make an attractive herbarium specimen.

The leaflets are arranged in two rows that arise laterally from the upper edge of the rachis. They are usually spread out horizontally in one plane; sometimes they bend upward but rarely to such an extent that they are erect. On older plants of Microcycas calocoma the leaflets bend downward. The leaflets are definitely articulated with the rachis in Zamia, Ceratozamia, and Microcycas, but not in the other genera. In Dioon the base of the leaflet is as broad as its widest part; in the other genera the leaflets are more or less attenuated toward the base, the insertion being sometimes quite narrow. In most species of Cycas the leaflets are decurrent at the base, often to the next leaflet below. The leaflets may be either opposite or alternate along the rachis, but often the

arrangement is not constant for an individual species; in fact, frequently it is not the same at the apex of a leaf as at its base.

In seedlings the first leaves have only a few leaflets, the number increasing each year until the plant reaches maturity. In an adult plant the leaflets range from as few as 5 on each side in Zamia pygmaea and Z. ottonis to as many as 100 or more on each side in Cycas circinalis, Dioon spinulosum, and Macrozamia denisonii. The leaflets of most cycads are linear-lanceolate, but vary from ovate in Zamia pygmaea and a few other species to very narrowly linear in Zamia angustissima and Encephalartos ghellinckii. Forked leaflets are found in Cycas micholitzii and Macrozamia heteromera. In length the leaflets vary from 1-3 cm. in Zamia pygmaea to as much as 50 cm. in some specimens of Z. wallisii and Ceratozamia mexicana. The leaflets of Zamia angustissima, only 1-2 mm. wide, are the narrowest in the Cycadaceae, while those of Z. wallisii, up to 25 cm. wide, are the broadest.

Some genera are characterized by leaves having an entire margin. These are Cycas, Stangeria, Macrozamia, Microcycas, and Ceratozamia. In Bowenia, Dioon, Encephalartos, and Zamia some species have entire leaflets, while others have leaflets that are more or less toothed. Sometimes the degree of serration depends upon the age of the plant. Thus, Encephalartos altensteinii and Dioon edule have spiny leaflets when young and entire leaflets when mature.

The venation of the leaflets is dichotomous, a condition inherited from the Cycadofilicales and, still farther back, from the ferns. However, most of the forking is so near the base of the

leaflet that taxonomists describe the venation as parallel. In is usually described
Dioon no forking takes place except at the base, but in most of the other genera close examination will reveal dichotomous branching of the veins throughout the leaflet. This is particularly apparent in species with broad leaflets, such as Zamia skinneri, which has very conspicuous veins. Cycas and Stangeria are the only genera with a midrib. In Cycas the leaflet is without any side veins, the midrib being the only vein present. In Stangeria lateral veins extend out from the midrib at right angles to it. In the other genera all the veins are equivalent.

See chapter on hand lenses for discussion of epidermal and stomatal characters.

Cones and Sporophylls

All cycads are strictly dioecious. Their sporophylls are borne in spiral succession on an elongated axis and are generally organized to form compact strobili that are apparently terminal or nearly so. In Cycas, however, the megasporophylls form a loose crown at the apex of the stem. At first they are tightly pressed together, but later separate and finally hang down (Fig. 34). After the seeds ripen, the original meristem of the stem resumes its activity, forming successive crowns of scales, foliage leaves, and megasporophylls. When a male cone is formed in Cycas, the original meristem is used up and a new one forms at the base of the peduncle. When growth of the stem is resumed and a new crown of leaves appears, the cone is pushed to one side. The same condition prevails in the formation of both male and female cones in all the other genera except Macrozamia and Encephalartos. In these two genera the original meristem is not used up in the formation of a cone but later contributes to the elongation of the stem; the cones are lateral structures, arising close to the stem apex in the axils of young leaves.

Some cycads produce cones almost simultaneously. That they really appear in succession is revealed by their difference in size during early stages; but, as they mature, they reach about the same size (Fig. 140). In a group of male cones the oldest sheds pollen somewhat earlier than the others; in a group of female cones the

oldest cracks apart a little earlier; thus the pollination period is prolonged. More than a single male cone may be produced in Macrozamia, Encephalartos, and Zamia, whereas in the other genera the male cones are generally solitary. The female cones may occur in groups of two, three, or more in Macrozamia and Encephalartos; elsewhere they are usually borne singly.

Where multiple cones are produced, the origin of each may involve the apical meristem of the stem, as where only one cone arises. This appears to be the situation in Zamia. In Macrozamia and Encephalartos, on the other hand, the cones appear in the axils of leaves and the apical meristem continues the growth of the stem. Macrozamia moorei presents an extreme case in that as many as one hundred male cones, all of which are axillary, may appear on a single plant (Fig. 9).

Although the sporophylls are always borne spirally, their arrangement is so regular in the male cones of Dioon and in both the male and female cones of Bowenia, Microcycas, Ceratozamia, and Zamia that, in surface view, they seem to stand in vertical rows. The microsporophylls of all cycads are borne in definite cones, but the megasporophylls of Cycas, as previously noted, form a loose crown, while those of Dioon are in a rather loose cone. In the other genera the megasporophylls form a compact cone. The male strobilus is usually smaller than the female, especially in thickness, and has a greater number of sporophylls. In Bowenia and Zamia both kinds of cones are smaller than in the other genera.

The smallest cones in the family are found in Zamia pygmaea, where the male cones are only 3 cm. long and 1 cm. in diameter, the female cones 4.5 cm. long and 2.5 cm. in diameter. Among the largest are those of Macrozamia denisonii, where the male cones are 24-40 cm. long and 10-15 cm. in diameter, the female cones 40-60 cm. long and 30 cm. in diameter. Exceptional male cones in this species reach a length of 80 cm. and exceptional female cones a length of nearly 1 m., the latter weighing 38 kilos. Exceptional female cones of Encephalartos longifolius are not so long but may weigh as much as 45 kilos.

The microsporophylls of cycads may be flat, as in Cycas, or peltate, as in Zamia. In both cases there is a stalk-like basal portion and a sterile apex. The abaxial surface bears the microsporangia, which are generally grouped in sori of 2-6. The microsporangia range from over 1,000 per sporophyll in some species of Cycas to a comparatively few in Zamia, the lowest number in the family, 10-14, occurring in Z. pygmaea. The microsporangia may form a continuous group or, as in Zamia and some species of Macrozamia, may be separated into two groups by a sterile median line.

The megasporophylls of cycads exhibit a striking reduction series, ranging from pinnate types with as many as 8 or 10 ovules to peltate types with only 2 ovules. The most primitive condition is seen in Cycas revoluta, where the megasporophylls are 20-30 cm. long and distinctly leaf-like (Fig. 26). The lower portion, or petiole, is slender and stalk-like, while the rachis consists of a narrow fertile portion that is expanded above into a broad sterile blade. The fertile portion bears several ovules, most commonly 3, along

each lateral margin, while the sterile blade bears a number of reduced leaflets up to 5 cm. long. In the other species of Cycas the leaflets of the megasporophyll become smaller and smaller, finally being represented by mere serrations, as in C. circinalis (Fig. 35). The ovules are reduced to a single pair in C. cairnsiana and C. normanbyana, the number characteristic of all the other genera.

The megasporophylls of Dioon are without any serrations, but the sterile blade is long and acuminate (Fig. 56). In Macrozamia the blade is reduced to a median spine that is particularly conspicuous in M. miquelii (Fig. 78). In Encephalartos and Ceratozamia the terminal part of the blade is suppressed, but the leaflets are often represented by serrations. Reduction has gone still farther in the other genera, the megasporophyll being a thick peltate structure with scarcely any resemblance to a leaf. Reduction of the sporophylls reaches its extreme in Zamia.

no reduction on "seeds"?
I.W.T.

CYCADACEAE

Lindley, J., Nat. Syst., 2nd ed., p. 312 (1836); Miquel, F., A. W., Monogr. Cycad. (1842), Prodr. Syst. Cycad. (1861); De Candolle, A., Prodr. 16[2]:522-547 (1868); Regel, E. von, Gartenfl. 25:47-51, 140-144, 202-205, 370-373 (1876); Chamberlain, C. J., The Living Cycads (1919); Pilger, R., Cycadaceae in Engler and Prantl's Natürl. Pflanzenf., 2nd ed., 13:44-82 (1926); Schuster, R., Cycadaceae in Das Pflanzenreich 4[1]:1-168 (1932).

Woody plants, commonly tree-like. Stem stout, aerial and columnar or subterranean and tuberous, unbranched or sometimes slightly branched; with a large pith, scanty zone of wood, and large cortex. Leaves relatively large, coriaceous, borne in alternating series with short, [redacted] ovate to subulate scales (cataphylls) acting as bud scales; pinnate or, in Bowenia, bipinnate; generally borne in a crown at the apex of the stem; developed in spiral succession from an apical meristem, except in Bowenia. Leaflets with only "parallel" (dichotomous) venation, except in Cycas and Stangeria, which have a midrib; in Cycas with no veins except the midrib and in Stangeria with a midrib and lateral veins extending at right angles to it.

Strictly dioecious plants with all sporophylls arranged spirally and in more or less compact cones, except the megasporophylls of Cycas, which form a loose crown. Cones borne singly or in small groups at or very near the apex of the stem, relatively large, most commonly ovoid or cylindric. Microsporophylls (stamens) scale-like and flat, or peltate, with a sterile tip, the lower surface bearing numerous microsporangia usually grouped in sori of 2-6. Megasporophylls (carpels) either scale-like, flat, and narrowed to a point, or more or less peltate and stalked; with 2-10 marginal ovules in Cycas and 2 suspended ovules in the other genera. Ovules sessile, but in Dioon

and occasionally in Bowenia some appearing stalked because portions of the sporophyll are drawn out during growth of the ovules and cone. Fertilization by multiciliate sperms. Seeds large; globose, ovoid, or oblong; the outermost layer of the integument fleshy and usually colored, the middle layer crustaceous or bony; endosperm abundant; embryo with 2 cotyledons or, in Ceratozamia, with only 1.

The nine genera are so well marked that they may be recognized without difficulty.

Key to the Genera

I. Leaflets with a midrib but without side veins; megasporophylls in a loose crown, long, flat, with 2-10 marginal ovules . . . 1. Cycas

II. Leaflets with a midrib and side veins; megasporophylls in a compact cone, peltate, with 2 suspended ovules . . . 2. Stangeria

III. Leaflets without a midrib, veins parallel; megasporophylls in a loose or compact cone, peltate, with 2 suspended ovules

A. Leaflets not articulated with the rachis

1. Leaflets bipinnate or occasionally tripinnate . . . 3. Bowenia

2. Leaflets pinnate

a) Leaflets broad at base; megasporophylls in a loose cone, very unequally peltate; ovules on stalk-like outgrowths of the megasporophyll . . . . . 4. Dioon

b) Leaflets narrowed at base; megasporophylls in a compact cone, about equally peltate; ovules sessile

(1) Leaflets generally with a basal swelling, nearly always entire; sporophylls acuminate, terminating in a median spine . . . . . 5. Macrozamia

(2) Leaflets without a basal swelling; entire, toothed, or lobed; sporophylls obtuse, not terminating in a median spine . . . . 6. Encephalartos

B. Leaflets articulated with the rachis

1. Leaflets deflexed on the rachis, entire; microsporophylls flat, obtuse; megasporophylls with a thick top and 3 shallow grooves above and below . . . 7. Microcycas

2. Leaflets not deflexed, entire; sporophylls with a thick top bearing 2 horns . . . . . 8. Ceratozamia

3. Leaflets not deflexed, generally toothed; sporophylls with a thick flat top without horns . . . . 9. Zamia

1. CYCAS L.

Linnaeus, C., Spec. Plant., 1st ed., p. 1188 (1753), Gen. Plant., 5th ed., p. 495 (1754); Smith, J. E., Trans. Linn. Soc. 6:312 (1802); Miquel, F. A. W., Mongr. Cycad., 21-33 (1842), Prodr. Syst. Cycad., 6-7, 16-17 (1861); De Candolle, A., Prodr. 16/2:525-529 (1868); Hooker, J. D., Flora Brit. India 5:655-658 (1890); Bailey, F. M., Queensl. Flora 5:1501-1502 (1902); Schuster, J., Pflanzenreich 4/1:655-658 (1932).

Stem an aerial trunk, typically unbranched, 1-7 m. tall, covered with an armor of persistent leaf bases. Leaves many in a crown, 1-3 m. long; petiole generally with two rows of spines representing reduced leaflets. Leaflets linear or linear-lanceolate, entire, with a prominent midrib but no other veins. Vernation of both rachis and leaflets strongly circinate.

Male cones solitary, ovoid or long ovoid-cylindric, short stalked. Microsporophylls closely imbricate, flat, cuneate, generally abruptly tapering to a sharp point, the microsporangia covering all the lower surface except the sterile tip. Megasporophylls at first closely imbricate and appressed into a cone-like structure, then expanding into a loose crown. Original meristem persistent in center throughout life of plant, producing successive crowns of vegetative leaves and occasionally a crown of megasporophylls. Megasporophylls long, consisting of a petiole and a rachis differentiated into a lower fertile portion bearing 1-5 ovules along each lateral margin and an upper flattened portion ("sterile blade") bearing reduced pinnae several centimeters long, or these represented by mere serrations. Seeds reddish, orange-red, or brownish.

About 20 species, some of which are highly variable. A widely distributed genus ranging from Australia, New Guinea, and other

South Pacific islands to southern Japan, southern China, Indo-China, Thailand, Malaya, East Indies, southern India, Ceylon, and Madagascar. Name from κυϕας , a name given by Theophrastus to a kind of palm. Type species: C. circinalis L.

Cycas is unique in the venation and vernation of its leaflets, the organization of its megasporophylls to form a loose cluster rather than a compact cone, and its leaf-like megasporophylls with as many as five pairs of lateral ovules. The continued growth of the stem tip through the crown of megasporophylls is also characteristic.

Key to the Species

I. Blade of megasporophll deeply pectinate or pinnatifid, the segments 2 cm. or more in length

A. Ovules more than 2 on each megasporophyll

1. Leaflets less than 10 mm. in width, not forked

a) Leaflet margins revolute . . . . 1. C. revoluta

b) Leaflet margins flat

(1) Blade of megasporophyll broadly orbicular; stem not swollen at base

(a) Leaflets 13-18 cm. long; megasporophylls about 25 cm. long, glabrous . 2. C. taiwaniana

(b) Leaflets 18-25 cm. long; megasporophylls about 15 cm. long, villous . 3. C. pectinata

(2) Blade of megasporophyll ovate-rhomboid; stem swollen at base . . . . 4. C. siamensis

2. Leaflets more than 20 mm. in width, forked . 5. C. micholitzii

B. Ovules 2 on each megasporophyll

1. Leaflets 4-5 mm. wide, flat; megasporophylls about 20 cm. long . . . . . 6. C. wadei

2. Leaflets 10-20 mm. wide, undulate; megasporophylls 6-7 cm. long . . . . . 7. C. undulata

II. Blade of megasporophyll laciniate, the segments less than 2 cm. long

A. Leaflets 12-18 cm. long, 3 mm. wide, their margins revolute; blade of megasporophyll 2 cm. wide . . 8. C. beddomei

B. Leaflets 20-30 cm. long, 9-11 mm. wide, their margins flat; blade of megasporophyll 3.5-5 cm. wide . 9. C. chamberlainii

III. Blade of megasporophyll spinose-toothed or entire

A. Ovules more than 2 on each megasporophyll

1. Leaflets 20-30 cm. long

a) Leaflets 9-13 mm. wide; blade of megasporophyll ovate-lanceolate

(1) Blade of megasporophyll about 4 cm. wide, short-toothed . . . . . 10. C. circinalis

(2) Blade of megasporophyll 2-3 cm. wide, crenulate or subentire . . . . 11. C. thouarsii

b) Leaflets 14-20 mm. wide; blade of megasporophyll ovate-rhomboid, minutely dentate . 12. C. rumphii

2. Leaflets 10-20 cm. long

a) Leaflets less than 10 mm. wide

(1) Blade of megasporophyll spinose-dentate

(a) Leaflets glabrous; megasporophylls densely tomentose . . . . 13. C. media

(b) Leaflets and megasporophylls glabrous . . . . . 14. C. lane-poolei

(c) Leaflets furfuraceous below; megasporophylls densely tomentose . 15. C. furfuracea

(2) Blade of megasporophyll entire . . 16. C. basaltica

b) Leaflets 10-15 mm. wide . . . . . 17. C. kennedyana

B. Ovules 2 on each megasporophyll

1. Leaflets 4 mm. wide, their margins revolute; megasporophylls up to 35 cm. long, the blade rhomboid-lanceolate . . . . . 18. C. cairnsiana

2. Leaflets 5-6 mm. wide, their margins flat; megasporophylls 15 cm. long, the blade narrowly lanceolate . . . . . 19. C. normanbyana

1. Cycas revoluta Thunb.

Thunberg, [C. P.], Fl. Japon., p. 229 (1784); Smith, [J. E.], Trans. Linn. Soc. 6:312 (1802); Hooker, [W. J.], Bot. Mag. 57: t. 2963, 2964 (1830); Miquel, [F. A. W.], Monogr. Cycad., p. 23 (1842), Prodr. Syst. Cycad. 6, 16 (1861).

Stem in the field seldom more than 2-3 m. high and 30-40 cm. in diameter, generally unbranched. In temple grounds and on old estates sometimes reaching a height of 9 m. and a diameter of 1.75 m., with as many as 90 branches covering an area of 100 square meters. Leaves 15-30 in a crown, the larger ones 1-2 m. long, upper surface dark green and glabrous, lower surface paler and with a brownish pubescence when young, becoming glabrous later. Petiole about 20 cm. long, rounded below, somewhat ridged above between two rows of spines that are reduced leaflets, these 2 mm. long, very densely woolly at base with long reddish hairs, glabrous above. Rachis 80-150 cm. long, rounded above and below except that the two sides are ridged by decurrence of the leaflets. Leaflets 75-125 on each side, crowded, subopposite, the upper ones alternate, arising at an angle of 35-40 degrees from the rachis, linear, the apex tapering and ending in a sharp reddish brown spine, narrowed at the base, the lower edge strongly decurrent on the rachis, margins strongly revolute; largest leaflets 12-18 cm. long and 5 mm. wide, the upper and lower ones much smaller; midrib prominent chiefly below.

Male cones cylindric, yellowish, 40-50 cm. long, 8-12 cm. in diameter, short stalked. Microsporophylls narrowly lanceolate, cuneate, 5 cm. long, 2 cm. wide at the broadest part, tapering to 7 mm. at the bottom; exposed part deltoid and abruptly tapering to an acuminate tip up to 5 mm. long, densely woolly. As the cone dries, microsporophylls becoming strongly deflexed. Microsporangia 200-450, in sori of 3 or 4, occasionally 5, covering the entire lower surface except a sterile notch at the top.

Megasporophylls much more numerous than the leaves in a vegetative crown, 100-200 not rare, oblong-ligulate, 20-30 cm. long, covered with a dense tomentum of long hairs which are reddish at the base of the petiole and yellowish elsewhere; entire megasporophyll reddish upon removal of the tomentum. Petiole 8-10 cm. long, rachis 14-20 cm. long and bearing 2 or 3 ovules, occasionally 4, on each side of its lower half. Rachis expanded above into a deeply pinnatifid "sterile blade" 1.5-2.5 cm. wide exclusive of the 15-20 subterete reduced pinnae on each side, which are 2-5 cm. long, naked, sharp-pointed, and reddish.

Seeds obovoid, bilateral, flattened, emarginate, yellow tomentose becoming glabrous and orange-red with age and disappearance of much of the tomentum, 3.5 cm. long, 3 cm. in larger diameter, 2.5 cm. in smaller diameter. Stony coat smooth, 3.2 cm. long, 2.2 cm. in larger diameter, often sharp-pointed at the base, apex sometimes with two points between which the stony coat splits at germination; often with two lines from apex to base along the larger diameter.

Geographic distribution: Southernmost Japan, with particularly good stands at Mitsuhama Ito, on the Ryukyu Islands, and in a few other places. At Oshima and elsewhere in southern Japan growing as if native. Cultivated in tropical and subtropical regions all over the world. In Florida and the southern parts of the Gulf States and in southern California this species flourishes in the open, and it is a conservatory plant everywhere.

2. Cycas taiwaniana Carruth.

Carruthers, W., Jour. Bot. 31:2 (1893); Metcalf, F. P., Flora Fukien 1:18 (1942).

Leaves 1.8 m. long, glabrous, paler beneath. Leaflets numerous, subopposite, arising from the terete rachis at an angle of 60 degrees, linear-lanceolate, tapering at the base to about 3 mm., decurrent, 13-18 cm. long, about 7-8 mm. wide. Male cones subcylindric. Microsporophylls spinose acuminate. Megasporophylls about 25 cm. long, nearly glabrous, with a slender petiole and fertile portion, the latter bearing 3 or 4 ovules above the middle. Sterile blade orbicular or oval, about 10 cm. long and 5 cm. wide, deeply cut on both sides into linear acuminate spines (the reduced pinnae) up to 2 cm. long, the terminal portion somewhat longer, broad and serrate. Seeds ellipsoidal, the stony layer with 1 or 2 prominent ribs.

Geographic distribution: Formosa, South China. A little-known species closely related to C. revoluta L. and differing from it chiefly in the form of the megasporophylls.

3. Cycas pectinata Griff.

C. wallichii Miq.

Griffith, W., Notul. plant. asiat. 4:10 (1854); Miquel, F. A. W., Monogr. Cycad., p. 32 (1854); Hooker, J. D., Flora Brit. India 5:657 (1890).

Stem reaching a height of 3 m., sometimes branched at the top. Leaves 1.5-2 m. long, recurved, bright green above, paler beneath, glabrous. Petiole about 45 cm. long, subquadrangular, with a few distant spines. Leaflets opposite or alternate, narrowly linear, subfalcate, tapering to a minute apical spine, decurrent at the base, with flat margins, 18-25 cm. long, about 8 mm. wide.

Male cones cylindric-ovoid, yellowish or reddish yellow, about 40 cm. long and 15 cm. in diameter, short stalked. Microsporophylls deltoid-clavate, abruptly acuminate, 4 cm. long, 2.5 cm. in diameter, the apex much thickened and bearing a terminal, spine-like, ascending point about 4 cm. long; the exposed parts tomentose. Megasporophylls about 15 cm. long, yellow villous, petiole and fertile portion about 7.5 cm. long, with 2 or 3 pairs of ovules above the middle; sterile blade broadly orbicular, long acuminate, about equal to the rest of the sporophyll in length, 6.5-8.5 cm. in width, the margin deeply subulate-pectinate with spiny teeth (the reduced pinnae) 2 cm. long, terminating in a point 3-4 cm. long with 1 or 2 spiny teeth. Seeds ovoid, orange-red or yellow, about 4 cm. long.

Geographic distribution: Nepal, eastern India, and Burma; Bengal, at 600 m. elevation; Assam; often in pine forests.

4. Cycas siamensis Miq.

Miquel, F. A. W., Bot. Zeit. 21:333 (1863); Regel, E., Illus. Hort. 28:157 (1881); Hooker, J. D., Flora Brit. India 5:657 (1890).

Stem an erect trunk up to 2 m. high, 20-26 cm. in diameter, abruptly widened at the base to a much greater diameter, surface rough and cracked in older plants. Leaves 0.6-1.2 m. long, shiny green above, paler beneath, pubescent when young. Petiole 45-65 cm. long, furrowed above, rather flat below, with distant recurved spines except in the lower part; rachis rounded below, rounded-angular above. Leaflets about 40-100 or more on each side, linear-lanceolate, subfalcate, acute, abruptly spinulose-mucronate, slightly attentuated at the base, decurrent, margins flat but slightly thickened, larger leaflets up to 20 cm. long and 5-7 mm. wide, upper and lower ones shorter; midrib prominent on both sides but thicker below.

Male cones oblong-oval, up to 30 cm. long, 6-8 cm. in diameter. Microsporophylls cuneate, 2-3 cm. long, about 2 cm. wide, narrowed to 5 mm. at the base; sterile area rhomboid, 6 mm. long, brown tomentose; apex fragile subulate, 10-14 mm. long, reflexed upward. Megasporophylls 5-7.5 cm. long, yellow tomentose, spatulate-obovoid below, with 1-3 ovules on each side. Sterile blade broadly ovate-rhomboid, long acuminate, equalling the rest of the sporophyll in length, up to 2.5 cm. wide, pectinate-pinnatifid, the reduced pinnae crowded, erect, up to 2 cm. long. Seeds semi-immersed in marginal pits, globose, yellowish, very smooth, 2.5-3 cm. in diameter; stony coat scarcely angled, shining yellow.

Geographic distribution: Thailand (Siam), abundant in dry woods, Pulocondor; Burma, abundant on plain beyond Ban-Meh-Wang, between Lakon and Phre, at Pang Pooey; also in Cochin China.

Closely related to C. pectinata Griff.

5. Cycas micholitzii Dyer

Dyer, W. T. T., Gard. Chron. 38:142 (1905); Fedde, F., Rep. Nov. Spec. 1:171 (1907); Prain, D., Bot. Mag. 135: t. 8242 (1909).

Stem sometimes subterranean, 20-60 cm. high, 4-5 cm. in diameter or swollen at the base to 10-12 cm. Leaves 2 or 3 in a crown, 1-3 cm. long, erect, glaucous when young, becoming bright green and glabrous, paler beneath. Petiole up to 1 m. long, armed with short, rather flat spines. Leaflets about 15-20 on each side, 4 cm. apart, once or twice deeply and dichotomously incised, the segments linear-lanceolate, acuminate, 20-30 cm. long, 20-25 mm. wide.

Male cones narrow cylindric, gradually tapering to an acute apex, yellow, glabrous, 15-18 cm. long, 4 cm. in diameter; peduncle 3 cm. long. Microsporophylls subspatulate or broadly cuneate, orange at the margin, 10 mm. long, 8 mm. wide, the sterile part 8 mm. long, very shortly acuminate. Microsporangia in sori of 3 or 4. Megasporophylls 8 cm. long, orange at base; ovules 1-4; sterile blade green, ovate-rhomboid, about the same length as the rest of the sporophyll, 3 cm. wide, deeply pectinate, the reduced pinnae erect, subulate, 1.5-2.5 cm. long. Seeds green, becoming yellowish, about 2.5 cm. long.

Geographic distribution: Annam, Indo-China. Related to C. pectinata Griff. and C. siamensis Miq., differing from them in having forked leaflets and a very short or obsolete acumen on the microsporophylls instead of a long slender one.

6. Cycas wadei Merr.

Merrill, [F. D.,] Philippine Jour. Sci. 60:233 (1936).

Stem up to 5.3 m. high, usually much shorter, in many mature plants less than 1 m. high, often branched, 30–48 cm. in diameter at the swollen base, rather rapidly and then gradually tapering to 10–20 cm. below the crown of leaves. Leaves numerous, about 75 cm. long, glabrous when mature. Petiole about 20 cm. long, with two rows of short spines about 1.5 mm. long; rachis rounded and smooth on lower surface, blunt-angled on upper surface. Leaflets about 90 on each side, rather crowded, rigid, linear to linear-lanceolate, straight or somewhat falcate, sharply acuminate, base slightly narrowed, margins flat, not at all revolute, 15–20 cm. long, 4–5 mm. wide, the uppermost and lowest 8 cm. long, with no transition into petiolar spines.

Male cones cylindric, somewhat narrowed below, more strongly tapering above, 40–70 cm. long, 9–10 cm. in diameter. Microsporophylls somewhat rhomboid, tapering below to a narrow stalk, about 3 cm. long, 1.5–2 cm. wide, apex truncate, glabrous above, exposed portion puberulent, strongly ascending, the sterile tip 5–6 mm. long, rounded to acute or to somewhat acuminate. Megasporophylls up to 22 cm. long, rather densely ferruginous-pilose, the petiole and fertile portion about 15 cm. long, 1 cm. wide, with mostly 2 ovules. Sterile blade ovate, up to 10 cm. long and 8 cm. wide, pectinate-pinnatifid, the reduced pinnae about 15 on each side, usually ascending, linear, sharp-pointed, rather rigid, pubescent and below glabrous above or entirely glabrous, up to 3.5 cm. long, the tip of the sterile blade usually long-acuminate, with few, gradually shorter, ascending lobes or the uppermost ones reduced to teeth only 1–2 mm. long. Seeds ovoid to ellipsoid, not flat-

tened, brown, glabrous, shining, rather obscurely and minutely apiculate, 3.2–4 cm. long, 2.5–3 cm. in diameter. Stony coat pale, somewhat shining, 9–15-ribbed.

Geographic distribution: Known only from the small island of Culion, in the Philippines. The above account is taken from Merrill's very complete description.

7. Cycas undulata Desf.

C. tonkinensis Hort.

Desfontaines, R. L., Catal. Hort. Paris (1820); Gaudichaud, C., in Freycinet's Voy. Bot., p. 434 (1826); Miquel, F. A. W., Prodr. Syst. Cycad. 7, 17 (1861); Linden, L., and Rodigas, E., Illus. Hort. 32:27 (1885).

Stem, slender, erect, cylindric. Leaves about 15 in a crown, about 2 m. long, bright green and glabrous. Petiole about 1 m. long and 2 cm. in diameter, broadened to 4.5 cm. in diameter at base; rounded below, bluntly triangular above with two grooves at the sides, bearing sharp spines throughout its length. Rachis about 1 m. long, rounded below, somewhat more sharply angled above than the petiole, with two grooves at the sides. Leaflets 100 or more on each side, opposite or nearly so, linear-lanceolate, acuminate, pungent, upper margin narrowed at the base almost to the midrib, lower margin decurrent, often twisted at the base, undulate along the margins; largest leaflets up to 36 cm. long and 18 mm. wide, the uppermost 12-14 cm. long and 10-20 mm. wide, the lowest 16-18 cm. long and 12-13 mm. wide.

Male cones not available. Megasporophylls very numerous, 6-7 cm. long, the group before spreading about 10 cm. in diameter. Petiole 2.5 cm. long; rachis bearing one ovule on each side, the terminal blade oval, tomentose, about 1.5 cm. long and 1 cm. wide exclusive of the 5-7 reduced pinnae, which are linear-lanceolate, pungent, and up to 2.5 cm. long. Seeds nearly spherical, light yellow, very smooth, about 3 cm. in diameter.

Geographic distribution: In the vicinity of Tonking, China. Said to be abundant on the Marianna Islands. Chiefly known in cultivation. Descriptions in the literature are very incomplete. The foregoing account is based on several specimens in the Phipps Conservatory, Pittsburgh, Pennsylvania, U. S. A.

8. Cycas beddomei Dyer

Dyer, W. T. T., Trans. Linn. Soc., ser. 2, Bot. 2:85 (1883); Hooker, J. D., Flora Brit. India 5:658 (1890).

Stem very short, only about 6 cm. or less in height. Leaves about 1 m. long. Petiole about 15 cm. long, strongly quadrangular, minutely spiny in upper one-third, tomentose at base; rachis subquadrangular. Leaflets linear, spinose acuminate, margins strongly revolute, 12-18 cm. long and 3 mm. wide; midrib prominent below.

Male cones oblong-ovoid, about 30 cm. long and 7 cm. in diameter, very short stalked. Microsporophylls oblong-deltoid, long acuminate, 18-20 mm. long, 10 mm. wide, the sterile tip strongly deflexed in upper half of cone, ascending near base of cone, fuscous pubescent, becoming somewhat glabrous. Megasporophylls long-ligulate, slender, 15-20 cm. long, ferruginous pubescent, bearing 2 ovules on each side above the middle. Sterile blade ovate-lanceolate, about 8 cm. long and 2 cm. wide, tapering into a long acuminate point, deeply laciniate, the reduced pinnae 7-10 mm. long and sharp-pointed. Seeds globose, sometimes slightly compressed, 4 cm. in diameter.

Geographic distribution: Southern India—Madras, abundant on the hills. Although it resembles C. revoluta in several respects, this species is regarded by Dyer as "a very reduced form of C. circinalis."

9. Cycas chamberlainii Brown and Kienholz

Brown, W. H., and Kienholz, R., Philippine Jour. Sci. 26:47 (1925).

Trunk slender, seldom branched, reaching a height of about 8 m.; when 1 m. high, diameter of stem 9-10 cm., becoming 15-20 cm. in larger specimens. Leaves 1-1.6 m. long, nearly glabrous or sparingly brown hairy on underside, densely hairy on both sides at base of leaflets. Petiole 25-45 cm. long, with marginal spines 3 mm. long, densely brown hairy when young. Rachis 90-115 cm. long, subterete, somewhat flattened and [redacted], slightly grooved along the upper side, deeply grooved when dry, with prominent brown hairs, particularly along the sides. Leaflets 80-95 on each side, opposite or alternate, slightly oblique, falcate, gradually tapering to a sharp but not spiny point, base decurrent almost or quite to next leaflet below, margin revolute only in dried specimens; 20-30 cm. long, 9-11 mm. wide.

Male cones ovoid, rounded at the apex, 13 cm. long, 8 cm. in diameter. Microsporophylls cuneate, edges slightly concave, 3.5 cm. long, 1.6-2 cm. wide, short-stalked, smooth above except at the tip, which is densely brown tomentose; terminating in an erect slender spine about 1 cm. long. Megasporophylls 15-22 cm. long, densely brown tomentose. Petiole obscurely 4-6-angled, flattened, 1.5-[illegible] cm. wide just below the basal pair of ovules. Ovules 4-6, usually 6, crowded, usually opposite. Sterile blade broadly subdeltoid to ovate, usually strongly curved upward, 6-8 cm. long, 5.5-5 cm. wide, deeply laciniate, with 4-10 spine-like pinnae on each side averaging 1.5-1.7 cm. long, and with a terminal spine 2-4 cm. long. Seeds ovoid, flattened, 4 cm. long, 3 cm. wide, 2.5 cm. thick; fleshy layer at top 3 mm. thick at side; stony layer about 1 mm. thick.

Geographic distribution: Luzon, Philippine Islands--Pampanga Province, Mount Arayat. Brown and Kienholz, from whom the above account is taken, state that C. chamberlainii is very distinct from C. rumphii, the common lowland species in the Philippines, in its much shorter and differently shaped megasporophylls and in the small size of the male cone, but particularly in the slender trunk and in the seed characters. The seed of C. chamberlainii is much smaller than that of C. rumphii and is obovoid rather than ellipsoid.

10. Cycas circinalis L.

Linnaeus, C., Spec. Plant., 1st ed., p. 1188 (1753); Hooker, W. J., Bot. Mag. 55: t. 2826, 2827 (1
Miquel, F. A. W., Monogr. Cycad., p. 27 (1842), Prodr. Syst. Cycad. 7, 17 (1861); Hooker, J. D., Flora Brit. India 5:656 (1890).

Stem in largest plants 5-7 m. high and 25-40 cm. in diameter, very seldom branched. A plant 25 years old, with a stem 1 m. high and 20 cm. in diameter, will have reached the coning stage. Leaves 15-20 in a crown, 2-3 m. long, bright green above, paler beneath, glabrous. Petiole 60-70 cm. long, rounded below, bluntly triangular above between two rows of sharply deflexed spines, these 2-3 mm. long, unarmed below. Rachis 1.5-2.5 m. long, rounded below, bluntly triangular above. Leaflets 90-120 on each side, opposite or alternate, arising at a slight angle from the rachis, linear-lanceolate, usually subfalcate but often nearly straight especially in the upper part of the leaf, acuminate, narrowed at the base and strongly decurrent to the next leaflet below, margins flat or scarcely revolute; larger leaflets 20-30 cm. long and 9-13 mm. wide, upper and lower ones about 12 cm. long and 10 mm. wide.

Male cones cylindric-ovoid, tapering above, yellowish, 60-70 cm. long, 15-18 cm. in diameter; peduncle 5-7 cm. long. Microsporophylls obovate-deltoid, long acuminate, 4-5.3 cm. long, with a slender upturned tip about 2.5 cm. long; exposed part densely tomentose with short brown hairs. Microsporangia 600-800, in sori of 3 or 4, occasionally 5, covering the entire lower surface except a sterile notch at the apex. In cones 60 cm. long from young plants, microsporangia less crowded and fewer (200-400) and in very distinct sori.

Megasporophylls 15-20 in a crown, lanceolate, 25-30 cm. long, densely tomentose with short yellowish brown hairs, green upon removal of hairs. Petiole 10-20 cm. long, tetragonal; rachis about

15 cm. long, broadly quadrangular, with 3 or sometimes 4 ovules on each side. Sterile blade above the ovules ovate-lanceolate, acuminate, about 4 cm. wide, its pinnae reduced to small spinose teeth. Seeds ovoid, bilateral, somewhat flat, orange-red, glabrous at maturity, up to 7 cm. long, larger diameter up to 5.2 cm., shorter diameter up to 4.7 cm., the fleshy coat up to 4 mm. thick. Stony coat smooth, flat at the bottom, sharp-pointed, with two median ridges at the sides prominent above and less so below.

Geographic distribution: Ceylon, southern India, Sumatra, Java, Borneo, and probably on many islands north of Australia. Plants mistaken for this species or regarded as varieties of it have increased the range. Probably the most variable of all species of Cycas, with some variants described as species and some real species described as variants.

11. Cycas thouarsii R. Br.

C. madagascariensis Miq.

Brown, R., Prodr. Fl. Nov. Holl. 1:347, sine descrip. (1810); Miquel, F. A. W., Comment. Phytogr., p. 127 (1840), Monogr. Cycad., p. 32 (1842), Linnaea 17:699 (1843), Prodr. Syst. Cycad. 7, 17 (1861); Stapf, O., Kew Bull., p. 1 (1916); Prain, D., Flora Trop. Africa 6:345 (1917).

Stem 4-6 m. high, about 45 cm. in diameter, sometimes branched when old. Leaves 1.5-3 m. long, bright green above, paler beneath, glabrous. Petiole 1-1.5 m. long, subterete, spiny above, glabrous; rachis convex below, caniculate above. Leaflets 60-70 on each side, linear-lanceolate, subfalcate, acute, slightly narrowed and decurrent at the base, margins flat; 20-30 cm. long, 9-13 mm. wide. Male cones ovoid-cylindric, brown, 30-40 cm. long, 12-17 cm. in diameter; peduncle less than 5 cm. long, slightly pubescent. Microsporophylls obovate-deltoid, truncate, 5-7 cm. long, with a strongly upturned hook-like beak up to 2 cm. long, the exposed portion reddish tomentose. Microsporangia in sori of 3 or 4. Megasporophylls spatulate, 20-30 cm. long, covered with a rusty-yellow tomentum, ovules 4 or 5 on each side. Sterile blade flat, ovate-lanceolate, acute, 8-10 cm. long, 2-3 cm. wide, scarcely wider than the fertile portion, the margin crenulate or subentire. Seeds globose, slightly compressed, red, 5-6 cm. long, 4.5 cm. in diameter.

Geographic distribution: Eastern and northwestern coastal regions of Madagascar. Also in Comoro Islands and on Zambezi Delta, where its introduction was probably due to human agency. This species is doubtfully distinct from C. circinalis L. and by some authors is regarded as a variety or geographical form of it. Prain, however, regards it as more nearly allied to C. rumphii Miq.

12. Cycas rumphii Miq.

Miquel, F. A. W., Bull. Sci. Phys. et Nat. Néerl. 2:44 (1839), Monogr. Cycad., p. 29 (1842), Prodr. Syst. Cycad. 7, 17 (1861); Hooker, J. D., Flora Brit. India 5:657 (1890).

Stem up to 6 m. or more in height and often much branched. Leaves 1-2 m. long, dark glossy green. Petiole obtusely triangular, with small spines 2-3 mm. long; rachis subterete. Leaflets 50-100 on each side, opposite, linear-lanceolate, subfalcate, with subacuminate pungent apex and decurrent base, margins flat or slightly revolute, 20-30 cm. long, 14-20 mm. wide, midrib prominent on both sides.

Male cones long ovoid, reddish tomentose, short stalked. Microsporophylls cuneate, short acuminate, 3.5-5 cm. long, thickened and obliquely truncate at the apex, with a short upturned and sometimes cauducous point about 1 cm. long. Megasporophylls long spatulate, about 30 cm. long, narrower than in C. circinalis, rusty tomentous, with 3-5 ovules; sterile blade ovoid-rhomboid, minutely spinose-toothed above, entire below, rather abruptly acuminate. Seeds ellipsoid or subglobose, somewhat flattened, orange, 5-7 cm. long, 4-4.5 cm. in diameter.

Geographic distribution: Moist wooded regions of Burma, Ceylon (possibly introduced), Andaman Islands, Nicobar Islands, Malay Archipelago, New Guinea, Amboina, Philippine Islands, and northern Australia (York Peninsula). Closely related to C. circinalis L., but distinguished by its shorter leaves, wider leaflets, truncate short-pointed microsporophylls, and narrower megasporophylls with fewer and shorter teeth. C. riuminiana Porte, from the Philippine Islands, has been reduced by E. R. Merrill, in Philippine Bur. Sci. Publ. 18, 1:1 (1921), to C. rumphii Miq., the common lowland species. The original description of C. riuminiana by Regel in Gartenfl. 12:16 (1863), based on sterile specimens, mentions no characters by which it may be distinguished from C. rumphii Miq. or from C. chamberlainii Brown and Kienholz.

13. Cycas media R. Br.

Brown, R., Prodr. Fl. Nov. Holl. 1:348 (1810); Miquel, F. A. W., Monogr. Cycad., p. 26 (1842), Prod. Syst. Cycad. 7, 16 (1861); Bentham, G., Flora Austral. 6:249 (1873); Mueller, F. von, Fragm. Phytog. Austral. 8:171 (1874); Bailey, F. M., Queensl. Flora 5: 1501 (1902); Gardner, C. A., Kimberley Div. West. Austral., Forests Dept. Bull. no 32:31 (1923).

Stem in large plants 2-3 m. high, 20-30 cm. in diameter, sometimes reaching a height of 4-6 m. and a diameter of 40-45 cm.; seldom branched; armor of leaf bases disappearing in very old plants. Leaves 10-15 in a crown, up to 20 in very large plants, 80-120 cm. long, pubescent at first, becoming glabrous. In plants 1-1.5 m. tall petiole about 20 cm. long, the lower 5-6 cm. free from spines, from that point to the rachis abruptly spiny, the spines 3-6 mm. long and very sharp. In plants 3 m. tall the spiny condition much reduced, and in plants 4-5 m. tall the petiole often spineless. Petiole rounded above and below, densely tomentose with short reddish hairs which easily rub off, base abruptly spreading. Rachis 60-100 cm. long, rounded above and below, tomentose in patches on the upper surface even in old leaves, glabrous below. Leaflets 60-100 on each side, occasionally more, mostly opposite or nearly so, narrowly linear-lanceolate, straight or subfalcate, pungent, upper margin narrowed at the base nearly or quite to the midrib, lower margin decurrent to the next leaflet below especially in the upper part of the leaf, margin flat; largest leaflets 10-20 cm. long and 6-7 mm. wide, the lowest pair about 4-6 cm. long and 4-5 mm. wide, often reflexed, the upper ones sometimes abortive; base tomentose below with short reddish hairs; midrib prominent on both sides.

Male cones ovoid or ovoid-cylindric, yellowish, 15-30 cm. long, 10-15 cm. in diameter. Microsporophylls cuneate, 3.5-5 cm. long, 1.5-2 cm. wide, short stalked, abruptly narrowed at the apex and ending in a sharp incurved point, covered with a dense yellow tomentum. Microsporangia 600-800, mostly in sori of 3 or 4, covering the entire lower surface except a sterile notch at the apex. Megasporophylls 20-30 cm. long, light yellowish brown, densely tomentose. Petiole usually longer than the rachis. Ovules most commonly 3 on each side, sometimes 4, rarely 2 or 5, the sterile blade above the ovules rhomboid, about 7 cm. long including the terminal spine, 3.5 cm. wide including the reduced spiny-tipped pinnae, the longest of which are 15-18 mm. in length.

Seeds bilateral, nearly round in broader diameter, oval in shorter diameter, brownish yellow, glabrous, 4.5-5 cm. long, 4.2-4.5 cm. in longer diameter, 3.5-4.2 cm. in shorter diameter. Stony coat smooth, obovoid, 4.5 cm. long, longer diameter 3 cm., shorter diameter 2.7 cm., tapered abruptly at the bottom to a stalk-like thickening about 2 mm. long, with a sharp point about 1 mm. long at the apex, and with a groove along each side where the stony coat splits at germination.

Geographic distribution: Queensland and Western Australia. In Queensland very abundant at Frenchman's Creek, near Rockhampton; Burnett and Dawson Rivers; Cape Upstart; Rockingham Bay and Mount Elliott. In Western Australia, common around Camden Sound in the Kimberley district, where it forms a conspicuous feature of the woolly-butt forest. At a short distance, three other Australian species of Cycas—C. kennedyana, C. normanbyana, and C. cairnsiana—look like C. media.

14. Cycas lane-poolei Gardner

Gardner, C. A., Kimberley Div. West. Austral., Forests Dept. Bull. no. 32:30 (1923).

Stem an erect trunk 3-3.6 m. high, 15-23 cm. in diameter. Leaves 60-75 cm. long, drooping, dark green above, paler beneath, glabrous. Petiole 23-30 cm. long, 6-8 mm. in diameter, armed with stout spines 4 mm. long, arranged alternately through their entire length. Leaflets numerous, linear, straight, acuminate with yellowish brown tips, upper ones decurrent to next leaflet below, lower not at all or only slightly decurrent, flat, 10-13 cm. long, 6-11 mm. wide, the midrib very conspicuous.

Male cones not available. Megasporophylls about 20 cm. long and 13 mm. wide, petiolate, flattened, quite glabrous, usually bearing 2 ovules on each side above the middle; sterile blade ovate-triangular, 4.4 cm. wide, with two auricles or basal lobes, the margin and apex toothed with sharp pungent spines; apex 5 cm. long. Seeds ovoid-globular, yellowish green, hard and glabrous, covered with a glaucous powder when young, 5,7 cm. long, 5 cm. in diameter.

Geographic distribution: Kimberley district of Western Australia, northeast of Mount Hann, near the source of the Moran River; on rising ground in sandy soil, forming open forests with Eucalyptus latifolia and E. spenceriana.

15. Cycas furfuracea Fitzgerald

Fitzgerald, W. V., Jour. and Proc. Roy. Soc. West. Austral. 3:108 (1916-17); [illegible]

Stem an erect trunk 1.2-1.8 m. high. Leaves 60-75 cm. long, glabrous above, furfuraceous below: Petiole spiny in upper half; rachis glabrous. Leaflets numerous, rigid, linear, straight, pungent, not decurrent, margin somewhat revolute, occasionally bifid; up to 15 cm. long, 6 mm. wide, the lowest gradually smaller and passing into spines. Male cones narrow ovoid-deltoid, about 38 cm. long and 7.5 cm. in diameter, short stalked. Microsporophylls up to 2.5 cm. long and 1.2 cm. wide, terminating in stout, obtuse, upward curved point 8 mm. long, the lower surface tomentose. Megasporophylls 15-20 cm. long, densely ferruginous-tomentose. Ovules 1 or 2 on each side above the middle, the sterile blade ovate, 2.5-3 cm. wide, prominently spinose-toothed and terminating in a slender, obtuse, glabrous apex 2.5-4 cm. long. Seeds globose, yellow, about 3 cm. in diameter.

Geographic distribution: Kimberley Division, Western Australia—top of King Leopold Range; Mts. Herbert, Broome, and Bold Bluff; in sandy soil among sandstone and quartzite rocks. Related to C. media R. Br.

16. Cycas basaltica Gardner

Gardner, C. A., Kimberley Div. West. Austral., Forests Dept. Bull. no. 32:31 (1923).

Stem a stout erect trunk 1-2.5 m. high, swollen at the base to 60 cm., otherwise 45 cm. in diameter, rough and dark gray. Leaves up to 1.2 m. long, hoary tomentose when young, becoming glabrous with age. Petiole up to 20 cm. long with a concave base, spines not evident on mature leaves but a few on young leaves. Rachis convex or with a prominent ridge or angle above, narrower than the lower side, which is quite invisible from above. Leaflets numerous, linear, rigid, mucronate, the upper ones decurrent to the next leaflet below, the lower ones distant and scarcely or not at all decurrent, margins sometimes slightly revolute. ♂ Male cones narrow conical, the microsporophylls narrow cuneate with incurved points; microsporangia covering the sporophyll from the base to its incurved portion. Megasporophylls petiolate, densely ferruginous tomentose, usually with 4 ovules; sterile blade lanceolate, entire, with an acuminate apex ending in a rigid glabrous pungent point. Seeds globular, very slightly depressed, hard and glabrous, glaucous when young.

Geographic distribution: Western Australia—basalt hills near the Lawley River; in open forests of Eucalyptus foelscheana and E. spenceriana. Closely related to C. media, but the leaflets and megasporophylls are different; also related to C. cairnsiana, from which it differs chiefly in the number of ovules.

17. Cycas kennedyana F. Muell.

Mueller, F. von, Melbourne Chemist and Druggist (1882); Bailey, F. M., Queensl. Flora 5:1502 (1902).

Stem an erect trunk up to 4.5 m. high and 30 cm. in diameter, rarely branched in older plants. Leaves 20-30 in a crown, the larger ones 1-2 m. long, somewhat flexuous in the upper part, bright green above, somewhat paler below, glabrous. Petiole smooth or with a few spines in the upper part; rachis keeled below. Leaflets 100 or more on each side, opposite or alternate, broadly linear, acute and somewhat pungent, lower margin of upper ones decurrent, nearly flat, the larger ones 15-20 cm. long and 10-15 mm. wide, the lowest only one-half as long.

Male cones ovoid-ellipsoid, brownish yellow or somewhat fuscous woolly, up to 30 cm. long and 12 cm. in diameter, the peduncle about 3 cm. long. Microsporophylls narrowly cuneate, about 3.5 cm. long, 13-20 mm. wide, truncate, velvety downy. Microsporangia very numerous, in sori of 3 or 4, covering the entire unexposed lower surface of the sporophyll. Megasporophylls 20-25 in a cluster, 10-25 cm. long, velvety downy. Petiole rather long, ovules nearly always 2 on each side, the sterile blade above the ovules rhomboid, 10-18 mm. wide, with leaflets reduced to little more than serrations. Seeds globular, brown slightly tinged with orange, glabrous, 3.5-4.5 cm. long, 2.5-2.7 cm. in diameter. Stony coat bilateral with a strong line from apex to base on each side along which the coat splits at germination, 3.3-4 cm. long.

Geographic distribution: Queensland, Australia—Normanby Ranges near Port Denison.

[illegible] F. v. Mueller, descr. and compar. with Australasian Supplement (Chemist and Druggist) 5 (47): 55 (1882)*; Bailey, F. M., Queensl. Flora 5: 1502 (1902).

---

* Reference completed through the assistance of Mr. A. W. Jessep, Director and Government Botanist, Melbourne Botanic Gardens and National Herbarium, South Yarra, S.E.1., Australia.

Standardized Feb. 8th, 1949.

18. Cycas cairnsiana F. Muell.

Mueller, F. von, Fragm. Phytogr. Austral. 10:63, 121 (1876); Bailey, F. M., Queensl. Flora 5:1502 (1902).

Stem stout, often 4-5 m. high and 40-50 cm. in diameter, frequently spreading somewhat at the base.[1] Branching plants

[1] Among many large specimens south of Cairns, Queensland, I did not see any which even approached the 1.5 m. base diameter and the 90 cm. diameter at the top cited in Schuster's monograph in Das Pflanzenreich. Mueller gives the circumference at the base as 5 feet and at the summit as 3 feet.

are not rare. Leaves 1-1.5 m. long, pale glaucous green on both sides. Base of petiole slightly pubescent, sparingly spinescent in upper part. Leaflets narrowly linear, narrowed at the apex to a pungent point, the lower margin decurrent, the upper scarcely narrowed, margins revolute; 16-18 cm. long, 4 mm. wide; midrib strongly prominent beneath. In seedlings lowest leaflets only slightly smaller than the rest, rachis often ending in a terminal leaflet; longest leaflets 12.5 cm. in length and 8 mm. in width.

Male cones up to 38 cm. long and 8 cm. in diameter; peduncle about 2 cm. long. Microsporophylls cuneate, truncate, 2.5 cm. long, 8.5 mm. wide, the fertile part scarcely longer than the sterile, ending in an upturned triangular apex tipped by a beak about 4 mm. long. Microsporangia small and nearly covered by tomentum. Megasporophylls up to 35 cm. long, the petiole about 20 cm. long. Middle portion bearing one ovule on each side, the sterile blade rhomboid-lanceolate, 4 or 5 times as long as wide, the margin slightly dentate. Seeds bilateral, ellipsoid, shiny brown, 3.7 cm. long; stony coat 3.5-3.8 cm. long, larger diameter 2.6-2.7 cm., smaller diameter 2.4-2.5 cm., narrowed to a stalk-like base 4-5 mm. long, with a small spine up to 1 mm. long at the apex and with two

strong lines at the sides along which the seed splits at germination.

Geographic distribution: Queensland, Australia; abundant near Cairns, Newcastle Range, Robinson and Percy Rivers.

19. Cycas normanbyana F. Muell.

Mueller, F. von, Fragm. Phytogr. Austral. 8:169 (1874); Bailey, F. M., Queensl. Flora 5:1502 (1902).

Stem an erect trunk 1.8-3 m. high, occasionally up to 4 m., often conspicuously thickened at the base. Leaves in a dense crown, 1-1.7 m. long, shiny green on the upper side, dull below. Petiole with short distant spines about 2.5 cm. long; rachis tetragonal in the lower portion, becoming semi-terete higher up. Leaflets numerous, opposite, mucronate, the larger ones 20 cm. long, 5-6 mm. wide, gradually shorter toward the apex and base; midrib prominent beneath.

Male cones ellipsoid-cylindric, 30-35 cm. long, 12 cm. in diameter; peduncle about 2 cm. long. Microsporophylls narrowly cuneate, 2-6 cm. long, 10-12 mm. wide, the upper sterile part deltoid, about 1 cm. long, ending abruptly in a thickened beak 2-6 mm. long, tomentose below. Megasporophylls 15 cm. long, nearly always with 2 ovules. Sterile blade scarcely wider than the fertile part, narrowly lanceolate, 4-7 cm. long, 8 mm. wide, with a crenate-serrate margin. Seeds orange, 2.5-3.7 cm. long; stony coat slightly carinate above.

Geographic distribution: Queensland, Australia; near Port Denison and Port Darwin.

2. STANGERIA T. Moore

Moore, T., in Hooker's Jour. Bot. 5:228 (1853); Miquel, F. A. W., Prodr. Syst. Cycad. 7-8, 17-18 (1861); De Candolle, A., Prodr. 16[2]:529-530; Schuster, J., Pflanzenreich 4[1]:103-105 (1932).

Stem tuberous and subterranean, branched or unbranched, up to 30 cm. long, without any armor of leaf bases. Leaves few, appearing singly or several in a year, 0.5-1 m. long; petiole unarmed. Leaflets long lanceolate; entire, serrate, or deeply incised; with a strong midrib and fine side veins almost perpendicular to it, these once or rarely twice dichotomous, a few anastomosing. Vernation inflexed or somewhat circinate.

Male cones usually single but occasionally 2 or 3 together, cylindric, tapering to the apex, long stalked. Microsporophylls broadly cuneate, subsessile, somewhat rounded below and slightly pointed above, the lower surface covered with microsporangia. Female cones single, ovoid-cylindric, long stalked. Megasporophylls unequally peltate, somewhat elongated and thin above. Seeds dark red.

A monotypic genus confined to the eastern coastal region of South Africa. Named for Dr. Stanger, Surveyor General of Natal, who sent specimens of the plant to England in 1851. With respect to the venation of its leaflets, in which it is unique, Stangeria is the most fern-like of all cycads. In fact it was described originally as a species of Lomaria, one of the Polypodiaceae, and the mistake was not corrected until the cones were discovered.

1. Stangeria paradoxa T. Moore

S. eriopus (Kunze) Nash

Kunze, G., Linnaea 13:152 (1839) and 18:116 (1844); Moore, T., in Hooker's Jour. Bot. 5:228 (1853); Hooker, J. D., Bot. Mag. 85: t. 5121 (1859); Pearson, H. H. W., Trans. So. Afr. Phil. Soc. 16: 349-351 (1906); Nash, G. V., Jour. New York Bot. Gard. 10:164 (1909); Chamberlain, C. J., Bot. Gaz. 61:353-372 (1916); Hutchinson, J., and Rattray, G., Flora Capensis 5 (Suppl.):25-27 (1933).

Stem tapering toward the bottom, more or less rounded at the top, often branching near the base but seldom higher up, up to 30 cm. in length and 10 cm. in diameter, smooth. Leaves seldom more than 3 in any one year, often only 1 or 2, but more numerous when the stem branches and each axis bears leaves; bright green, tomentose when young, becoming glabrous. Petiole equal to or exceeding the rachis in length. In damp shady places and in greenhouses petiole often 60 cm. long and rachis up to 50 cm., but on the grass veld commonly only half as long. Petiole smooth and terete or subterete; rachis smooth, rounded below and nearly flat above (deeply grooved in dried specimens). Leaflets up to 20 pairs in the bush veld but usually only 12-14 pairs, in the grass veld 9-12 pairs; opposite or subopposite, long lanceolate, acute or rounded at the apex; entire, irregularly finely or coarsely serrate or, in rare cases, so deeply incised as to be almost bipinnate; up to 40 cm. long and 6 cm. wide. Lower leaflets with petiolules up to 5 cm. in length, upper leaflets connate, with the lower border strongly decurrent in the upper two or three pairs and less decurrent below until the condition disappears.

Male cones cylindric, ~~solitary~~, brownish, woolly at first, becoming glabrous, up to 17 cm. in length and 4 cm. in diameter, with a peduncle up to 10 cm. long. Outer surface of microsporophylls rhomboid or

somewhat hexagonal, 1.5–2 cm. wide, the upper outer face thin and pointed, the lower blunt. Microsporangia about 200 in the largest cones and 130 in the smallest, mostly single, not divided into two groups by a sterile line. Female cones solitary or several together, densely tomentose, up to 22 cm. long and 8.5 cm. in diameter. Megasporophylls unequally peltate, the upper border rounded, slightly pointed, and tapering to a thin edge, the lower part more or less growing over the ovules; larger sporophylls 4–4.5 cm. wide. Seeds broadly ellipsoid, about 3.5 cm. long; stony layer 2.5 cm. long, 1.5 cm. wide, with a thin sharp ridge at the base, a feature which distinguishes it from all other cycads. Fleshy layer usually with 8 bundles.

Geographic distribution: Abundant on the grass veld in the Ngoye region of Zululand and extending south through Natal to the Kowie River, Bathurst Division. Very abundant in the forests around Manubie, Kentani, in the Transkei, and only less abundant on the grass veld near East London. Throughout its range, occupying a narrow strip along the coast.

Rattray found Stangeria near Port Elizabeth and gives that as its western limit. I hunted for days at van Staadens, near Port Elizabeth, in what seemed to be favorable localities, with many plants of Encephalartos longifolius, but did not find a single plant of Stangeria.

Stangeria grows on the grass veld under conditions so dry that it might be called xerophytic, and in the bush veld under conditions ranging from drier mesophytic to almost hydrophytic. The plants seem very responsive to ecological conditions and the typical forest form looks so different from the grass form that at least two species would be recognized were it not for the numerous intergrades indicating a single polymorphic species. The original description was based

on the forest form, in which the petiole is nearly terete, the rachis somewhat flattened above, the apex of leaflet acute or even acuminate, its margin flat and serrate, and the upper margin of the sporophyll acute. The grass form has the petiole slightly flattened and the rachis grooved on the upper surface, the apex of leaflet rounded or obtuse, its margin entire and revolute, and the upper margin of the sporophyll usually rounded.

I studied Stangeria at various places from the Ngoye region of Zululand down to East London, observing it both in the forest and on the grass veld. There appeared to be only one polymorphic species. I dug up several plants at East London and sent them to Chicago, where they have survived for thirty years. The leaflets are now flat and serrate, with acute apices, and one plant has leaves as large as I have ever seen in the forest.

Stangeria was first collected by Drege and von Gueinzius at Port Natal and determined as Lomaria coriacea (Linnaea 10:506, 1836). Later Kunze named it Lomaria eriopus (Linnaea 13:152, 1839), but without giving a description. Therefore the name Stangeria paradoxa Hook. f. must remain.

3. BOWENIA Hook. f.

Hooker, J. D., Bot. Mag. 89: t. 5398 (1863) and 98: t. 6008 (1872); De Candolle, A., Prodr. 16^{2}:534 (1868); Schuster, J., Pflanzenreich 4^{1}:85-86 (1932).

Stem tuberous and subterranean, globose or subcylindric, branched, up to 1 m. long, without an armor of persistent leaf bases. Leaves relatively few, 1-2 m. long, bipinnate or occasionally tripinnate; petiole unarmed. Leaflets lanceolate or subovate, entire or toothed, with "parallel" (dichotomous) venation. Vernation of the main rachis and rachis of the primary pinnae circinate, vernation of leaflets straight.

Male cones single on branches of the main stem, ovoid-cylindric, short stalked. Microsporophylls peltate, obovate-cuneate, truncate, subsessile, the lower surface covered with microsporangia from base to middle. Female cones single on branches of the main stem, broadly ovoid, very short stalked. Megasporophylls peltate, the top thickened, truncate, hexagonal. In both cones the sporophylls seem to be arranged in vertical rows. Seeds red.

Two species, confined to northeastern Queensland, Australia. Named for Sir George T. Bowen, the first governor of Queensland. Type species: B. spectabilis Hook. f. This is the only genus of Cycadaceae in which the leaves are more than once pinnate.

Key to the Species

I. Leaves few; primary pinnae 3-5, starting together at top of petiole; with 1 or 2 pairs higher up; leaflets entire; diameter of stem much less than its length . . 1. B. spectabilis

II. Leaflets more numerous; primary pinnae more or less paired along main rachis; leaflets serrate or serrulate; diameter of stem as great or greater than its length . . . . . 2. B. serrulata

1. Bowenia spectabilis Hook. f.

Hooker, J. D., Bot. Mag. 89: t. 5398 (1863) and 98: t. 6008 (1872); Mueller, F. von, Fragm. Phytog. Austral. 5:171, 215 (1866), Gartenfl. 27:314 (1878), 37:246 (1888); Bentham, G., Flora Austral. 6:254 (1873); Bailey, F. M., Queensl. Flora 5:1507 (1902); Schuster, J., Pflanzenreich 4[1]:85-86 (1932).

Stem much longer than broad, the length exclusive of the root and up to the top of the cone often reaching 40 cm.; surface of the stem usually warty. Branches from the top of the stem usually only 1-3. Leaves 1-4 on each branch of the stem; foliage display scanty as compared with that of B. serrulata. In open places leaves about 1 m. long, but in the shade along streams often reaching 2 m. Entire leaf dark green and glabrous. Petiole long and smooth, with a spreading base, when old breaking off cleanly by an abscission layer. Rachis bipinnate, nearly terete, usually with 3-5 primary pinnae starting in a cluster at the top of the petiole, with one or two distant ones on each side higher up, each primary pinna 30 cm. or more in length, with 9-12 more or less paired leaflets. Leaflets ovate or ovate-lanceolate, acute, obliquely cuneate at the base, short-petioled; margin entire with no serration except occasionally in seedlings and very young plants; 5-10 cm. long, 1.6-4 cm. wide; veins 15-20.

Male cones [redacted] oblong-cylindric, 4-5 cm. long, 2-2.5 cm. in diameter, short stalked or subsessile, with 6-8 vertical "rows" of microsporophylls, 8-9 in a row. Peltate top of microsporophyll transversely hexagonal, tomentose. Female cones ovoid, up to 15 cm. long and 10 cm. in diameter, with 8-9 vertical "rows" of megasporophylls, 6 in a row. Megasporophylls hexagonal at the top, rugose, with a sharp transverse ridge, the largest 4.5 cm. wide and 3 cm. high; peduncle 1-3 cm. or less in length. Seeds

broadly ellipsoid, about 2.5 cm. long and 2 cm. in diameter, occasionally with a short pseudo-stalk like that of Dioon, adhering in pairs to the sporophylls and the sporophylls to the rachis; fleshy coat 0.5 mm. thick. Stony coat ~~very thin,~~ about 0.3 mm. thick, very smooth; bundles 5-8, most commonly 6, hardly recognizable except in the upper part.

Geographic distribution: Originally discovered along the Endeavour River; Rockingham Bay, associated with Macrozamia denisonii; bushy hills near McKay River; summit of Mt. McAllister. Abundant at Babinda, south of Cairns; not reported as far south as Byfield.

2. Bowenia serrulata (André) Chamberlain

André, E., Illus. Hort. 26:184 (1879); Chamberlain, C. J., Bot. Gaz. 54:419-423 (1912); Lawson, A. A., Trans. Roy. Soc. Edinburgh 54:357-394 (1926).

Stem broader than long, up to 30 cm. in width, smooth, with 1-10 or more branches which in older plants may branch again. Leaves one or more on each branch, averaging 1.3 m. in length with many up to 2 m., dark green and glossy. Petiole up to 70-90 cm. long, definitely continued as a rachis giving off 3-5 pairs of primary pinnae, each bearing 6-16 leaflets. Leaflets sharply acuminate, obliquely cuneate at the base, short-petioled, margins sharply serrate except at the base; veins 20-30, with long slender fibers resembling veins between them.

Male cones oblong-cylindric, 6-7 cm. long, 3-5 cm. in diameter, with a fleshy peduncle 2-4 cm. long, with 8-13 vertical rows of microsporophylls, 8-10 in a row. Top of microsporophyll about 1.2 cm. broad and 5 mm. high, covered with globular glandular hairs. Microsporangia about 70-100, mostly single, covering more than one-half of the lower surface and without a sterile line dividing them into two groups. Female cones broadly ovoid, 7-10 cm. long. Seeds ellipsoid, 3.2 cm. long, 2.4 cm. wide; fleshy coat 2 mm. thick at base, elsewhere 1 mm. Stony coat about 0.5 mm. thick, very smooth; bundles 6-8, most commonly 7, hardly recognizable except near the micropyle.

Geographic distribution: Abundant at Byfield and Maryvale, Queensland, about 30 kilometers from Yeppoon.

Since I strongly object to founding new species upon trivial characters and have little respect for sub-species, varieties, and forms, it may be worth while to repeat and add somewhat to the

differences which entitle the Bowenia, so abundant around Byfield, to be regarded as a distinct species.

The two species differ decidedly in general appearance. B. serrulata has such abundant foliage that it is a conspicuous part of the underbrush in the prevailing Eucalyptus forest, while B. spectabilis, even where fairly abundant, is hardly noticable. In B. serrulata the petiole is more definitely continued as a rachis, giving off 3-5 pairs of pinnae; in B. spectabilis there are often 3-5 primary pinnae clustered at the top of the petiole, with 1 or 2 distant ones on each side higher up. While both conditions may be found in both species, the distinction is a valid one.

The entire or serrate character of a leaf margin is worthless as a diagnostic character in some plants, but very reliable in others. In Stangeria a leaflet may be so deeply incised as to be almost pinnate, with a strong vein running into the lobe and giving off side veins; while on the same plant other leaflets may be nearly entire. I have wandered through the Babinda region examining hundreds of plants of B. spectabilis without finding any spinulose leaflets except on seedlings. Around Byfield, among thousands of plants of B. serrulata, I did not see any with entire leaflets.

The stem is very characteristic. In B. spectabilis the stem is elongated fusiform, much longer than broad, and with sometimes up to five branches at the top; in B. serrulata it is spherical or turnip-shaped, usually broader than long, with 1-10 or more branches bearing the leaves and cones.

When I visited Babinda, the pollen had been shed and the ovulate cones were too small for diagnosis. When I visited Byfield, the pollen was nearly ready for shedding, a good stage for taxonomic

description, but the ovulate cones were hardly breaking through the bud scales. Consequently a first-hand comparative description of the cones is not possible.

The seeds of B. serrulata are larger, 3.2 cm. long and 2.4 cm. wide, while those of B. spectabilis are 2.5 cm. long and 2 cm. wide. In B. serrulata the average number of bundles is 7 and in B. spectabilis it is 6. The fleshy coat is thin in both species, but is twice as thick in B. serrulata as in B. spectabilis. The stony coat, while very thin in both, is slightly thicker in B. serrulata.

The fact that the two species are separated geographically is an additional reason for regarding them as distinct.

The two species are doubtless related, and, if one is the ancestor of the other, B. serrulata is probably the older. The several cycads the young plants have spinulose leaflets and the older plants entire leaflets. While the theory of recapitulation should not be pushed too far, in Bowenia it would make B. serrulata the ancestor and B. spectabilis the descendant.

4. DIOON Lindl.

Lindley, J., Bot. Reg. Misc. no. 82, append., p. 59 (1843); Lemaire, C., Illus. Hort. 2:91-94 (1855); Miquel, F. A. W., Prodr. Cycad. 10, 22 (1861); De Candolle, A., Prodr. 16^{2}:537 (1868); Standley, P. C., Contr. U. S. Nat. Herb. 23^{4}:48 (1920); Schuster, J., Pflanzenreich 4^{1}:124-128 (1932).

Stem a stout, unbranched, aerial trunk 1-3 m. high, rarely up to 16 m. (in D. spinulosum), with an armor of persistent leaf bases which is conspicuous down to the ground even in plants a thousand years old. Leaves many in a crown, 1-3 m. long; petiole unarmed except in D. spinulosum. Leaflets lanceolate or linear, rigid, entire or spinose-toothed, with the base as wide as the rest of the leaflet; venation "parallel" (dichotomous). Vernation of entire leaf perfectly straight.

Male cones solitary, mostly cylindric, sessile. Microsporophylls closely imbricate, flat, long, broadly cuneate from a narrow base, short stalked, the tip pointed or rounded. Microsporangia covering most of the lower surface, sometimes separated into two groups by a sterile middle line. Female cones solitary, ovoid or cylindric, very short stalked, the upper megasporophylls rather loose. Megasporophylls loosely imbricate, unequally peltate, broadly ovate or lanceolate, short stalked, the outer part rounded or acute above. During growth some of the ovules pull out parts of the sporophyll and appear to be stalked. Seeds white or cream-colored.

The genus includes at least 5 species and is probably confined to Mexico. Cultivated plants seem to be responsible for reports of a wider distribution. Lindley named the genus Dion, an impossible contraction derived from δις (two) and ωον (egg). Since all cycads except most species of Cycas have two ovules on each megasporophyll,

the name Dioon is not particularly appropriate. Type species: D. edule Lindl. Next to Cycas the megasporophylls are more leaf-like than those of other cycads and are grouped in a less compact cone.

Dioon is more widely distributed in Mexico than the records of ~~1910~~ 1909 indicate. Dr. J. N. Rose labeled specimens, most of them collected by Dr. C. A. Purpus, D. pinoi, D. madrense, ~~D. australis,~~ ~~D. pallida, and D. tellezii~~. He distributed leaves of some of these, but died before making any descriptions. He may have been waiting for more complete material. I have received rather complete material of D. madrense and some material of D. pinoi. The others should not be described until more material is available.

Key to the Species

I. Petioles without spines

A. Leaflets of adult plants entire; seeds with a narrow pit at the chalaza . . . . . 1. *D. edule*

B. Leaflets with 1 or 2 (sometimes 3) strong spines on the upper border and occasionally with 1 or 2 on the lower border; seeds with a narrow pit at the chalaza . . . . . 2. *D. purpusii*

C. Leaflets with 2 or 3 (sometimes 4) strong spines on the upper border and occasionally with 1 or 2 on the lower border; seeds with a broad pit at the chalaza . . . . . 3. *D. pinoi*

D. Leaflets in upper half of leaf with 1 or occasionally 2 sharp but weak spines on the upper border, very few or none on the lower border; seeds with a broad pit at the chalaza . . . . . 4. *D. madrense*

II. Petioles with spines; leaflets with 5–8 strong spines on the upper border and 4–7 on the lower border; seeds without a pit at the chalaza . . . . . 5. *D. spinulosum*

1. Dioon edule Lindl.

Lindley, J., Bot. Reg. Misc. no. 82, append., p. 59 (1843); Lemaire, C., Illus. Hort. 2:91-94 (1855); Miquel, F. A. W., Prodr. Syst. Cycad. 10, 22 (1861); Hooker, J. D., Bot. Mag. 101: t. 6194 (1875); Chamberlain, C. J., Bot. Gaz. 42:321-358 (1906) and 47: 215-236 (1909).

Stem stout, in larger plants commonly 1-1.5 m. tall and 20-30 cm. in diameter, sometimes reaching a length of 3 m. Stems of older plants leaning or prostrate, frequently with buds at base. Leaves 15-20 in a crown, rarely up to 35, very flat, rigid, about 1.6 m. long in plants with stems 30 cm. high, dark green, pilose when young, becoming glabrous. Petiole varying in length with age of plant, naked, without spines. In seedlings with 3 or 4 leaves petiole up to 30 cm. long; in plants 20 years old seldom reaching 20 cm. and usually not more than 10 cm. long. Rachis convex above, flat beneath. In plants with stems 30 cm. high leaflets about 120 on each side, up to 11 cm. long and 8 mm. wide, with 11-13 veins showing scarcely a single dichotomy beyond the base. In plants 1 m. or more in height largest leaflets reaching 18 cm. in length and 9 mm. in width. Leaflets linear-lanceolate, pungent, always paired, the upper pair connate throughout most of its length. Lower leaflets smaller than the others but not reduced to spines. Lowest leaflets longer in seedlings, usually half as long as leaflets in middle of leaf. In plants 20 years old lowest leaflets only 1 cm. long, next leaflets twice as long, the others increasing gradually up to the maximum length. Leaflets of older plants perfectly entire, those of seedlings with several spines near the tip, a condition which gradually disappears as the plant becomes older.

Male cones cylindric, 10–20 cm. long and 7–11 cm. in diameter just before shedding of pollen, when the length may become doubled. Microsporophylls apparently in vertical rows, although really strictly spiral in arrangement, cuneate, terminating in a sharp point which curves upward and is hairy on the exposed portion. Microsporangia averaging about 300, mostly in sori of 3 or 4, occasionally 5. Female cones ovoid, 20–30 cm. long, 10–20 cm. in diameter. Megasporophylls broadly lanceolate, acute, 10–20 cm. long, densely covered with light brown wool. Seeds white or cream-colored, averaging 3 cm. in length and 2 cm. in diameter, very smooth, with a narrow deep pit at the chalazal end. Diameter of pit variable, even in seeds from the same cone, as the following data show:

Source of seed	Number counted	Diameter range	Average diameter
Chavarrillo	15	1–4 mm.	2.2 mm.
Pascon	66	1–4 mm.	2.5 mm.
Huatusco	13	1.5–4.5 mm.	3.0 mm.
Tepatate	11*	1–5 mm.	3.9 mm.

*From the same cone

Geographic distribution: Abundant at Chavarrillo, near Jalapa, State of Veracruz, also at Palmar and Colorado and between these places, also at Huatusco; Pascon, in the mountains west of Tampico; Tepatate, near Jacala, State of Hidalgo; Nuevo León; Tamulipas; Tampacoalá, near Hacienda de Limón; Victoria, Sierra Madre. Growing in dry situations in bright sunlight; associated with various xerophytic shrubs, small cacti, bromeliads, and ferns.

In a patch of Dioon edule it is easy to pick out a plant here and there with leaflets narrower or broader than the average.

Herbarium taxonomists have described such fluctuations as var. angustifolium and var. latipinnum. In very dry places the rachis, especially near the tip, may elongate so slightly that the leaflets overlap, thus affording an opportunity for var. imbricatum. In damp shaded places the leaflets may be rather widely separated, affording still another opportunity which, so far as I have noted, has not yet been utilized.

2. Dioon purpusii Rose

Rose, J. N., Contr. U. S. Nat. Herb. 12:260-261 (1909).

Stem short, crowned by numerous leaves, these often 1 m. or more long, stiff and ascending, dark green and glabrous. Petiole somewhat tetragonal, without spines. Leaflets rather widely separated below, closely set above, linear-lanceolate, pungent, entire on the lower margin but usually with 1, 2, or rarely 3 sharp spine-like teeth on the upper margin, 5-9 cm. long, 9-11 mm. wide. Male cones 15-20 cm. long, the microsporophylls with ovate tips. Female cones ovoid, about 44 cm. long, 20 cm. in diameter near the base. Megasporophylls 10-15 cm. long, very woolly. Seeds about 4 cm. in diameter.

Collected by D. T. MacDougal and J. N. Rose in Tomellín Canyon, ~~Canon,~~ Oaxaca, in 1906, and by C. A. Purpus in Sierra Mixteca, Puebla, in 1908. The specimens found by MacDougal and Rose were in a deep canyon well shaded by bushes and small trees.

The above description is based on that of Dr. Rose, with a few additions from cultivated specimens. The statement in the original description that the microsporophylls have recurved tips is incorrect, as is plainly shown by the specimens distributed by Dr. Rose. The piece of male cone on the type sheet (U. S. National Herbarium no. 454142) is mounted upside down. The sporangia would be on the adaxial face of the sporophyll if the tip were recurved. The tips turn upward, as in other species of Dioon.

Geographic distribution: Southern Puebla, northern Oaxaca, and in Chiapas.

In April, 1908, I traveled from Las Sedas to Tomellín and found at Santa Catarina a new species which had not yet been described. The leaves agree with Dr. Rose's description. A small

pit at the chalazal end of the seed is about the same as in D. edule, with an average diameter of 2.5 mm.

Edward Howard collected [illegible] specimens of Dioon in Chiapas, about 40 kilometers inland from the coast and about 160 kilometers north of Guatemala. I have examined leaves from two of these plants that were transplanted to southern California. In some leaves the spiny character is about as in Dr. Rose's description. One large plant has a trunk 2.1 m. tall and 30 cm. in diameter, with leaves 1.1 m. long, petiole 16-21 cm. long, and leaflets 8.5 cm. long and 11 mm. wide. The lowest leaflets have no spines, but the spiny character of the others is a little more pronounced than in D. purpusii. Specimens distributed by Dr. Rose show occasional spines on the lower border and spines lower down than in the type. Although most of the leaves of the Howard specimens have more spines than in the type, some agree very closely. If the description of D. purpusii were broadened by allowing the leaflets to have a few more spines, the specimens from Chiapas, as far as the leaves are concerned, could easily be included in it.

3. Dioon pinoi Rose sp. nov.

Stem in larger plants 4-5 m., occasionally up to 6 m. high. Leaves about 1 m. long. Petiole 7 cm. or more in length, somewhat tomentose; rachis densely tomentose on the lower side. Leaflets about 90 on each side, inserted obliquely, opposite or subopposite, most of them with 2 or 3 (sometimes 4) strong spines on the upper border and occasionally with 1 or 2 on the lower border, the lower leaflets not so spiny; sometimes revolute, tomentose on the margins, even on old leaves. Largest leaflets 9 cm. long and 10 mm. wide, the lowest about 1 cm. long; veins 12-15. Male cones not available. Female cones smaller than in D. edule. Megasporophylls 9-9.5 cm. long, 4.5-5 cm. wide at the base. Seeds 3.5 cm. long and 2.5 cm. wide. The pit at the chalaza was measured in only three seeds; in two it was circular, 5 and 6 mm. in diameter; in the other it was oval, 9 mm. by 7 mm.

Geographic distribution: Lower region of Sierra Madre near Hacienda del Pinoi, Monserrato, Chiapas, Mexico.

This species was distributed but not described by J. N. Rose. The foregoing description is based on Dr. Rose's material in the U. S. National Herbarium, material in the New York Botanical Garden, and from both material and letters sent to me from Dr. C. A. Purpus, who made all the collections.

4. Dioon madrense Rose sp. nov.

Stem an aerial armored trunk. Leaves 1 m. long. Petiole 10-25 cm. long, oval in transverse section with 2 indistinct grooves, smooth; rachis 50-80 cm. long, rounded below, with 2 distinct grooves above. On a plant with a stem 30 cm. high and 14 cm. in diameter, leaflets 80-90 on each side, the largest 9.7 cm. long, 5 mm. wide, with 10 veins; the lowest 3.5-4.5 cm. long, 3 mm. wide, with 6 veins. On larger plants, up to 100 leaflets on each side, the largest 18 cm. long, 7 mm. wide, with 12 veins; the lowest 8 cm. long, 4 mm. wide, with 8 veins. Leaflets narrowly linear, pungent; most leaflets in upper half of leaf with 1 or occasionally 2 small sharp but weak spines on the upper border, the leaflets of many leaves without a single spine on the lower border.

Male cones cylindric, 21.5 cm. long, 7.5 cm. in diameter (only one cone measured). Microsporophylls 3 cm. long, stalk the same length, exposed tip pointed above and rounded below, very woolly. Microsporangia more or less separated into two groups of 60-80 each, mostly in sori of 3 or 4, occasionally 5. Female cones ovoid, up to 30 cm. long. Exposed surface of megasporophylls cuneate, 6 cm. long, 4 cm. wide at the bottom, rounded at the top, densely woolly. Seeds cream-colored, fleshy coat not more than 1 mm. thick; stony coat 2.5 cm. long, 2 cm. in diameter, smooth, with 14 bundles near the chalaza and 12 at the corona; chalazal pit circular or oval, about 4 mm. in diameter.

Geographic distribution: Near Los Mochis, Sinaloa, Mexico. Coll. C. F. Edmunds. J. N. Rose collected material between Aguacate and Dolores in 1892. No. 2014.

5. Dioon spinulosum Dyer

Dyer, W. T. T., in Hemsley's Biol. Centrali-amer. Bot. 3: 191 (1882-1886); Fichler, A. W., Gartenfl. 2:411 (1883); Chamberlain, C. J., Bot. Gaz. 48:401-413 (1909).

Stem taller and more slender than in D. edule, rarely branched; commonly 3-6 m. in height, occasionally 12 m., rarely reaching 16 m. On plants 2 m. in height, leaves reaching a maximum length of about 2 m.; dark green and glabrous. In damp shady places, leaves often 3 m. long. In seedlings petiole naked, up to 90 cm. in length, the lowest leaflets nearly as long as those higher up. Reduced leaflets appearing on older plants, becoming spines on plants about 10 years old. In plants with stems about 2 m. tall, leaflets about 120 on each side, up to 20 cm. long and 23 mm. wide, with some leaflets only 15 cm. long and 15 mm. wide. Leaflets long lanceolate, acuminate, pungent, with 5-8 sharp spines on the upper border and 4-7 on the lower border. Occasionally spines much reduced, most of the leaflets of some plants being entire. Such plants have been described as D. pectinatum.

Male cones long ovoid, about 25 cm. long and 10 cm. in diameter before the sudden elongation at shedding of pollen, when the length doubles. Microsporophylls long cuneate, the outer part gray woolly, curved upward, obtuse. Microsporangia up to 700, generally in sori of 4 or 5, sometimes 3, only slightly separated into two groups at the top. Female cones cylindric-ovoid, up to 60 cm. long and 27 cm. in diameter, with average cones about one-fifth smaller. Megasporophylls more closely imbricated than in D. edule, the stalk irregularly triangular in transverse section and much wrinkled; outer part of sporophyll perpendicular to the stalk, gray woolly, rounded above in some specimens, in others

nearly as pointed as in D. edule. Seeds white and smooth but slightly yellowish when mature; stony coat 4-5.5 cm. long, 2.5-3.5 cm. in diameter, the chalaza without a pit.

Geographic distribution: Northern limit apparently at Tierra Blanca, about 70 kilometers south of Veracruz. Very abundant beyond the Papaloapan River at Tuxtepec, about 120 kilometers south of Veracruz. The original description by Dyer gives Progreso, in Yucatan, as the locality and Eichler's description cites Cordoba, State of Veracruz. The species does not occur in either of these places except in cultivation.

This is the only species of Dioon in which the leaflets are gradually reduced to spines. The leaves are long and have a graceful curve, in striking contrast to the straight rigid leaves of the other species. The female cones are cylindric-ovoid, while the megasporophylls are either rounded or acute.

5. MACROZAMIA Miq.

Miquel, F. A. W., Monogr. Cycad. 35-38 (1842), Prodr. Syst. Cycad. 8, 10, 18, 22 (1861); De Candolle, A., Prodr. 16^{2}:534-537 (1868); Bentham, G., Flora Austral. 6:250-254 (1873); Moore, C., Jour. Roy. Soc. N. S. Wales 17:115-122 (1883), Handb. Flora N. S. Wales 378-380 (1893); Bailey, F. M., Queensl. Flora 5:1503-1507 (1902); Schuster, J., Pflanzenreich 4^{1}:86-103 (1932).

Stem in some species columnar and tall, occasionally up to 18 m. (in M. hopei), but generally tuberous and subterranean or, if aerial, less than 1 m. high; rarely branched; covered with an armor of persistent leaf bases. Leaves appearing singly or simultaneously, in some species often up to 100 in a crown; from less than 1 m. up to 3 m. in length; petiole unarmed or rarely spinescent. Leaflets narrowly lanceolate, entire (often with a few spines at the tip in M. fawcettii, M. flexuosa, M. pauli-guilielmi, and seedlings), generally with a callus-like swelling at the base, with "parallel" (dichotomous) venation. Vernation straight.

Male cones usually more than one, ovoid or cylindric, mostly long stalked. Microsporophylls peltate, broadly to narrowly triangular; the top broadened, flattened or broadly rhombic, with a median terminal spine. Microsporangia covering the entire lower surface or separated into two groups by a median sterile line. Female cones single or frequently 2 or more together, ovoid or cylindric, short stalked. Megasporophylls peltate, with a broad top which is either flat or tapering and rhombic, with a median terminal spine. Seeds in most species some shade of red; in a few species orange or brownish.

The genus, with about 16 species (the number depending largely on the diagnosis of M. spiralis), is confined to Australia, most

of the species occurring near the eastern coast. Name from μακρος (long) and Zamia. Type species: M. spiralis (Salisb.) Miq.

The occurrence of a terminal spine on the sporophylls is a distinctive feature of the genus. Macrozamia is frequently confused with the African genus, Encephalartos, but in Macrozamia the leaves are not so rigid, the margins of the leaflets have no spines (except rarely), while the sporophylls of Encephalartos are obtuse or truncate and lack a terminal spine.

Key to the Species

I. Stems tall, 1-18 m. high; leaves not spirally twisted

A. Leaflets inserted along middle of upper surface of rachis, falcate, without a basal callus, lowest not much smaller than rest; seeds brownish

1. Leaflets 10-12 mm. wide, pungent; male cones 25-40 cm. long; microsporophylls pointed at apex . 1. *M. denisonii*

2. Leaflets 12-20 mm. wide, acuminate; male cones 20 cm. long; microsporophylls rounded at apex . 2. *M. hopei*

B. Leaflets inserted along sides of rachis, straight, lowest reduced but not spine-like; seeds reddish

1. Leaflets 9-10 mm. wide, callus nearly white; female cones 70-90 cm. long . . . . . 3. *M. moorei*

2. Leaflets 7-9 mm. wide, callus reddish; female cones up to 50 cm. long . . . . . 4. *M. reidlei*

II. Stems subterranean, occasionally up to 1 m. or more

A. Rachis of leaves straight or nearly so.

1. Leaflets flat, not erect, lowest reduced

a) Leaves 1-1.5 m. long; leaflets 25-30 cm. long, lowest reduced but not spine-like

(1) Callus white

(a) Leaflets 11-12 mm. wide; seeds scarlet. . . . . 5. *M. spiralis*

(b) Leaflets 8 mm. wide; seeds orange . 6. *M. mountperriensis*

(2) Callus pale yellow, leaflets 8-10 mm. wide . . . . . 7. *M. cylindrica*

b) Leaves up to 2 m. long; leaflets up to 40 cm. long, lowest reduced to spines, callus white or reddish . . . . . 8. M. miquelii

2. Leaflets erect, lowest not much smaller than rest

a) Rachis narrow; leaflets up to 15 cm. long, 6 mm. wide, callus dull red . . . . 9. M. secunda

b) Rachis up to 12 mm. wide; leaflets up to 38 mm. long, 19 mm. wide, callus lacking . .10. M. platyrachis

B. Rachis of leaves twisted

1. All leaflets simple

a) Leaflets without spines at tip

(1) Leaves not over 0.5 m. long; leaflets 15-22 cm. long, callus bright red . .11. M. corallipes

(2) Leaves more than 2 m. long; leaflets 30-40 cm. long, callus white . . .12. M. douglasii

b) Leaflets with a few spines at tip

(1) Leaflets about 18 mm. wide, with 5-6 spines at tip . . . . . .13. M. fawcettii

(2) Leaflets less than 6 mm. wide, with 2-3 spines at tip

(a) Leaflets flexible; male cones 15-18 cm. long; seeds orange red . .14. M. flexuosa

(b) Leaflets rigid; male cones 8-10 cm. long; seeds golden yellow . .15. M. paulô-guilelmi

2. Some leaflets forked . . . . . .16. M. heteromera

1. Macrozamia denisonii C. Moore and F. Muell.

M. peroffskyana (Regel) Miq.

Regel, E. von, Bull. Soc. Nat. Moscow 30:184 (1857), Gartenfl. 25:3-6 (1876); Mueller, F. von, Fragm. Phytog. Austral. 1:41, 243 (1858), 8:173 (1874); Miquel, F. A. W., Arch. Neerl. 3:252 (1868); Bentham, G., Flora Austral. 6:253 (1875); Moore, C., Handb. Flora N. S. Wales, p. 379 (1893); Bailey, F. M., Queensl. Flora 5:1506 (1902).

Stem tall, the larger ones 3-7.5 m. high and 25-45 cm. in diameter, sometimes with 1, 2, or 3 branches. Leaves 12-25 in a crown and often appearing to be twice as many because crown remains green after next one is fully grown, 2-3 m. long, dark glossy green, retaining a purplish tinge for several months, not spirally twisted. Petiole 20-40 cm. long, rounded tetragonal, smooth, woolly at base. Leaflets about 100 on each side, inserted longitudinally along the middle of the upper surface of the rachis, alternate or opposite, linear-lanceolate, flexible, falcate, pungent, only slightly contracted at base, the lower border decurrent; callus wanting; largest leaflets 20-40 cm. long, 10-12 mm. wide, the lowest not much smaller than the rest; veins 8-14, obscure. Leaflets of seedlings without spines.

Male cones ovoid, 25-40 cm. long, 10-15 cm. in diameter. Microsporophylls 2.5-3.5 cm. wide, very thick, the apex a short triangular or lanceolate reflexed point. Microsporangia covering most of the under surface, not separated into groups. Female cones long ovoid, tomentose, 40-60 cm. or occasionally up to 1 m. in length, 30 cm. in diameter at the base, and up to 38 kilos in weight. Megasporophylls 5 cm. wide, tapering to an obtuse or lanceolate reflexed point, swollen on the upper side above the seeds, with a median lobe on the under side partly covering the seeds. Seeds brownish; stony coat 6 cm. long, 3 cm. in diameter, very oblique at base, with 12 bundles.

Geographic distribution: Along the Burnett River, Moreton Bay, forests near Durandgo, Rockingham Bay, abundant on Tambourine Mountain near Brisbane, and in other parts of southern Queensland. Near Lismore and at Dorrigo in New South Wales, and along the Manning River.

2. Macrozamia hopei W. Hill

Hill, W., ex Moore, C., Jour. Roy. Soc. N. S. Wales 17:116 (1884), ex Bailey, F. M., Syn. Queensl. Flora Suppl. 1, p. 52 (1886), Queensl. Flora 5:1506 (1902).

Stem the tallest of all cycads, up to 18 m. high and 40 cm. in diameter, erect even in the tallest plants, distinctly ribbed. Leaves 40 or more in a crown, about 2.1 m. long, glossy above, not spirally twisted. Petiole 60 cm. long, enlarged and wooly at the base. Leaflets about 80 on each side, inserted longitudinally along the middle of the upper surface of the rachis, linear-lanceolate, falcate, thick, very acuminate but not pungent, the base slightly contracted and decurrent; callus wanting; 20-30 cm. long, 12-20 mm. wide, the lowest leaflets not much smaller than the rest; veins 12-17, rather obscure.

Male cones very characteristic, sufficient to identify the species; 20 cm. long, 12 cm. in diameter, with 10 vertical "rows" of sporophylls, 7 in a row; apex of microsporophyll represented by a spine in other species, 2 cm. wide at the base and rather broad throughout, thin at the sides, 2.5-3.2 cm. long, rounded at the top, strongly incurved. Microsporangia covering the entire under surface without any sterile notch at the top. Female cones tomentose, about 60 cm. long, 20-25 cm. in diameter. Megasporophylls 5-6 cm. wide, 2.5 cm. in vertical thickness, with thin and wavy edges, terminating in a blunt or more or less lobed reflexed apex. Seeds brownish, 5-6 cm. long, 2.5-3.5 cm. in diameter.

Geographic distribution: Daintree and Johnstone Rivers in northern Queensland; fine specimens about 30 kilometers from Cairns.

... F. v. Mueller, ... and ... Australasian Supplement (Suppl. only) 4 (35): 84 (1881)

... confirmed through the assistance of Mr. A. W. Jessep, ... and Government Botanist, Melbourne Botanic Gardens ... National Herbarium, South Yarra, S.E.I., Australia

... letter dated Feb. 8th, 1949.

3. Macrozamia moorei F. Muell.

Mueller, F. von, Pharm. Jour. Victoria (1881); Mueller, F. von, ex Moore, C., Handb. Flora N. S. Wales, p. 379 (1893); Bailey, F. M., Queensl. Flora 5:1506 (1902); Chamberlain, C. J., Bot. Gaz. 55:141-154 (1913).

Stem tall, the most massive in the family, many 3-4 m. high and 60 cm. in diameter, the tallest 7 m. high and 70 cm. in diameter, covered with a heavy armor of leaf bases which are woolly on the under side. Among hundreds of plants, not a single branching specimen was seen. Leaves 50-100 in a crown, 2-3 m. long, grayish, glabrous, not spirally twisted. Petiole and rachis somewhat flattened above, rounded triangular below, with leaflets extending almost to the base; 4 cm. wide at level of lowest leaflets, 5-7 cm. wide farther down at broadest part. Leaflets 50-70 on each side, attached along the edges of the flattened upper side of the rachis, mostly opposite below, opposite or alternate above, linear-lanceolate, pungent, very rigid; callus nearly white; 20-30 cm. long, 9-10 mm. wide, the lowest 5-8 cm. or sometimes only 1 cm. long, but the smallest like small leaflets and not like spines; veins 10-12. Leaflets of seedlings entire.

Male cones axillary and very numerous, often more than 20 and sometimes up to 100, cylindric, glabrous, about 35 cm. long, 5-8 cm. in diameter; peduncle smooth, 6 cm. long. Microsporophylls thin, 3 cm. long, 1.5 cm. wide, the central spine about 1 cm. long in upper part of cone and much shorter below. Microsporangia about 200, mostly in sori of 3, separated into two groups at the top by a pointed sterile region but covering the entire lower surface. Female cones axillary, 2-4, less frequently 1, occasionally up to 8, cylindric, glabrous, 70-90 cm. long, 30 cm. in diameter,

up to 16 kilos in weight. Megasporophylls smooth, fleshy, 7.5 cm. long, 3.5 cm. high, outer surface with a thin crest across the middle, the central spine 3 cm. long in middle of cone but longer above and shorter below, with two lateral lobes partly covering the seeds. Seeds with fleshy coat thick and irregular from pressure in the cone, reddish, 5.5 cm. long, 3.5 cm. wide. Stony coat thick, 4.5 cm. long, 3.3 cm. wide, oblique at the base, with 10-12 bundles.

Geographic distribution: Very abundant at Springsure, Queensland, about 320 kilometers west of Rockhampton, where in 1911, the government was destroying it because cattle, eating the poisonous leaves, were dying in great numbers. Also reported near the Clarence River.

4. Macrozamia reidlei (Gaud.) C. A. Gardn.

M. fraseri Miq., M. preisii Miq., M. macdonnelli F. Muell.

Gaudichaud, C., in Freycinet's Voy. Bot., p. 434 (1826); Miquel, F. A. W., Monogr. Cycad., p. 37 (1842), Prodr. Syst. Cycad. 8, 18 (1861); Bentham, G., Flora Austral. 6:252 (1873); Baird, A. M., Jour. Roy. Soc. W. Austral. 25:153-175 (1938-39).

Stem stout, very variable, perhaps with age and locality; near Perth, subterranean or 30-60 cm. high; at Gingin, north of Perth, 1.2-1.5 m. high; on the coast south of Perth, 3-4.5 m. high[1]; with a strong armor of leaf bases, even when subterranean.

[1] The tall plants have been called M. dyeri F. Muell., but since the cones and leaves are the same size and there are all intergrades in size of stem, there should be no separate species.

Leaves 20 or more in a crown, up to 2 m. in length, not spirally twisted. Petiole 30 cm. or more long, petiole and rachis smooth, somewhat flattened, triangular below. Leaflets 50-70 on each side, inserted somewhat obliquely on upper edges of rachis, crowded above but separated below, mostly opposite, linear-lanceolate, pungent, with a reddish callus at base, 25-30 cm. long, 7-9 mm. wide, the lower leaflets reduced but leaf-like; veins 9 or 10. Leaflets of seedlings with 1-3 spines or lobes on lower border and 1 on upper border.

Male cones usually 2-5, frequently 6 or 7, cylindric, 25-30 cm. long, 10-15 cm. in diameter just before elongation for shedding pollen, when they may reach 48 cm. in length, woolly when young, smooth when mature. Microsporophylls flat, cuneate, 7.5 cm. long, 2.7 cm. wide, thin, with a spine up to 7 cm. long terminating the upper sporophylls, about 3.5 cm. long in the middle of the cone,

and 1.5 cm. long at the base. Microsporangia in upper part of cone in two groups with a sterile portion between, lower down continuous but with a sterile notch at the top and bottom; microsporangia about 750, mostly in sori of 5. Female cones single, sometimes 2 or 3, rarely 7, ovoid, the largest 50 cm. long, 25 cm. in diameter and 15 kilos in weight; most cones smaller, woolly when young[1], smooth when mature; peduncle long and covered with tomentum which easily rubs off. Megasporophylls 5-7 cm. broad, 2-2.5 cm. in vertical thickness, longest spines in upper part of cone 11-14 cm. long, at base of cone 3 cm. long. Seeds reddish, 4.5-5.5 cm. long, 3.5-4 cm. in diameter, very smooth, with 12-14 bundles easily seen at top.

[1] On bracts covering young cones the tomentum is so abundant that it can be used to stuff pillows.

Geographic distribution: Confined to Western Australia. At Donnybrook near Lowden, in the Tarrah Forests of the Darling Range near Preston Valley, and at Noggerup on the Preston River, Kalamunda, at Crawley and Wembley on the coastal plain several kilometers from Perth. Northern limit apparently at the Greenough River, just south of Geraldton, from where it extends to Esperance on the southern coast. Confined to a narrow coastal strip, seldom getting as far as 130 kilometers inland.

In Schuster's monograph, this species, together with Macrozamia dyeri F. Muell., M. macdonnelli F. Muell., and possibly others, ~~in~~ is included under M. preisii Lehm. emend. Schuster. It is nearly equivalent to M. fraseri Miq. M. dyeri includes only the larger specimens of M. reidlei; there is no difference in leaves or cones.

5. Macrozamia spiralis (Salisb.) Miq.

M. tridentata (Willd.) Regel

Salisbury, R. A., Prodr. stirp., p. 401 (1796); Willdenow, K. L., Spec. Plant. 4:845 (1799); Brown, R., Prodr. Fl. Nov. Holl. 1:348 (1810); Miquel, F. A. W., Monogr. Cycad., p. 36 (1842), Prodr. Syst. Cycad. 8, 18 (1861); Bentham, G., Flora Austral. 6: 251 (1873); Regel, E. von, Gartenfl. 25:229 (1876); Moore, C., Handb. Flora N. S. Wales, p. 379 (1893); Bailey, F. M., Queensl. Flora 5:1504 (1902); Brough, P., and Taylor, M. H., Proc. Linn. Soc. N. S. Wales 65:494-524 (1940).

Stem subterranean, long, seldom rising above the ground in its northern range but sometimes 1 m. or more high at its southern limit; when growing on rocks or thin soils up to 60 cm. in diameter, with an armor of leaf bases even when subterranean. Roots often reaching 1 m. in length. Leaves on old plants in favored localities up to 50 in a crown, up to 1-1.5 m. in length, entirely straight or somewhat spirally twisted in the upper part, wooly when young, becoming glabrous. Petiole 30-45 cm. long, smooth, rounded triangular below, somewhat flattened above, the expanded base very woolly; rachis somewhat elevated between the leaflets. Leaflets 30-50 on each side, inserted longitudinally and obliquely on the edges of the rachis, approximately opposite, linear-lanceolate, straight or slightly falcate, flat, pungent, with a pale callus at the contracted base; largest leaflets 25-30 cm. long, 11-12 mm. wide, lowest leaflets 3-7 cm. long, seldom any more reduced; veins 8-10, very prominent on the under side. In seedlings leaflets with 1 or 2 spines at tip on lower margin and 1 on upper margin.

Male cones averaging 3 or 4, up to 7-10, cylindric; average length at shedding of pollen 38 cm., 10 cm. in diameter; peduncle up to 16 cm. long. Microsporophylls flat, rhomboid-ovate, about 18 mm. wide, the lower ones with only a pungent spine, lengthening to 15 mm. on upper ones. Microsporangia in two groups separated by a sterile line at the top and bottom of the cone but more or less confluent in the middle. Average number of microsporophylls per cone 345, average number of microsporangia per sporophyll 342, with as many as 400 on larger ones; in sori of 3, 4, or 5, with 3 the most frequent number. Female cones averaging 2 or 3, up to 5 or 6, cylindric, more or less woolly, average length 35 cm., maximum 45 cm., average diameter 19 cm., diameter of largest cones only 18 cm., average weight 3.6 kilos, maximum 5.7 kilos; peduncle 10-11 cm. long. About 100 megasporophylls, the spiral arrangement prominent with no suggestion of vertical "rows." Exposed portion of megasporophylls smooth, rhomboid, 2.5-4 cm. wide, the spine in lower part of cone 2 cm. long, toward the top 6 cm. long, incurved. Average number of viable seeds per cone 126. Seeds scarlet, 3.5 cm. long, 2.7 cm. in diameter; stony coat 3 cm. long, 2.3 cm. in diameter, smooth, with 10-12 bundles prominent at top but scarcely distinguishable below.

Geographic distribution: Southern Queensland almost to southern limit of New South Wales, typically in open Eucalyptus forest, extending from the coast inland several hundred meters, occasionally in isolated groups up to 15-25 kilometers. There are probably more individuals of this species than of any other in the family.

6. Macrozamia mountperriensis F. M. Bailey

Bailey, F. M., Syn. Queensl. Flora, Suppl. 1, p. 50 (1886), Queensl. Flora 5:1505 (1902), Compreh. Cat. Queensl. Plants, 2nd ed., 516-517 (1909).

Stem subterranean, sometimes slightly above the ground, ovoid, covered by an armor of leaf bases, 50 cm. long, 35 cm. in diameter. Leaves as many as 80 in a crown, about 1.5 m. long, deep green, not twisted. Petiole 40-45 cm. long, somewhat angular, with a swollen base covered by dense mouse-colored wool; rachis with a raised ridge between the two rows of leaflets. Leaflets about 50 on each side, mostly opposite, long linear, pungent, with a rather prominent white callus at the base, the larger ones about 25 cm. long and 8 mm. wide, the lower ones only slightly shorter than the rest; veins 8-12.

Male cones cylindric, tapering slightly toward the top, about 30 cm. long and 4 cm. in diameter; peduncle about 30 cm. long, surrounded by numerous densely woolly scales about 12 cm. long and 4-8 mm. wide. Microsporophylls with a very short spine except at top of cone; microsporangia covering the under surface. Female cones cylindric, 20-40 cm. long, 8-10 cm. in diameter; peduncle about 30 cm. long. Megasporophylls fleshy, about 3.5 cm. wide, 3 cm. high, with a very prominent, sharp, transverse ridge prolonged in the center into an erect, flat, linear-lanceolate spine 2.5-5 cm. long. Seeds deep orange, about 2.7 cm. long and 1.7 cm. in diameter; stony coat smooth, with 9 bundles distinguishable.

Geographic distribution: Mount Perry, Queensland. Abundant at Rockhampton, Berserker Range.

7. Macrozamia cylindrica C. Moore

Moore, C., Jour. Roy. Soc. N. S. Wales 17:119 (1883), Handb. Flora N. S. Wales, p. 379 (1893).

Stem tuberous and subterranean. Leaves 90-120 cm. long, slender, pale green, glabrous, not spirally twisted. Petiole smooth; 35 cm. or more in length, flat above, rounded below, rachis nearly flat below, with two widely separated grooves above, somewhat elevated between the grooves. Leaflets about 60 on each side, arising obliquely from the edges of the rachis, linear-lanceolate, straight, flexible, pungent, slightly contracted at the base, inserted obliquely but twisted so that the leaf is flat; callus pale yellow, prominent; larger leaflets 25-30 cm. long, 8-10 mm. wide, with 5-8 veins; the lowest leaflets 8-12 cm. long, 5-8 mm. wide, with 5 or 6 veins; occasionally with a few small pungent teeth below the lowest leaflets but without a gradual reduction from leaflets to spines.

Male cones strictly cylindric, 17-25 cm. long, 3.5-4.5 cm. in diameter. Peltate part of microsporophylls thick, rhomboid-truncate, about 12 mm. wide, tapering to a fine incurved point scarcely recognizable in the lower part of the cone but increasing to about 6 mm. at the top. Female cones not available.

Geographic distribution: Southeastern Australia—low flat ground between Richmond and Clarence Rivers, New England Plateau, Moona Plains, East Cunderang, Mount Danar Gungal.

This species, one of the most elegant of the genus, is characterized by its slender graceful habit and its bright pale yellow callus. Although many plants were seen in the field and Sydney Botanic Gardens, no female plants were found.

8. Macrozamia miquelii (F. Muell.) A.DC.

Mueller, F. von, Fragm. Phytogr. Austral. 3:38 (1862-63); Bentham, G., Flora Austral. 6:253 (1873); Bailey, F. M., Queensl. Flora 5:1504 (1902).

Stem subterranean, occasionally slightly above ground, massive ovoid, about 40 cm. in diameter at the base, completely covered with an armor of leaf bases but appearing quite smooth, the lower flattened end bearing numerous fleshy roots. Leaves as many as 80-100 in a crown, up to 2 m. in length, nearly straight. Rachis somewhat triangular in cross section, flattened above or somewhat elevated between the two rows of leaflets; expanded base of petiole more woolly than in M. spiralis. Leaflets 35-50 on each side, all arising obliquely from the margins of the rachis, many more opposite or subopposite than alternate, long linear, straight or falcate, pungent, the narrowed base with a large white or reddish callus; largest leaflets 40 cm. long, 7-9 mm. wide, with 8 or 9 veins; gradually smaller toward the top but even the uppermost 15-20 cm. long, 3 mm. wide, and with 4 or 5 veins; lower leaflets reduced to short stiff spines.

Male cones cylindric, 15-25 cm. long, up to 4.5 cm. in diameter and with about 500 sporophylls spirally arranged with no appearance of vertical rows. Microsporophylls thick, cuneate, 2 cm. long and 1.5 cm. wide in the larger cones, the apex rhomboid, the upper ones with a spine 6-12 mm. long, the lower ones almost spineless. Microsporangia 140-160, more or less separated into two groups but often confluent; in sori of 3-5, with 3 the commonest number. Female cones cylindric, 15-25 cm. long, 8-12 cm. in diameter, outer peltate part of sporophyll fleshy, rhomboid, 3.5 cm. wide, 2.5 cm. high, with a very thin transverse ridge prolonged

in the center into a spine which is very short at the base of the cone but reaches a length of 3-5 cm. above. Seeds red, 3.2 cm. long, 2 cm. in diameter. Stony coat 2.9 cm. long, 1.8 cm. in diameter, very smooth but with an average of 11 bundles throughout the entire length, their insertion very oblique; bundles in corona very prominent with an average of 11.

Geographic distribution: Taylor's Range, near Brisbane, to Rockhampton, Queensland. Fairly abundant at Byfield, a few hours walk south of Yeppoon.

9. Macrozamia secunda C. Moore

Moore, C., Jour. Roy. Soc. N. S. Wales 17:120 (1883), Handb. Flora N. S. Wales, p. 379 (1893).

Stem subterranean, tuberous, ovoid, covered by a slightly woolly armor of leaf bases. Leaves 60-90 cm. long, usually glabrous, sometimes glaucous, sharply recurved near the top, not twisted. Petiole and rachis flat above, rounded below. Leaflets 40 or more on each side, close together, mostly opposite or nearly so, arising rather vertically from the edges of the rachis, linear-lanceolate, falcate, rigid, tapering gradually to a somewhat pungent apex and tapering more abruptly to the base; callus dull red; 10-15 cm. long, 6 mm. wide, the lower leaflets about as long as the rest; veins 6-9.

Male cones not available. Female cones about 15 cm. long and 9 cm. in diameter. Megasporophylls with sharp points at the base of the cone, increasing to spines at the top. Seeds not available.

Geographic distribution: New South Wales near Reedy Creek, east of Mudgee; near Dubbo. Dr. Charles Moore, for many years the Director of the Sydney Botanic Gardens, who was familiar with practically all the New South Wales species in the field, states that while this species is more nearly like M. corallipes than any other, its more spreading habit, the vertical character of the leaflets, and the non-cortorted, recurved, pointed, falcate leaves at once distinguish it from all others.

10. Macrozamia platyrachis F. M. Bailey

Bailey, F. M., Queensl. Agric. Jour. 5:356 (1898), Queensl. Flora 5:1503 (1902), Compreh. Cat. Queensl. Plants, 2nd ed., 514-515 (1909).

Stem subterranean, turnip-shaped, about 30 cm. long, 20 cm. in diameter, smooth but completely covered by an armor of thin leaf bases. Leaves about 12 in a crown, about 1 m. long, glabrous or when young very thinly pulverulent, not spirally twisted. Petiole 12-20 cm. long, not woolly at the base; petiole and rachis flat on upper surface, convex below, broadest part of rachis reaching 12 mm. (suggesting the specific name). Leaflets about 23 on each side, inserted along the thin edges of the rachis, broadly linear, falcate, erect, obtusely acuminate, very coriaceous, without a callus at the base, the largest 38 cm. long and 19 mm. wide, the lowest about as long as the rest; veins 15-17, prominent.

Male cones cylindric, 8-10 cm. long, 2.5 cm. in diameter; peduncle about same length as cone. Exposed ends of microsporophylls triangular and terminating in an erect slender spine about 10 mm. long. Female cones oblong, about 16 cm. long, 3-7 cm. in diameter. Transverse ridges of megasporophylls acute and very prominent, prolonged in the center into a flat, erect, sharp-pointed spine 7-10 mm. long. Seeds oblong, reddish brown, 2.5 cm. long.

Geographic distribution: Near Planet Downs, Queensland.

11. Macrozamia corallipes Hook. f.

Hooker, J. D., Bot. Mag. 98: t. 5943 (1872); Moore, C., Jour. Roy. Soc. N. S. Wales 17:120 (1883), Handb. Flora N. S. Wales, p. 379 (1893).

Stem subterranean, subspherical, about 20 cm. in diameter or elongated to nearly 60 cm. without much change in diameter, smooth or woolly. Leaves 30–45 cm. long, somewhat rigid, forming a rather contracted crown, dark green above, paler below. Petiole 25 cm. long, terete, 3–4 mm. in diameter but at base gradually widened to 1.5 cm., the sides and back of the widened part densely woolly, elsewhere smooth. Rachis much twisted, rounded below, with two grooves above and a raised ridge between the two rows of leaflets. Leaflets 25–50 on each side, mostly opposite, inserted obliquely on the margins of the rachis, linear-lanceolate, narrowed above to a red pungent apex, narrowed and decurrent at the base; callus bright red; 15–22 cm. long, 7–10 mm. wide, the lower leaflets not much shorter than the rest but sometimes a few reduced to short spines; veins 6–12.

Male cones glaucous green, smooth, cylindric, 13–18 cm. long, 5 cm. in diameter; peduncle stout, smooth, 8 cm. long. Microsporophylls 18 mm. wide, ridge tapering to an incurved spiny point which is short or obsolete in the lower part of the cone and gradually increasing to 12–15 mm. at the top. Microsporangia covering the under surface. Female cones glaucous green, 10–15 cm. long, 8–10 cm. in diameter, peltate part of megasporophylls much thickened, the transverse ridge in the lower sporophylls merely acute in the middle, increasing to a spine 3–6 mm. long at the top of the cone. Seeds red, 2.6 cm. long, 2.2 cm. in diameter.

Geographic distribution: New South Wales—near Sydney, north of Penrith on the Hawkesbury, dry ridges between Glenbrook and Blaxland, at Wascoe's on Western Road, Port Jackson to Blue Mountains, Mulgoa.

12. Macrozamia douglasii W. Hill ex F. Muell.

Hill, W., ex Mueller, F. von, Census Austral. Plants 1:110 (1882); Mueller, F. von, Melbourne Chemist and Druggist (1883); Bailey, F. M., Queensl. Flora 5:1505 (1902).

Stem generally tuberous and buried in sand but sometimes up to nearly 1 m. high, 30 cm. in diameter. Leaves 50 or more in a crown, 2-2.4 m. long, deep green, spirally twisted. Petiole about 60 cm. long, the base wide and densely woolly; rachis somewhat triangular in cross section, rounded angular below, flattened above with leaflets inserted along two grooves with an elevated ridge between them. Leaflets about 160 on each side, arising obliquely from the rachis, mostly opposite, linear, thin, acute, contracted at the base, with a small white callus; central leaflets 30-42 cm. long, 10 mm. wide, the lower ones much shortened; veins 8-11.

Male cones ellipsoidal, 17 cm. long, 6 cm. in diameter; peduncle glabrous, 30-40 cm. long; terminal spine almost lacking in the lower microsporophylls but reaching a length of 5-6 cm. in the upper ones. Female cones 20-40 cm. long, 10-12 cm. in diameter. Megasporophylls 5-6.5 cm. wide, 2.5-3 cm. high, the transverse ridge often developed into a thin wing with only a small central point in the lower part of the cone but increasing to 18 mm. at the top, with a conspicuous depression at the base of the spine. Seeds red, 2.5-3.5 cm. long, 1.8-2.5 cm. in diameter; stony coat smooth.

Geographic distribution: Fraser Island, Queensland.

13. Macrozamia fawcetti C. Moore

Moore, C., Jour. Roy. Soc. N. S. Wales 17:120 (1883), Handb. Flora N. S. Wales, p. 380 (1893).

Stem usually subterranean, ovoid, with an armor of densely tomentose leaf bases. Leaves 4-6 in a crown, 0.6-1.2 m. long, dark glossy green above, paler beneath, hairy when young, becoming glabrous. Petiole about one-third the length of the leaf, very smooth, very woolly at the base; rachis flat above, rounded or keel-shaped below, becoming subterete toward the apex of the leaf, much twisted. Leaflets 20-25 on each side, broadly linear-lanceolate, subfalcate, rounded or obtuse at the apex or tapering abruptly to a sharp point; callus red; many leaves with leaflets having 5 or 6 sharp spines at the tip or seldom more than 1 cm. from the tip; some leaves with leaflets having only 1 or 2 spines or none; leaflets 15-25 cm. long, 18 mm. wide with the broadest part above the middle; veins 10-12.

Male cones 20 cm. long, 6.5 cm. in diameter; peduncle long, woolly at base. Microsporophylls flat, with small sharp spines. Female cones 17 cm. long, 9 cm. in diameter; peduncle 7 cm. long. Megasporophylls 4.5 cm. wide, 1.2-2.5 cm. high, transverse ridge sharp, prolonged abruptly into a narrow spine 12-17 mm. long, which on both kinds of sporophylls [redacted] finer and narrower than in any other species. Seeds nearly globose, red, 2.8 cm. in diameter.

Geographic distribution: New South Wales along Richmond River, Acacia Creek, Crawford River, Limeburners Creek, Hunter River, Murrundi, Morriset, Tenterfield, Grafton. The presence of spines at the tips of some of the leaflets is very distinctive.

14. Macrozamia flexuosa C. Moore

Moore, C., Jour. Roy. Soc. N. S. Wales 17:121 (1883), Handb. Flora N. S. Wales, p. 380 (1893), ~~Proc. Linn. Soc. N. S. Wales 4, 227 (1880).~~

Stem subterranean, about 20 cm. long, 12 cm. in diameter, covered by an armor of slightly wooly leaf bases. Leaves 60-90 cm. long, considerably spirally twisted, flexuous. Petiole 16 cm. or more long, flat above, rounded below, smooth, wooly at base. Rachis flat above but somewhat raised between the two rows of leaflets, flattened or rounded angular below, glabrous. Leaflets erect, flexible, long linear-lanceolate, tapering rather abruptly to a pungent point, the apex with sometimes 2 or 3 small spines even in adult plants; largest leaflets 20-25 cm. long, 5-7 mm. wide, the lowest not much shorter than the rest; veins 7-9.

Male cones 15-18 cm. long, 5 cm. in diameter. Microsporophylls pointless at base of cone but with rather long sharp points at the top. Female cones ovoid, about 15 cm. long, 8 cm. in diameter, with a short smooth peduncle. Peltate part of megasporophylls broadly rhomboid, with a short spine at the base of the cone, increasing to 5 cm. at the top. Seeds orange-red, 2-2.5 cm. long, 1.7 cm. in diameter; micropyle excentric; stony coat smooth, corona 6-radiate.

Geographic distribution: New South Wales between Raymond Terrace and Stroud, Limeburners Creek, Stewart's Brook, Murrurandi, Acacia Creek, Crawford River at Bullahdelah. Charles Moore remarks that this species is very different in character and habit of growth from any other known to him.

15. Macrozamia pauli-guilielmi W. Hill and F. Muell.

Mueller, F. von, Fragm. Phytog. Austral. 1:86, 243 (1858); Bentham, G., Flora Austral. 6:251 (1873); Moore, C., Handb. Flora N. S. Wales, p. 380 (1893); Bailey, F. M., Queensl. Flora 5:1504 (1902).

Stem subterranean, ovoid, covered by an armor of densely woolly leaf bases. Leaves 16-20 in a crown, about 60 cm. or occasionally up to 1 m. in length, glabrous, more or less twisted. Petiole 10-12 cm. long, 6-8 mm. wide, the base broad and woolly and with thin scarious edges, the upper surface of the petiole and rachis very flat, rounded below, in dried specimens flat above and below. Leaflets up to 100 on each side, narrowly linear, falcate, revolute, pungent, the base contracted and bearing a prominent white callus, the tip with 1-3 small spines even in adult plants; 15-25 cm. long, 2-4 mm. wide; veins 2-4, prominent.

Male cones conical, 8-10 cm. long, 4 cm. in diameter; peduncle tomentose, 2.5-7 cm. long, Microsporophylls 12 mm. wide, 6 mm. high, the lower ones with a very small spine, the upper ones with a spine 4-6 mm. long, slightly recurved and pungent. Microsporangia small, covering the entire under surface. Female cones conical, glabrous, up to 13 cm. long, 8 cm. in diameter at the base; peduncle 4 cm. long, densely tomentose. Megasporophylls 2.5-3.5 cm. wide, 1.2-2 cm. high, with a very prominent transverse ridge prolonged in the center into an erect spine about 2.5 cm. long and not more than 2 mm. wide. Seeds angular, golden yellow, 2.5 cm. long; stony coat smooth, 11 bundles distinguishable.

Geographic distribution: Southeastern Queensland and into New South Wales. Near Stanthorpe and at Tinana Creek, Maryborough. The leaflets of the Maryborough plants are narrower than those at Stanthorpe. Maranoa River, Wide Bay, Mackenzie River, Moreton Bay, Maitland, Expeditionary Range.

16. Macrozamia heteromera C. Moore

Moore, C., Jour. Roy. Soc. N. S. Wales 17:122 (1883), Handb. Flora N. S. Wales, p. 380 (1893).

Stem subterranean, 15-20 cm. long, 8-10 cm. in diameter, with an armor of leaf bases covered by a reddish wool. Leaves 5-10 in a crown, seldom more than 60 cm. long, erect, sometimes glaucous but usually light green and glabrous, hairy when young, usually spirally twisted. Petiole 10 cm. long, the lower half densely and permanently woolly on the under side and edges but smooth on the upper surface; both petiole and rachis flat above and rounded below. Leaflets about 50 on each side, inserted on the edges of the rachis, cuspidate, tapering at the base; callus small, often red; 10-15 cm. long, some or most of the leaflets once, or twice, or three-times forked; when not forked, up to 7 mm. wide with 10 veins; when twice forked the terminal segments 1-3 mm. wide with 1-3 veins.

Male cones oblong-cylindric, about 25 cm. long and 6.5 cm. in diameter. Microsporophylls tapering to a short acute point. Female cones ovoid, 15-20 cm. long, 10-12 cm. in diameter; peduncle short, woolly at base. Megasporophylls few and large, 6 cm. wide, 3 cm. high, the lower ones with a transverse ridge merely acute in the middle, the upper ones with a narrow spine 10-15 mm. long and with a depression below it.

Geographic distribution: New South Wales—Warrumbungle Ranges, Castlereagh River country, Rocky Glen between Coonabarabran and Gunnedah, Narrabri, Tamworth. Plants at Narrabri are more robust, with glaucous leaflets seldom more than once forked (var. glauca C. Moore). Plants at Tamworth have very narrow glabrous leaflets usually twice forked (var. tenuifolia C. Moore).

6. ENCEPHALARTOS Lehm.

Lehmann, J. G. C., Nov. et minus cogn. stirp. pugillus 6: 1-14 (1834); Miquel, F. A. W., Monogr. Cycad. 39-60 (1842), Prodr. Syst. Cycad. 8-10, 18-22 (1861); De Candolle, A., Prodr. 16^{2}/:530-533 (1868); Prain, D., Flora Trop. Africa 6^{2}:346-354 (1917); Schuster, J., Pflanzenreich 4^{1}/:105-124 (1932); Hutchinson, J., and Rattray, G., Flora Capensis 5^{2}/(Suppl.):28-44 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:5-64 (1945).

Stem subterranean and tuberous or columnar and aerial, depending on the species; rarely branched; often 1-2 m. tall, rarely reaching a length of 15 m. (in E. laurentianus). Aerial stems and tops of subterranean stems covered with an armor of leaf bases (in E. latifrons and E. laurentianus on very old plants scaled off by repeated abscissions). Leaves usually many in a crown, generally more than 1 m. long (in E. laurentianus up to 6 m.); petiole usually unarmed but sometimes with two rows of spines representing reduced leaflets. Leaflets linear, linear-lanceolate, or ovate-lanceolate; rigid; entire or with spines, coarse teeth, or lobes; with "parallel" (dichotomous) venation. Vernation straight.

Male cones usually in groups of 2 or more, cylindric or ellipsoid, mostly long stalked. Microsporophylls peltate, more or less cuneate, short stalked or subsessile, the exposed portion thickened, rhomboid or rounded hexagonal, never ending in a spine but sometimes abruptly tapered into a truncate or depressed top (umbo), the lower surface densely covered with microsporangia. Female cones usually single but often in groups of 2 or more, ovoid or cylindric, mostly short stalked. Megasporophylls peltate, long stalked, flattened or somewhat cuneate, the exposed portion rhomboid or rounded hexagonal, with an irregularly toothed ridge or abruptly narrowed

into a truncate or depressed top (umbo); never ending in a spine. Seeds usually some shade of red, sometimes yellow or brownish.

The genus, with about 20 species, is confined to Africa, most of the species occurring in the southeastern part of South Africa, especially near the coast. A few are found in tropical Africa, even north of the equator. Name from ἐν κεφαλῇ (in head) and ἄρτος (bread). Encephalartos is often called Bread Palm or Kaffir Bread because the African natives use the large bud and the seeds to make a kind of bread. Type species: E. longifolius (Jacq.) Lehm.

Key to the Species

I. Stem subterranean or nearly so, rarely up to 1 m.

A. Leaves less than 70 cm. long; leaflets entire, less than 10 cm. long, lowest not reduced to spines 1. E. brachyphyllus

B. Leaves more than 70 cm. long; leaflets toothed or lobed, some entire, more than 10 cm. long

1. Leaflets with a sharp apex distinct from the marginal teeth, veins not more than 30

a) Leaflets linear-lanceolate

(1) Leaflets more than 12 mm. wide, green

(a) Leaflets thick, with 2 or 3 spines at apex, [redacted] up to 25 cm. long; sporophylls not umbonate . . . 2. E. villosus

(b) Leaflets thin, with pungent apex, [redacted] 12-15 cm. long; sporophylls umbonate . . . . 3. E. barteri

(2) Leaflets 8-12 mm. wide, glaucous . . 4. E. poggei

b) Leaflets ovate-lanceolate

(1) Leaflets with coarse spiny lobes, glaucous . . . . . 5. E. horridus

(2) Leaflets spinose-toothed, not lobate, green

(a) Leaflets 18-25 cm. long, 30 mm. wide 6. E. gratus

(b) Leaflets 10-13 cm. long, 18-25 mm. wide . . . . . 7. E. septentrionalis

2. Leaflets divided at apex into 3-5 triangular pungent lobes, oblong-elliptic, 6 cm. wide, veins 40-50 . . . . . 8. E. kosiensis

II. Stem an aerial trunk 1-9 m. tall

A. Leaflets entire, toothed, or lobed; cones not woolly: seeds red (orange in no. 16)

1. Leaflets glaucous, 13-16 mm. wide, entire or with 1 or 2 lobes on lower margin, lowest not reduced to spines . . . . . 9. E. lehmannii

2. Leaflets green, 2 cm. or more wide

a) Leaflets with 3 coarse lobes on lower margin, ovate-lanceolate, lowest not reduced to spines, veins prominent . . . . . 10. E. latifrons

b) Leaflets mostly entire, lanceolate

(1) Mature leaflets pubescent below, lowest reduced to spines, veins prominent; sporophylls not umbonate . . . . 11. E. paucidentatus

(2) Mature leaflets glabrous, lowest not reduced to spines, veins obscure; sporophylls umbonate . . . . 12. E. longifolius

c) Leaflets spinose-toothed, entire on very old plants, broadly linear-lanceolate, lowest not reduced to spines, veins obscure . . . . . 13. E. altensteinii

d) Leaflets spinose-toothed, lower ones with 4 or 5 lobes on upper margin, ovate-lanceolate, lowest reduced to spines, veins prominent . 14. E. woodii

e) Leaflets spinose-toothed, lowest reduced to spines

(1) Leaflets linear-lanceolate, 20-25 cm. long, 2 cm. wide; sporophylls umbonate . 15. E. hildebrandtii

(2) Leaflets ovate-lanceolate, 35-50 cm. long, 4-7 cm. wide; sporophylls not umbonate . . 16. E. laurentianus

B. Leaflets entire; cones very woolly; seeds yellow

1. Leaflets glabrous, 6-8 mm. wide, veins prominent

a) Leaflets up to 17 cm. long, linear, veins 8–10 . 17. E. friderici-guilielr

b) Leaflets up to 12–14 cm. long, lanceolate, veins 12 . 18. E. lanatus

2. Leaflets thinly pubescent, 1.5–2 mm. wide,

linear, veins 3–4, obscure . . . . . 19. E. ghellinckii

1. Incephalartos brachyphyllus Lehm. XX

E. caffer (Thunb.) Miq.

Zamia caffra

Thunberg, C. P., Nov. Act. Soc. Scient. Upsal. 2:285, as to fig. 5 and part of description only (1775), Prod. Fl. Cap. 2:92 (1800); Lehmann, J. G. C., Cat. Hort. Hamb., p. 97 (1836) ex Lehmann and De Vriese, Tijdschr. Nat. Gesch. 4:414 (1838); Miquel, F. A. W., Monogr. Cycad., pp. 49, 53 partly (1842), Prodr. Syst. Cycad. 9, 20 (1861); De Candolle, A., Prodr. 16[2]:532 (1868); Hutchinson, J., and Pattray, G., Flora Capensis 5[2] (Suppl.):29 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:13 (1945).

Stem subterranean, up to 45 cm. in length, covered with woolly leaf bases. Leaves about 14 in a crown, seldom more than 60 cm. long (suggesting the specific name), pubescent when young, becoming glabrous. Petiole 15-24 cm. long; petiole and rachis smooth but pubescent beneath. Leaflets about 60 on each side, crowded, approximately opposite in upper half of leaf, opposite or alternate below, narrowly linear-lanceolate, pungent, narrowed and decurrent at the base, entire in mature plants but with a few spines at the tip in seedlings and young plants; largest leaflets 9 cm. long and 10 mm. wide, the upper and lower ones shorter but none reduced to spines; veins 10-13, very prominent on the lower side.

Male cones usually single but sometimes 2 or 3, ovoid-cylindric, green, 20-30 cm. long, 5-7 cm. in diameter; peduncle about 12 cm. long. Microsporophylls cuneate, 3 cm. long, 3 cm. wide, 2.5 cm. high, rhomboid and concave at the top, rugose. Microsporangia 300-400, mostly in sori of 3, covering the entire under side except the exposed tip. Female cones usually single, ovoid, greenish yellow, nearly glabrous, up to 28 cm. long and 12 cm. in diameter; peduncle 6 cm. long. Megasporophylls up to

4.5 cm. wide and 2 cm. high, thin at sides and lower border, which is conspicuously toothed, the top rounded rhomboid and concave. Seeds broadly oblong, red, 2.3 cm. long, 1.8 cm. in diameter; stony coat with about 10 prominent ribs or grooves.

Geographic distribution: Abundant in the Ngoye region of Zululand, where it is associated with Stangeria paradoxa, extending south in the coastal country as far as East London and Bathurst.

This is the E. caffer Lehm. of Hutchinson and Rattray's account, the E. caffer Miq. of Schuster's monograph, and the E. caffer var. brachyphyllus of De Candolle. It is not the E. caffer of Sir Joseph Hooker, the large plant at van Staadens, which is correctly designated as E. longifolius Lehm. In his original description of Cycas caffra, Thunberg confused these two species. The name, E. caffer, has been applied by various authors to both species, while Lehmann, according to Schuster, applied it to E. horridus. The small plant of Zululand could not have suggested the names Encephalartos, Bread Palm, or Kaffir Bread.

2. Encephalartos villosus (Gaertn.) Lem.

Gaertner, J., De Fruct. et Semin. Plant. 1 (1788); Lemaire, C., Illus. Hort. 14:79 (1867); Dyer, W. T. T., Bot. Mag. 108: t. 6654 (1882); Smith, F. G., Bot. Gaz. 43:187-204 (1907); Sedgwick, P. J., Bot. Gaz. 77:300-310 (1924); Hutchinson, J., and Rattray, G., Flora Capensis 6[2] (Suppl.):30 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:17 (1945).

Stem stout, subterranean, very woolly, with armor of leaf bases distinct down to the root. Leaves usually not more than 3 or 4 in a crown, generally 2-3 m. long but occasionally up to 5m., gracefully curving, bright green, very woolly when young, becoming nearly glabrous when mature except at the base, where the woolly condition is permanent. Petiole terete; rachis flattened above and with two grooves, rounded below. Leaflets 50-100 on each side, approximately opposite, linear-lanceolate, pungent and with 1 or 2 strong spines close below the apex; upper margin with 3-6 strong spines and lower margin with 1-3, some plants with nearly entire leaflets but even these with the characteristic spines at the apex; largest leaflets up to 25 cm. long and 19 mm. wide, the lower ones gradually smaller and the lowest 5-15 reduced to spines; veins 15-25. Leaflets of seedlings oblanceolate, with more spines; the lowest smaller but not reduced to spines.

Male cones usually 2-7, cylindric, slightly tapering toward the apex, yellowish green and glabrous, 20-50 cm. long, 6-12 cm. in diameter; peduncle up to 25 cm. long. Microsporophylls 3.5-5 cm. long, 3.5-4 cm. wide, 2-2.5 cm. high; top rounded, rhomboid, its lower border crenate-denticulate. Microsporangia averaging 720 on larger sporophylls, mostly in sori of 3 or 4, covering the under surface. Female cones usually solitary but occasionally

up to 5, cylindric or subovoid, orange-yellow when ripe, glabrous, usually about 35 cm. long but varying from 20 to 50 cm., 8-16 cm. in diameter; peduncle up to 20 cm. long. Megasporophylls 3-4 cm. long, 2.5-3.5 cm. wide, 2.5-3.5 cm. high, overlapping downward, almost smooth, the top somewhat rounded rhomboid with a projection at each side, the lower border conspicuously and irregularly dentate. Umbo absent, the megasporophylls thus differing from the conspicuously umbonate ones of E. hildebrandtii. Seeds ellipsoid, scarlet, 4 cm. long, 2 cm. wide; stony layer 2.7 cm. long, 1.6 cm. wide, with 11-13 strong ridges.

Geographic distribution: South Africa--shaded localities from the Keiskama River northward into Natal and extending as far as Delagoa Bay; abundant near East London and Kentani; occurring from sea level to 500 m. elevation and from the coast to about 65 kilometers inland. According to Henderson, this species also occurs in Swaziland, where the plants have leaflets up to 2.5 cm. wide.

3. Encephalartos barteri Carruth. ex Miq.

Carruthers, W., ex Miquel, F. A. W., Arch. Néerl. 3:243, as to Barter's plant only (1868); Prain, D., Bot. Mag. 135: t. 3232 (1909), Flora Trop. Africa 6[2]:348 (1917).

Stem very short and subterranean, rarely rising above the ground and reaching a height of 30 cm., 20-25 cm. in diameter, ellipsoid, covered with woolly leaf bases. Leaves 1-1.7 m. long, erect or suberect, bright green. Petiole 10-12 cm. long; petiole and rachis subterete, tomentose at first, becoming glabrous. Leaflets about 80 on each side, opposite or subopposite, thinly coriaceous, linear-lanceolate, slightly falcate, acuminate, pungent, somewhat narrowed at the base, with about 4 small teeth along each margin, 12-15 cm. long, 12-18 mm. wide, lower leaflets smaller and passing into weak spines.

Male cones narrow cylindric, pale green, 12-20 cm. long, 4-5 cm. in diameter; peduncle 4-6 cm. long, sparingly tomentose at first, becoming glabrous. Microsporophylls deltoid, fertile portion 1.2 cm. long and 18 mm. wide; apex triangular, 2 cm. wide, the lateral angles acute, the lower very obtuse, umbonate. Female cones oblong-ellipsoid, dark olive-green, 20-25 cm. long, 12 cm. in diameter, subsessile. Top of megasporophylls wide rhomboid, 6 cm. wide, 3 cm. high, lateral angles explanate, upper very obtuse, lower obtuse, umbonate. Seeds ovoid-oblong, faintly angled, crimson, 3.5 cm. long, 2.5 cm. wide.

Geographic distribution: Tropical Africa—Gold Coast, Dahomey, northern Nigeria.

4. Encephalartos poggei Aschers.—

F. lemarinelianus De Wild. and Durand

Ascherson, P. F. A., Verh. Bot. Ver. Prov. Brandenburg 20:25 (1878); De Wildeman, E., and Durand, T., Compt.-rend. Soc. Roy. Bot. Belg. 39:80 (1900); De Wildeman, E., Études Fl. Bas.- et Moyen-Congo 1:9 (1903); Prain, D., Flora Trop. Africa 6[2]:349 (1917).

Stem short, 30-60 cm. high, occasionally up to 1-2 m., 20 cm. in diameter, ellipsoid or subcylindric, occasionally forked, closely covered with woolly leaf bases. Leaves 0.7-1.3 m. long, glaucous. Petiole and rachis subterete, tomentose at first and remaining so near the base. Leaflets 20-60 on each side, rigid, linear-lanceolate, slightly falcate, acute, pungent, abruptly and rather unequally narrowed at the base, the lower margin usually entire or occasionally with 2 or 3 teeth, the upper margin with 1-4 teeth mainly near the base or sometimes entire; 8-15 cm. long, 8-12 mm. wide.

Male cones narrowly cylindric, greenish or orange-yellow, 15-20 cm. long, 5-6 cm. in diameter; peduncle 10 cm. long, nearly glabrous. Microsporophylls deltoid, the fertile portion 1.9 cm. long, nearly as wide, the top rhomboid, 2.5 cm. wide, the lateral angles acute, the others very obtuse, ridged, not umbonate. Female cone oblong-ellipsoid, becoming pale salmon-colored, 20-23 cm. long, 11-12 cm. in diameter, subsessile. Apex of megasporophylls wide rhomboid, 4.5-5 cm. wide, 1.6-1.9 cm. high, lateral angles explanate, upper and lower very obtuse, surface divided into 3 or 4 facets, the center raised but not umbonate. Seeds ovoid, faintly angled, brownish red, about 2.5 cm. long.

Geographic distribution: Belgian Congo, in dry savannas.

5. Encephalartos horridus (Jacq.) Lehm.

Jacquin, N. J., Fragm. Bot. 1:27 (1809); Lehmann, J. G. C., Pugill. 6:14 (1834); Hutchinson, J., and Rattray, G., Flora Capensis 5[2] (Suppl.):32 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:20 (1945).

Stem subterranean or slightly raised above the ground, subspherical, about 15 cm. in diameter, longer in older plants; very woolly at the top. Leaves usually not more than 5-10 in a crown but in cultivation as many as 16, about 70 or occasionally up to 90 cm. long, often so recurved in upper portion that a circinate condition is permanent, glaucous until full grown. Petiole terete, 10-15 cm. long, smooth; rachis somewhat flattened above, rounded below, smooth. Leaflets 20-30 on each side, arising at a considerable angle from the rachis, approximately opposite, very thick and rigid, obliquely ovate-lanceolate, horribly sharp-pointed, contracted and slightly decurrent at the base, with 2 or 3 sharp-pointed lobes in different planes mainly on the lower margin, rarely with a lobe on the upper margin, the lower 3-5 leaflets on each side entire; leaflets 10-16 cm. long, 2-3 cm. wide (5 cm. including the lobes), the lowest only 2-3 cm. long but not reduced to spines; veins 15-30, obscure.

Male cones solitary, cylindric, tapering at the ends, yellow, about 30 cm. long and 6.5 cm. in diameter; peduncle about 8 cm. long. Microsporophylls broadly obovate, somewhat rounded in outline, short stalked, 2.4-4 cm. long, 1.8-3.5 cm. wide, the top rugose, low rhomboid-pyramidal with truncate rhomboid tip. Microsporangia covering the entire under surface except about 2 mm. at the sides. Female cones solitary, cylindric, 25-35 cm. long, 15-20 cm. in diameter, short stalked. Megasporophylls 5.5-6 cm. long, 4.3-4.5

cm. wide, 3 cm. high, the peltate top very rugose, low rhomboid-pyramidal with truncate apex about 1.5 cm. wide, with pointed projections extending down the sides and partly covering the seeds. Seeds oblong, slightly angular, red, 4.3–4.5 cm. long, the end next to the rachis flat. Stony coat 3 cm. long, 2 cm. wide, with 8–10 ridges conspicuous at base, distinguishable at the top, and with the intermediate three-quarters smooth.

Geographic distribution: South Africa—fairly well distributed in the Addo Bush, Uitenhage Division; Cuylor Manor between Port Elizabeth and Uitenhage, Bethelsdorp, in the Kanoia Scrub southwest of Grahamstown. I studied this species only at Despatch, near Port Elizabeth, where it is associated with Aloe, Cotyledon, shrubby Euphorbia, and other xerophytes that are so spiny that the region is almost impenetrable.

6. Encephalartos gratus Prain

Prain, D., Kew Bull., p. 181 (1916), Flora Trop. Africa 6: 352 (1917).

Stem usually very short, often entirely subterranean, globose or ellipsoid, 30-40 cm. high, 30 cm. in diameter; occasionally subcylindric, 1.25 m. high and 70 cm. in diameter; covered with woolly leaf bases. Leaves usually 1.2-1.5 m. or occasionally up to 2 m. long, dark green. Petiole and rachis subterete, permanently tomentose. Leaflets 30-70 on each side, firm, ovate-lanceolate, falcate, acuminate, pungent, oblique at the base and widely cuneate or rounded on the upper edge, narrowly cuneate on the lower edge, with 1-4 teeth on the lower margin and 2-4 strong teeth on the upper margin mainly in the lower half; the tip occasionally 2-spinescent, in young plants often 4-5-spinescent; 18-25 cm. long, 3 cm. wide.

Male cones up to 5 or more, ovoid to fusiform, yellow-green dotted with red, 30-40 cm. long, 8-10 cm. in diameter; peduncle 15-17 cm. long, tomentose. Microsporophylls wide obovate-deltoid, the fertile portion 2 cm. long and equally as wide; the top rhomboid and 2 cm. wide, lateral angles acute, upper very obtuse, ridged, faintly umbonate. Female cones sometimes up to 10, subcylindric to narrow conical, yellow-green, up to 60 cm. long, 15-20 cm. in diameter; peduncle 12-14 cm. long. Top of megasporophylls wide rhomboid, 5.5 cm. wide, 3 cm. high, lateral angles explanate, upper and lower very obtuse, umbonate near the lower angle. Seeds ellipsoid or ovoid, distinctly angled, dull vermilion, 3.3-3.8 cm. long.

Geographic distribution: Nyasaland, 700-900 m. elevation, usually in rocky places.

7. Encephalartos septentrionalis Schweinf.

Schweinfurth, G., Bot. Zeit. 29:334 (1871); Braun, A., Ind. Sem. Hort. Berol. p. 18 (1874); Prain, D., Flora Trop. Africa 6[2]: 350 (1917).

Stem usually very short, globose, 30 cm. in diameter, scarcely rising above the ground but sometimes cylindric and up to 60 cm. high, covered with woolly leaf bases. Leaves about 1.5 m. long, dark green, densely tomentose at first, becoming nearly glabrous. Petiole and rachis subterete, more or less tomentose. Leaflets about 50 on each side, firm, ovate-lanceolate, distinctly falcate, acute, pungent, abruptly and rather unequally rounded or wide-cuneate at the base, insertion broad, with 3-8 teeth along each margin mainly in the basal half; 10-13 cm. long, 18-25 mm. wide.

Male and female cones not available. Seeds ovoid, not angled, about 2.5 cm. long.

Geographic distribution: Central Africa—Ubangi-Shari Territory, Dar Banda, Boro Valley; Upper Nile Land—Golo, Bongo; Unganda; confined to savannas.

8. Encephalartos kosiensis Hutch.

Aitken, R. D., and Gale, G. W., Bot. Surv. S. Afr. Mem. 2:18 (1921); Hutchinson, J., Kew Bull., p. 512 (1952); Hutchinson, J., and Rattray, G., Flora Capensis 3/2 (Suppl.):34 (1933); Ogilvie, B. M. L., Kew Bull., pp. 655-657 (1939); Henderson, M. R., Jour. S. Afr. Bot. 11:27 (1945).

Stem up to 45 cm. high. Leaves up to 1 m. long, dark olive-green above, lighter below, glabrous. Petiole 8-11 cm. long; both petiole and rachis smooth and not grooved on the upper side. Leaflets about 25 on each side, crowded, slightly overlapping, not quite in one plane, mostly opposite, oblong-elliptic, without a definite apex but divided into 3-5 broadly triangular pungent lobes; base broad, unequal, the upper margin subcordate and the lower margin almost at a right angle to the rachis; margin firm and revolute, with 3 or 4 smaller lateral teeth on the upper margin and 0-3 on the lower, the number on the lower margin reduced toward the base of the leaf; largest leaflets at the middle of the leaf 16 cm. long and 6 cm. wide, decreasing toward the base until the lowest 1-3 pairs are little more than spines; veins in largest leaflets 40-50, rather obscure. Even in a 2-year-old seedling, leaflets so characteristic that species can be identified.

Male cones 1-3, cylindric, orange-brown, glabrous, tapering slightly at both ends, 39 cm. long, 9-10 cm. in diameter; peduncle 12 cm. long, pubescent at the base. Microsporophylls obovate, 2.5-3 cm. wide, 1-1.5 cm. high, the top rhomboid and slightly rugose, with an irregularly rhomboid, flat, smooth area at the tip about 1.5 cm. wide and nearly 1 cm. high. Female cones mostly solitary, ovoid, orange but turning yellow at maturity, glabrous, about 27 cm. long, 19-20 cm. in diameter; peduncle 8-10 cm. long, cream-colored,

glabrous. Megaporophylls very rugose, almost echinate on the unexposed surfaces, the top rhomboid, 3.5-5.5 cm. wide, 2.5-3.5 cm. high, with a smooth, slightly convex, irregularly rhomboid tip. Seeds orange, 4.5 cm. long and 1.5 cm. in diameter; stony coat 2.5-2.8 cm. long, 1.5 cm. in diameter, with 11-14 bundles.

Geographic distribution: Zululand—east of Ingwavuma, near Kosi Lake; Kosi Bay.

9. Encephalartos lehmannii Lehm.

Lehmann, J. G. C., Pugill. 6:14 (1834); Hooker, W. J., Bot. Mag. 89: t. 5371 (1863); Hutchinson, J., and Rattray, G., Flora Capensis 5[2] (Suppl.):34 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:27 (1945).

Stem often 1 m. in height and occasionally up to 3 m., not woolly. Leaves about 1 m. long, the tip recurved but less so than in E. horridus, both young and old so glaucous that the plant has a characteristic grayish green color. Petiole about 20 cm. long, subterete, smooth; rachis somewhat grooved above, rounded below. Leaflets 30-50 on each side, opposite or alternate, not overlapping, linear-lanceolate, pungent, entire or with 1 or 2 strong-pointed lobes on the lower margin resembling those of E. horridus; 12-18 cm. long, 13-16 mm. wide, the lowest about 1.5 cm. long; veins 15-18, obscure on the lower side and hardly distinguishable above.

Male cones ellipsoid, reddish, about 18 cm. long and 8 cm. in diameter, short stalked. Microsporophylls 3.5 cm. long, 1.5 cm. wide, sterile top tapering rhomboid, almost as long as the fertile part, curved and flat at the top; microsporangia about 200. Female cones ellipsoid, reddish brown, about 45 cm. long and 30 cm. in diameter, subsessile. Megasporophylls 6 cm. long, 4 cm. wide, the peltate top irregularly rhomboid, very rugose, 3 cm. long, with rounded truncate tip and long-pointed lateral and median projections extending downward half the length of the seeds. Seeds red, 4 cm. long and 2.2 cm. wide, the tip truncate hexagonal; stony coat 3 cm. long, 1.8 cm. wide, with 12 bundles.

Geographic distribution: South Africa--in dry places from Willowmore Division to Grahamstown, in Bedford, Queenstown, Komgha, and on the Tsoma River in the Nquamqwe District. I studied this

species only in the Junction Farm region. Fine specimens have been set out on lawns throughout its entire range. Henderson regards E. lehmannii as a composite species and describes a number of segregates which he designates as forms, all of which are unnamed. I. C. Verdoorn, in Jour. S. Afr. Bot. 11:1-3 (1945) describes a new species, E. eugene-marasii, from the Waterberg District, Transvaal. It differs from E. lehmannii in several minor respects and is doubtfully distinct.

10. Encephalartos latifrons Lehm.

Lehmann, J. G. C., Tijdsch. Nat. Gesch. 4;424 (1837); Hutchinson, J., and Rattray, G., Flora Capensis 5 (Suppl.): 36 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:22 (1345).

Stem stout, up to 3 m. in height and 40 cm. in diameter, seldom branched, with an armor of leaf bases which becomes obscurred by repeated abscissions. Leaves 8-12 in a crown, about 1 m. long, strongly recurved at the tip, dark green above and lighter below, pubescent when young, becoming nearly glabrous. Petiole about 12 cm. long, terete, with a white ring at the base; rachis with two grooves above, rounded below, both the petiole and rachis smooth. Leaflets 20-30 on each side, opposite or alternate, overlapping, ovate-lanceolate, pungent, with usually 3 triangular spinescent lobes on the lower margin and rarely a small lobe on the upper margin; insertion very broad, up to 1.5 cm.; largest leaflets 15 cm. long, 3-5 cm. wide exclusive of the lobes; veins 30-50, very prominent below, obscure above. Young leaflets flat, becoming revolute as they mature and very revolute when dead and dry.

Male cones cylindric, rounded below and tapering above, brownish yellow, smooth, up to 70 cm. long, 15 cm. in diameter; peduncle 5 cm. long. Microsporophylls almost sessile, 6 cm. long, the fertile part 3 cm. wide at the top and 1.5-2 cm. wide at the bottom, the sterile top prolonged rhomboid, rugose, 1 cm. wide at the tip. Microsporangia 900-1,100, mostly in sori of 3 and 4, covering the under surface except notches at the top and bottom and 2 mm. at the thin sides. Female cones solitary, ovoid-ellipsoid, green, 60 cm. long, 20-30 cm. in diameter, 25-30 kilos in weight, subsessile. Megasporophylls long stalked, 6 cm. long, 7 cm. wide,

the sterile top irregularly rhomboid, umbonate, rugose, tapering to a small flattened tip. Seeds bright red, 4.1-5.5 cm. long, 2.7-3 cm. wide, the fleshy layer prolonged above and equalling half the length of the stony layer, irregularly hexagonal at the flat top. Stony coat 2.5-3 cm. long, 2 cm. wide, with 10-13 easily recognizable bundles.

Geographical distribution: South Africa—Uitenhage and Bathurst Divisions. According to Rattray, this species does not occur as far south as Bathurst or as far north as Grahamstown, and is most abundant at Trapps Valley, where I studied it.

As seen in the field, this species is one of the most characteristic of all cycads. Since descriptions written from herbarium sheets have made it a variety of E. horridus, it is worth while to note that E. latifrons has a tall, massive, aerial trunk, larger leaves with broader, nearly glabrous leaflets, microsporophylls with about 1,000 sporangia, and immense female cones weighing up to 30 kilos. E. horridus, on the other hand, has a subterranean stem, smaller leaves with narrower glaucous leaflets, microsporophylls with probably not more than 500 sporangia, and comparatively small female cones seldom weighing more than 4 kilos.

11. Encephalartos paucidentatus Stapf and Burtt Davy

Stapf, O., and Burtt Davy, J., in Burtt Davy's Flora Transvaal 1:40, 99 (1926); Hutchinson, J., and Rattray, G., Flora Capensis 5 (Suppl.):40 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:48 (1945).

Stem about 2 m. high and 30 cm. in diameter. Leaves about 2.4 m. long, somewhat twisted, green, more or less pubescent when young, becoming glabrous or nearly so above, the petiole about one-quarter as long as the rachis. Leaflets about 70 on each side, somewhat separated below, overlapping above, opposite or alternate, very rigid, narrowly lanceolate, subfalcate, pungent, mostly entire but the lower ones with a spine on the lower margin; middle leaflets about 25 cm. long and 2.5-3 cm. wide, the lower ones rather abruptly reduced to spines; veins 20-30, prominent.

Male cones glabrous, 45-60 cm. long, 15 cm. in diameter. Microsporophylls broadly oblong-lanceolate, 6.5 cm. long, the lower ones with a subrhomboid top and an irregularly toothed margin, the upper ones broadly acuminate and very rugose. Microsporangia nearly covering the under surface. Female cones not available.

Geographic distribution: Northeastern Transvaal, in partial shade at 1,000-1,300 m. elevation.

12. Encephalartos longifolius (Jacq.) Lehm.

E. lanuginosus Lehm.

E. caffer Hook. f.

Jacquin, N. J., Fragm. Bot. 1:28 (1809); Lehmann, J. G. C., Pugill. 6:14 (1834); Hooker, J. D., Bot. Mag. 82: t. 4903 (1856); Hutchinson, J., and Rattray, G., Flora Capensis 5[2] (Suppl.):38 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:40 (1945).

Stem often more stocky than in E. altensteinii, the largest 2-3 m. or rarely 4 m. high, 30-40 cm. in diameter, rarely branched; not woolly. In plants 1.5 m. tall, leaves about 15 in a crown or occasionally up to 30, the largest 1.2-1.6 m. long, usually with a characteristic curve like that of E. horridus but less pronounced, bluish green, finely pubescent at first, becoming glabrous. Petiole about 25 cm. long, flattened above, smooth, hairy when young, with a white ring at the base; rachis with a thick rib above, rounded below. Leaflets 30-40 on each side, crowded, semi-erect, very rigid, obliquely linear-lanceolate, obtuse or sharply acute and pungent, contracted and rather broad at the base, in young plants as spiny as in E. altensteinii and resembling that species, in plants more than 1 m. tall most leaflets entire but sometimes with an occasional spine on lower ones; largest leaflets 12-20 cm. long, 2.5-3.5 cm. wide, lower leaflets smaller; rather obscurely veined.

Male cones 1-12, cylindric, rounded above and tapering below, greenish brown, the larger ones 45-60 cm. long, 10-20 cm. in diameter; peduncle up to 5 cm. long. Microsporophylls 4-6 cm. long, 2-2.5 cm. wide, the fertile part subcuneate; the exposed top narrowed, quadrangular, recurved and flat at the tip, in the upper part of the cone as long as the fertile area but elsewhere less than one-third as long. Microsporangia averaging 650 on the

larger sporophylls, mostly separate but a few in sori of 3 and 4, covering the under surface except 1-2 mm. at the sides and, in the upper part of the cone, with a pointed sterile region above and below. Female cones usually solitary, cylindric, brown, 35-60 cm. long, 30-35 cm. in diameter, subsessile; when solitary up to 45 kilos in weight. Megasporophylls rhomboid in surface view, rugose, the top truncate and umbonate. Seeds broadly oblong, red, 4-5 cm. long, about 2.5 cm. in diameter; stony coat 3.2-3.5 cm. long, 2.2-2.5 cm. wide, smooth but with 11-14 bundles visible around the micropyle.

Geographic distribution: On rocks and slopes at van Staadens, about 30 kilometers west of Port Elizabeth, Union of South Africa. This is the type locality. Also recorded from Lower Albany, Komgha, Kattraria, and Natal. I studied the species at van Staadens, where it is associated with Schizaea pectinata, Todea barbara, Erica watsonia, Gladiolus, etc. It is also common in gardens and on lawns. This cycad, more than any other, is called the Kaffir Bread or Bread Palm. Many plants from which the tops were cut off for Kaffir bread a hundred years ago have new trunks growing from the wounded surface.

13. Encephalartos altensteinii Lehm.

Lehmann, J. G. C., Pugill. 6:11 (1834); Hooker, J. D., Bot. Mag. 117: t. 7162, 7163 (1891); Hutchinson, J., and Rattray, G., Flora Capensis 5[2] (Suppl.):39 (1933); Henderson, M. R., Journ. S. Afr. Bot. 11:41 (1945).

Stem usually not more than 2 m. high but occasionally up to 5 m., 20-30 cm. in diameter, the longest trunks prostrate with the growing apex turned up and bearing the crown of leaves and with young stems growing from the base. Leaves 25-40 in a crown, up to 1.5 m. long, slightly curved, dark yellow-green, paler beneath, glabrous when mature. Petiole 20-30 cm. long, subterete, widely spreading at the base, becoming glabrous; rachis rounded, with two grooves above. Leaflets 40-70 on each side, mostly opposite, broadly linear-lanceolate, pungent, revolute; in plants less than 2 m. high with 1-6 sharp spines on the upper margin and 1 or 2 less below; in old plants more than 2 m. high with all or nearly all the leaflets entire (the leaf then resembling that of E. longifolius); leaflets up to 18 cm. long and 2.5-3 cm. wide, the lower leaflets smaller but not reduced to spines; veins about 30, usually inconspicuous.

Male cones usually more than 1, cylindric, tapering gradually to apex and base, yellowish, 30-40 cm. long, 8-10 cm. in diameter; peduncle about 5 cm. long. Microsporophylls cuneate, sessile, 3.5-4 cm. long, 2-2.5 cm. wide; the top rugose, pointed, reflexed, with the tip rounded concave. Microsporangia about 560, mostly in sori of 3, separated at the top into two groups by a pointed sterile portion extending 2-5 mm. downward. Female cones one or several, long ovoid, yellowish brown, 40-50 cm. long, 20-25 cm. in diameter, about 2 kilos in weight when borne singly,

subsessile. Megasporophylls 8 cm. long, 6.5 cm. wide; the peltate top truncate, rhomboid-umbonate, very rugose, the tip rounded, 1.5 cm. in diameter, concave with a shallow groove extending backward and with two lateral pointed projections extending downward and partly covering the seeds. Seeds oblong, red, 4.5-5.5 cm. long, 2.5 cm. in diameter; stony coat 3 cm. long, 2.5 cm. in diameter, smooth above but with 10 conspicuous bundles, strong and forked below.

Geographic distribution: South Africa—from Kowie River in Bathurst Division northeast to Natal and eastern Transvaal; in the south extending from the coast to the Amatola Mountains; usually in shaded localities. I studied this species in the field at East London and Trapps Valley. It is planted in many botanical gardens and on many private lawns, where specimens are usually 1-2 m. in height. The form growing in Transvaal has been named E. transvenosus by Stapf and Burtt Davy in Burt Davy's Flora Transvaal 1:40, 99 (1926), a species also recognized by Henderson.

14. Encephalartos woodii Sander

E. altensteinii var. bispinna J. M. Wood

Wood, J. M., Ann. Rep. Bot. Gard. Natal, p. 8 (1907); Sander, F., Gard. Chron. 43:257 (1908); Prain, D., Kew Bull., p. 250 (1914); Hutchinson, J., and Rattray, G., Flora Capensis 6 (Suppl.):40 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11: 47 (1945).

Stem of larger plants 3-6 m. high and 20 cm. in diameter; occasionally branched. Leaves 25-30 in a crown, 1.3-2 m. long, slightly recurved, bright green and glabrous. Leaflets 60 or more on each side, mostly alternate, ovate-lanceolate, ovate in the lower part of the leaf, pungent, abruptly narrowed at base, the broader leaflets in the lower half of the leaf with 4 or 5 crowded spiny lobes on the proximal upper margin and 3 or 4 shorter lobes or spines on the distal upper margin, the spiny condition much less pronounced on the lower margin; middle leaflets up to 20 cm. long, 4 cm. wide; somewhat lower leaflets 17 cm. long, 5 cm. wide exclusive of the lobes; lowest leaflets gradually reduced to spines; veins about 40, prominent on the under side of broader leaflets.

Male cones usually more than 1, up to 18, cylindric, orange-yellow, up to 90 cm. long. Microsporophylls 6 cm. long, 3 cm. wide, the exposed part triangular with truncate top. Microsporangia 600-700, mostly in sori of 3, somewhat separated into two groups by sterile notches at top and bottom. No female cones have ever been described or even reported.

Geographic distribution: Ngoye, Zululand.

15. Encephalartos hildebrandtii A. Br. and Bouché

Braun, A., and Bouché, C., Ind. Sem. Hort. Berol., p. 8 (1874); Braun, A., Monatsb. Akad. Wiss. Berlin, p. 859 (1876), Sitzungsb. Gesell. Naturf. Freunde, 117-123 (1876); Stapf, O., Kew Bull., p. 386 (1914), Bot. Mag. 141: t. 8592 and 8593 (1915); Prain, D., Flora Trop. Africa 6[2]:351 (1917).

Stem cylindric, 1 m. or more high, occasionally up to 6 m., 30 cm. in diameter, seldom branched. Leaves 2-2.5 m. long, dark green above, paler beneath, very woolly when young, becoming glabrous. Petiole and lower third of rachis subterete, slightly 2-grooved above. Leaflets 50-90 on each side, ~~firm~~ rigid, linear-lanceolate, slightly falcate, acute, pungent, long cuneate at the base, with 3 or 4 sharp spines on the upper border and 1 or 2 less on the lower border, frequently with the characteristic 3-spinescent tip of E. villosus; the middle leaflets 20-25 cm. long and about 20 mm. wide, the upper ones 10 cm. long and 5 mm. wide, the lower ones gradually reduced to spines. Leaflets of seedlings oblanceolate with numerous spines at the rounded apex.

Male cones often more than 1, sometimes up to 7, ovate to cylindric, greenish or reddish, 20-45 cm. long, 6-10 cm. in diameter; peduncle 9 cm. long, tomentose. Microsporophylls obovate-deltoid, 3-3.5 cm. long, 1.5-1.7 cm. wide, the top rhomboid or hexagonal, with sharp radial lines extending horizontally and vertically from the apex, not umbonate. Female cones cylindric, yellowish green, 25-60 cm. long, 10-20 cm. in diameter, subsessile. Exposed top of megasporophylls rounded rhomboid, up to 5 cm. wide and 2.5 cm. high, distinctly umbonate, a shallow groove extending above and backward from the truncate apex. Seeds ellipsoid or ovoid, red, 3.5 cm. long, 2 cm. wide, the apex broadly truncate;

stony coat 3 cm. long, 1.5 cm. wide, with 10 strong bundles very prominent at the oblique base.

Geographic distribution: Kenya and Tanganyika Territory, confined to a narrow coastal belt extending from Mombasa to Dar-Es-Salaam; also on Zanzibar Island. Related to E. villosus (Gaertn.) Lem.

16. Encephalartos laurentianus De Wild.

De Wildeman, E., Études Fl. Bas- et Moyen-Congo 1:10 (1903); Prain, D., Flora Trop. Africa 6[2]:353 (1917); Lebrun, J., Rev. Zool. et Bot. Afr. 19:387 (1930).

Stem 4-9 m., rarely up to 15 m. in length, 50-75 cm., rarely 1.25 m. in diameter, cylindric, generally becoming prostrate with age, gray at first, becoming ivory white, leaf bases persistent for awhile, finally falling away. Leaves 3-6 m. long, dark green, glabrous. Petiole and rachis slightly angular, woolly at first, becoming glabrous. Leaflets up to 120 on each side, opposite, firm, ovate-lanceolate, falcate, acuminate, pungent, very oblique at the base and rounded on the upper edge, straight or concave on the lower edge, with 6-10 strong teeth along both margins except in the lower third, the tip in young plants occasionally 3-4-spinescent; 35-50 cm. long, 4-7 cm. wide; veins about 35. lowest leaflets reduced to spines;

Male cones 2-6, rarely 8, ovoid to narrow cylindric, pale green to bright red, tomentose, 20-35 cm. long, 6-10 cm. wide; peduncle 15-30 cm. long, tomentose. Microsporophylls obovate-deltoid, the fertile portion 2 cm. long, almost as wide, the apex rhomboid, 1.6-1.9 cm. wide, the lateral angles acute, the upper very obtuse, ridged, not umbonate. Microsporangia in two groups separated by a sterile line, in sori of 2-5. Female cones usually in 2's or 3's, oblong-ellipsoid, grayish green, about 45 cm. long and 20 cm. in diameter, subsessile. Megasporophylls 7 cm. long, the apex wide rhomboid, 6.5 cm. wide, 2 cm. high, lateral angles explanate, upper and lower very obtuse, vertically 2-ridged, not umbonate. Seeds ovoid-oblong, faintly angled, red or orange, 4 cm. long, 2 cm. wide.

Geographic distribution: Uganda, Belgian Congo, Angola.

17. Encephalartos friderici-guilielmi Lehm.

E. cycadifolius (Jacq.) Lehm. (?)

Jacquin, N. J., Fragm. Bot. 1:27, partly, as to t. 26 only (1809); Lehmann, J. G. C., Pugill. 6:8, 13 (1834); Hutchinson, J., and Rattray, G., Flora Capensis 5[2] (Suppl.):42 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:50 (1945).

Stem usually 1-2 m. high, occasionally up to 4 m., diameter of larger trunks 40-45 cm.; terminal bud the most woolly of all cycads, the woolly condition extending down four crowns, then diminishing until the trunk becomes smooth; petioles weathering off slowly for many years before abscission layer cuts them off smoothly, making the diameter of the trunk much greater at the top. Leaves 40-60 in a crown, a new crown appearing every year and remaining green for two years; 1-1.5 m. long, straight or nearly so; blue-green and woolly when young, becoming yellowish green and glabrous. Petiole up to 25 cm. long; petiole and rachis woolly, rounded below, broadly flattened and with two grooves above. Leaflets 50-125 on each side, separated below, overlapping above, mostly opposite, rigid, linear, straight or nearly so, pungent, revolute, entire but with an occasional spine in young plants; larger leaflets 17 cm. long and 6 mm. wide, upper and lower leaflets somewhat smaller but the latter not reduced to spines; veins 8-10, very prominent on the under side.

Male cones usually more than 1, long ellipsoid, densely covered with felt-like brownish wool, 20-25 cm. long, 6-8 cm. in diameter; peduncle about 4 cm. long. Microsporophylls thin and flat, 2.5-3 cm. long, 2.5-2.8 cm. wide, average number of microsporangia 800, in sori of 4 or 5, occasionally 6, mostly

in two groups separated by a sterile line and with a sterile margin about 2 mm. wide. Female cones usually 3-7 in a circle, from the axils of leaves, ellipsoid, very densely woolly, 15-25 cm. long, 12-15 cm. in diameter. Megasporophylls 5-6 cm. long, 4-5 cm. wide; peltate top extremely woolly, rugose, with two pointed lateral lobes and a median lobe extending downward and partly covering the seeds. Seeds yellow, 3.8-5 cm. long, 3-3.8 cm. in diameter; stony coat 2.3 cm. long, 1.5 cm. wide, nearly smooth, with 10 bundles.

Geographic distribution: South Africa—abundant at Queenstown, disappearing a little farther north, and extending south to the Amatola Mountains; common around the Thomas River but not reaching to the Toise River to the south; east to the village of Toslo. I studied this species on dolorite rocks at Queenstown and on the Windvogelberg at Cathcart.

18. Encephalartos lanatus Stapf and Burtt Davy

Stapf, O., and Burtt Davy, J., in Burtt Davy's Flora Transvaal 1:40, 99 (1926); Hutchinson, J., and Rattray, G., Flora Capensis 5[2] (Suppl.):43 (1935); Henderson, M. R., Jour. S. Afr. Bot. 11:52 (1945).

Stem up to 3 m. high. Leaves numerous, about 85 cm. long, glaucous when young, becomes glabrous. Petiole 12 cm. long; rachis subterete, woolly when young. Leaflets about 90 on each side, crowded, overlapping in upper part of leaf, opposite, lanceolate, pungent, entire, the largest 12 cm. long, 6-8 mm. wide, lower leaflets smaller but not reduced to spines; veins 12-14, prominent on the under side.

Male cones cylindric, densely woolly, 15 cm. long, 5 cm. in diameter, short stalked. Microsporophylls about 2 cm. wide, narrowly rhomboid at the top. Female cones solitary or several together, abruptly narrowed at each end, densely woolly, about 18 cm. long and 8 cm. in diameter, short stalked. Megasporophylls broadly rhomboid, about 5 cm. wide, 2.5 cm. high, densely but shortly tomentose except toward the margin, which forms a thick glabrous callus. Seeds broadly ellipsoid, probably yellow, about 2.5 cm. long.

Geographic distribution: Eastern Transvaal, from Middleburg through the Godwan River area to Barberton, north to Lyndenburg; generally at elevations of 1,000-1,700 m. This species is related to E. friderici-guilielmi Lehm.

19. Encephalartos ghellinckii Lem.

Lemaire, C., Illus. Hort. 14:80 (1867); Seward, A. C., Proc. Cambr. Phil. Soc. 9:340 (1897); Hutchinson, J., and Rattray, G., Flora Capensis 5[2] (Suppl.):43 (1933); Henderson, M. R., Jour. S. Afr. Bot. 11:57 (1945).

Stem stout, up to 2 m. or rarely 3 m. high and 60 cm. in diameter, usually leaning or prostrate in plants more than 1 m. high, woolly. Leaves 20-30 in a crown, up to 1 m. long, densely grayish tomentose at first, becoming thinly pubescent or glabrous, dark green. Petiole 20-30 cm. long, woolly until quite mature, the base permanently woolly; rachis flattened above, triangular below, sometimes twisted, woolly. Leaflets 20-50 on each side, mostly opposite, narrowly linear, pungent, entire, the larger ones 15 cm. long, 1.5-2 mm. wide, strongly revolute, the lower leaflets somewhat smaller but not reduced to spines; veins 3 or 4, obscure.

Male cones ellipsoid, narrowed below and rounded above, very woolly, up to 23 cm. long and 9 cm. in diameter, subsessile. Microsporophylls elliptic at the top, with thin wide margins, the under side covered with microsporangia except at the margins. Female cones ellipsoid, woolly, 20-38 cm. long, 15-23 cm. in diameter, subsessile. Megasporophylls few and large in relation to the size of the cone, up to 7 cm. wide and 3 cm. high; the apex rounded truncate or somewhat concave, about 7 mm. in diameter, the sides tapering to a thin edge. Seeds broadly ellipsoid, brown or yellow with a tinge of red below, about 3 cm. long.

Geographic distribution: Natal--from sea level at Umkomaas, near Durban, to 2,700 m. on the eastern slopes of the Drakensberg.

Can't find *Encephalartos ferox* mentioned.

Original publication checked Dec. 7, 1957 at Crerar.

Encephalartos ferox G. Bertoloni, Mem. della Accad. delle Sci. dell'Istit. di Bologna 3: 264. 1851.

The author's name needs checking. I believe it is listed in Kew as Bertoloni f.

John W. Thieret

7. MICROCYCAS A. DC.

Miquel, F. A. W., in Van Houtte's Fl. Serres et Jard. 7: 141 (1851); De Candolle, A., Prodr. 16/2:538 (1868).

Stem aerial and columnar, up to 10 m. in height, frequently branched, usually ringed by the alternation of scars of leaf bases and of bud scales; rings disappearing in old plants and the trunk becoming smooth. Leaves many in a crown, about 1 m. in length; petiole unarmed. Leaflets narrowly lanceolate, entire, jointed at the rachis, deflexed in old plants, with "parallel" (dichotomous) venation. Vernation of the rachis subcircinate, of the leaflets straight.

Male cones solitary, cylindric, short stalked. Microsporophylls flat, cuneate below, the sterile tip ovate and rather blunt. Microsporangia covering the entire basal two-thirds of the lower surface. Female cones solitary, cylindric, short stalked. Megasporophylls peltate, long stalked, the top cuneate, convex, and with three rounded shallow grooves on each side. Seeds red.

A single species, confined to a relatively small area in western Cuba, where it occurs in scattered patches with few individuals. Name from μικρος (small) and Cycas, a most unfortunate choice, since it is one of the tallest of cycads. Type species: M. calocoma (Miq.) A. DC.

Microcycas was first described as Zamia calocoma Miq., and plants of Zamia pumila may have been distributed as Microcycas calocoma; but its appearance in the field is so characteristic that no one could mistake it for any other cycad. De Candolle made the first fairly adequate description and Caldwell the first description of specimens in the field. The following is based on Caldwell's account, together with observations by H. A. van Hermann and by Dorothy Downie, and on my own study extending over the entire known range of the species.

1. Microcycas calocoma (Miq.) A. DC.

Miquel, F. A. W., in Van Houtte's Fl. Serres et Jard. 7:141 (1851); De Candolle, A., Prodr. 16[2]:538 (1868); Caldwell, O. W., and Baker, C. F., Bot. Gaz. 43:330-335 (1907); Caldwell, O. W., Bot. Gaz. 44:118-141 (1907); Downie, D. G., Bot. Gaz. 85:437-450 (1928); Schuster, J., Pflanzenreich 4[1]:128-130 (1932); Cendrero, O., Mem. Soc. Cub. Hist. Nat. 14:175-182 (1940); Foster, A. S., and San Pedro, M. R., Mem. Soc. Cub. Hist. Nat. 16:105-121 (1942).

Stem up to 10 m. tall and 66 cm. in diameter. Leaves up to 40 in a crown, about 1 m. long, bright green, finely tomentose when young, becoming glabrous. Petiole 10 cm. long, terete, [redacted] swollen at the base. Leaflets 50-80 on each side, opposite or alternate, bluntly pointed, callused at the base, slightly revolute, 8-20 cm. long, with 15-20 veins. Bud scales 4-6 cm. long, 1-1.5 cm. wide, woolly except on the lower half of the inner face.

Male cones solitary, cylindric, 25-30 cm. long, 5-8 cm. in diameter, with a woolly peduncle 2.5 cm. long. Microsporophylls 2.2-2.7 cm. long, 1.5-2 cm. wide, obtuse, the upper third tomentose, the basal two-thirds of the lower surface covered by 150-200 microsporangia not separated by a sterile median line. Microsporangia commonly 2 in a sorus, occasionally 1 or 3. Female cones borne singly, cylindric, tapering slightly from base to apex, 50-70 cm. long, 13-16 cm. in diameter, and weighing up to 9.5 kilos; peduncle short and woolly, with several [redacted] scale leaves. Megasporophylls 4.5-5 cm. long; peltate top thickened, convex, rhombic, 2-3 cm. high, hairy, with 3 rounded shallow grooves on each side; peduncle 3-3.5 cm. long, perpendicular to the cone axis. Seeds red, 2.5-3 cm. long, 1.8-2.5 cm. in diameter. Stony layer smooth, with indistinct corona; impressions of bundles hardly recognizable except at the chalaza.

Geographic distribution: Province of Pinar del Río, in western Cuba, from San Diego de los Baños to Sumidero, especially on the lowlands and mountains to the north of Consolación del Sur and Herradura. In geographic distribution and number of individuals Microcycas calocoma may be the most restricted species in the Cycadaceae.

8. CERATOZAMIA Brongn.

Brongniart, A., Ann. Sci. Nat. sér. 3, 5:5-9 (1846); Miquel, F. A. W., Prodr. Syst. Cycad. 10-11, 22-23 (1861); De Candolle, A., Prodr. 16[2]:546-547 (1868); Standley, P. C., Contr. U. S. Nat. Herb. 23[1]:49 (1920); Schuster, J., Pflanzenreich 4[1]:130-132 (1932).

Stem aerial and columnar, rarely branched, seldom more than 1 m. high, covered by an armor of persistent leaf bases in which large stipules play a conspicuous part. Leaves in large plants 10-20 in a crown, up to 1-2 m. long; petiole with scattered spines, except in C. kuesteriana. Leaflets lanceolate or linear, entire, jointed at the rachis, with "parallel" (dichotomous) venation. Vernation of rachis somewhat circinate, of leaflets straight or slightly curved.

Male cones solitary, long cylindric, tapering toward the apex, long stalked. Microsporophylls peltate, broadly cuneate, tapering to a narrow stalk, with two stout horns on the flat hexagonal top. Microsporangia covering the entire lower surface without a sterile line except at the exposed tip. Female cones solitary, cylindric, long stalked. Megasporophylls peltate, with a narrow stalk and two stout horns on the flat hexagonal top. Both kinds of sporophylls seem to be arranged in regular rows. Seeds white. Ceratozamia is the only cycad known to have but one cotyledon.

The genus includes at least 6 species and is probably confined to Mexico. Name from κέρας (horn) and Zamia. Type species: C. mexicana Brongn. The presence of two horns on the sporophylls is a distinctive feature of the genus. The species, especially C. mexicana, are so variable, that detailed field studies must precede any final diagnoses.

Key to the Species

I. Petiole very spiny near the base, less so above

A. Leaflets 10–20 mm. wide . . . . . 1. *C. mexicana*

B. Leaflets 3–7 mm. wide . . . . . 2. *C. purpusii*

II. Petiole sparsely spinescent

A. Leaflets 7–15 mm. wide . . . . . 3. *C. matudai*

B. Leaflets more than 3 cm. wide

1. Leaflets 30–40 cm. long, 3–5 cm. wide . 4. *C. latifolia*

2. Leaflets 20–30 cm. long, 5–7 cm. wide . 5. *C. micueliana*

III. Petiole unarmed . . . . . 6. *C. kuesteriana*

1. Ceratozamia mexicana Brongn.

Brongniart, A., Ann. Sci. Nat. ser. 3, 5:8 (1846) Bot.;
Chamberlain, C. J., Bot. Gaz. 53:1-19 (1912).

Stem seldom more than 1 m. high, rarely branched, often bent or prostrate. Leaves in adult plants 15-20 in a crown, the larger ones 1.5-2 m. long, dark green and glabrous. Petiole 35-60 cm. long, average length about 50 cm., subterete, very spiny near the base, less spiny higher up. Stipules large and fleshy. Rachis with two grooves on the upper side and a few spines on the lower side. Leaflets 30-50 on each side, more or less opposite, long lanceolate to linear, very acute, narrowed at the base, 30-50 cm. long, 10-20 mm. wide; veins averaging 15.

Male cones subcylindric, tapering gradually toward the apex, about 20 cm. long and 7 cm. in diameter just before shedding pollen, then elongating to two or three times this length with scarcely any increase in diameter; peduncle tomentose. Microsporophylls cuneate, 17 mm. long and 12 mm. wide, the stalk 2 mm. long. Microsporangia about 240, in sori of 3 or occasionally of 4, covering the entire unexposed lower surface except for a small notch at the apex. Female cones cylindric, smooth, 26-33 cm. long, 9-11 cm. in diameter; peduncle about 6 cm. long, sometimes up to 13 cm. Megasporophylls in 8-14 vertical rows of 9-13 each; the peltate top transversely hexagonal, 1-3.7 cm. wide, 0.9-1.7 cm. high, brownish hairy on the lower exposed portion. Seeds pubescent when young, smooth and white when mature, up to 2.6 cm. long and 1.8 cm. in diameter.

Geographic distribution: State of Veracruz--abundant on steep mountain side opposite Naolinco, near Jalapa; Almolongo Valley and Chiltoyas, near Jalapa; Mirador; Huatusco. Across the Papaloapan

River at Tuxtepec, State of Oaxaca. Growing in deep shade in moist rain-forests.

The leaves of C. mexicana are so variable that species, varieties, and forms have been based upon them. A crown of leaves produced, in 1936, by a plant in the University of Chicago Greenhouse had leaflets averaging 41 cm. long and 15 mm. wide, while the crown produced in 1938 had leaflets averaging 35 cm. long and 11 mm. wide. In both years a cone was produced with the crown of leaves.

Ceratozamia longifolia Miq. should not be regarded as a distinct species. Seeds of typical C. mexicana, taken from the same cone, will produce both C. mexicana and C. longifolia, the latter with leaflets 50 cm. long when grown in the ground in moist shady parts of the greenhouse. C. robusta Miq. may also be a variant of C. mexicana.

In the herbarium of the Chicago Natural History Museum are a number of specimens of Ceratozamia, consisting of leaves and microsporophylls, collected in the Sierra de los Cuchumantes, Department of Huehuetenango, Guatemala. Those from the trail between Catarina and San Andrés have leaflets about 1 cm. wide, in this and other respects corresponding to C. mexicana. Other specimens, from wooded slopes opposite the river from Finca Soledad, 8 kilometers southeast of Barillas, and along the Río Amelco below Finca San Raphael, have leaflets 2-3 cm. wide and may belong to another species.

2. Ceratozamia purpusii Rose sp. nov.

Stem, in the only specimens available, not more than 40 cm. high[1], covered by a rough armor of leaf bases. Leaves 1.2-1.6 m.

[1] Dr. Purpus says it is "the smallest stem in the genus."

long. Petiole 20-25 cm. long, very spiny below, less spiny above. Rachis up to 1.3 m. long, somewhat spiny in lower half, nearly smooth above. Leaflets 50-70 on each side, opposite or alternate, linear, 25-45 cm. long, 3-7 mm. wide, with 5 or 6 veins; curving until almost round in drying unless strongly pressed. Male cones about 22 cm. long before elongating at shedding of pollen, 6-7 cm. in diameter. Microsporophylls 15 mm. long, 7 mm. wide. Microsporangia about 130, mostly in sori of 3, covering the entire unexposed lower surface of the sporophyll. Female cones cylindrical, 20-39 cm. long, 9-11 cm. in diameter. No mature seeds available.

Geographic distribution: Chiapas, near Hacienda de Montserrato; in pine forests at slightly higher elevations than Dioon pinoi.

This species was distributed under the name of C. purpursii by J. N. Rose, who died before he had an opportunity to describe it. The foregoing description is based on specimens sent by Dr. Rose to various institutions, from notes and microsporophylls sent to me by C. A. Purpus, who collected all of Dr. Rose's material, and from plants collected by Edward Howard in Chiapas and grown under cultivation at Coronado Beach, Los Angeles, and San Marino, California. Since Dr. Purpus identified a leaf from the Coronado Beach plant as C. purpusii and stated that it is the only Ceratozamia in the region from which he and Mr. Howard made their collections, there seems to be no doubt that the specimens which Rose distributed and these living plants belong to the same species.

3. Ceratozamia matudai Lundell

Lundell, C. L., Lloydia 2:75 (1939)

Stem 30-50 cm. tall, 15-20 cm. in diameter. Leaves 75-122 cm. long, yellow-green, glabrous. Petiole armed with few short stout spines, subterete, the broad base densely and persistently tomentose, otherwise glabrous. Rachis flattened and shallowly bisulcate above, bearing a few short stout prickles, excurrent at the apex. Leaflets 23-44 on each side, subopposite to alternate, linear-lanceolate, subarcuate-patent, tapering to a long slender point, widest above the constricted base, 20-38 cm. long, ~~6.5~~ 7-15 mm. wide, the basal and apical leaflets shortest; veins 6-11, prominent beneath, obscure above.

Male cones cylindric-oblong, slightly narrowed toward the apex, abruptly and stoutly apiculate, 8-16 cm. long, 3-4.5 cm. in diameter; peduncle 8-11 cm. long, covered with small red scales, appressed hirsute at base, thick at apex, gradually narrowed to the contracted base. Microsporophylls 10-21 mm. long, 8-10 mm. wide, broadest at the center; fertile part 6-12 mm. long, cuneate, sterile part 3.5-10 mm. long including horns, truncate-pyramidal, the two pointed horns 1.5-4 mm. long at apex, suberect to strongly divaricate. Female cones ellipsoidal, about 15 cm. long, 9 cm. in diameter; peduncle longer than cone, up to 22 cm. long, stout, rarely armed, appressed hirsute and red scaly at first, glabrescent with age. Top transversely hexagonal, up to 3.5 cm. wide, 1.8 cm. high, base tomentose and red scaly, medially bicornute, the horns strongly divaricate, glabrous, their base red scaly, elevated. Seeds obovoid, about 3 cm. long, 2.3 cm. in diameter.

Type in the Herbarium of the University of Michigan, Fizi Matuda 2645, staminate plant, collected in broad-leaved forest on

northern slope of Mt. Ovando, Chiapas, Mexico, February 1939; alt. 1,000 m. C. matudai may be readily separated from C. mexicana Brongn. and C. kuesteriana Regel by its much longer peduncles and larger microsporophylls. On the basis of leaflet venation, it is nearest C. kuesteriana, but differs, aside from the characteristics mentioned, in having an armed petiole and rachis. The foregoing description is quoted, almost verbatim, from Lundell.

4. Ceratozamia latifolia Miq.

Miquel, F. A. W., Tijdschr. Wis. en Nat. 1:206 (1846), Prodr. Syst. Cycad. 11, 23 (1861).

Stem about the same size and shape as in C. mexicana and similarly covered with leaf bases. Leaves in plants 10 cm. high not so numerous as in C. mexicana, about 1-1.6 m. in length. Petiole 50-65 cm. long, terete, not so spiny as in C. mexicana. Rachis 60-100 cm. long, spiny in lower portion but nearly smooth above. Stipules large, fleshy, and more closely appressed than in C. mexicana, making the stem comparatively smooth. Stipules developing so early that they are fractured by the growing apex of the leaf and permanently surround base of leaf, forming a considerable part of the armor. Leaflets on plants with stems 10 cm. high not so numerous as in C. mexicana but much larger, 18-20 on each side, approximately paired, more or less evenly lanceolate but often with the upper border curved toward the tip, sharply acuminate, 30-40 cm. long, 3-5 cm. wide, with 20-30 veins. Cones not available.

In seedlings with two leaflets the petiole is smooth, with four leaflets it has a few small spines, and the spiny condition increases with the age of the plant. In seedlings with six leaflets spines have not yet appeared on the rachis. In seedlings with two leaflets the leaflets average 13 cm. long and 3.7 cm. wide; with six leaflets the lowest ones average 18 cm. long and 2.7 cm. wide.

Geographic distribution: In Zacuapan, Huatusco, Colipa, Miradór, and Jacala, Mexico; growing in shady forests. This species resembles C. migueliana H. Wendl., but its leaflets are longer and somewhat narrower.

5. Ceratozamia miqueliana H. Wendl.

Wendland, H., Index Palm., p. 68 (1854); Miquel, F. A. W., Prodr. Syst. Cycad., 22 (1861); Dyer, W. T. T., in Hemsley's Biol. Centrali-amer. Bot. 3:192 (1882-86).

Leaves 1-1.5 m. long, glaucous and pilose when young, becoming glabrous. Petiole about 45 cm. long, subterete, sparsely spinescent toward the base; rachis up to 90 cm. long, rounded below, flattened above. Leaflets 20-30 on each side, opposite or subopposite, lanceolate, subfalcate, abruptly acuminate, cuneate at base, 20-30 cm. long, 5-7 cm. wide; veins 35-40. Male cones long cylindric, gradually tapering toward the apex, about 25 cm. long, 3 cm. in diameter at base. Female cones ellipsoid, about 11 cm. long, 6.5 cm. in diameter. Peltate top of megasporophyll with distinct ridge; horns somewhat longer than in C. mexicana.

Geographic distribution: Mexico, locality unknown. All descriptions are based on cultivated material.

6. Ceratozamia kuesteriana Regel

Regel, E. von, Bull. Soc. Nat. Moscow 30:187 (1857), Gartenfl. 25:259 (1876).

Stem short and thick, covered with leaf bases, smooth. Leaves up to 1.5 m. long, erect, bright green on both sides, hirsute when young, becoming glabrous. Petiole 50-60 cm. long, subterete, unarmed or with an occasional small spine. Rachis 50-70 cm. long, terete except for two grooves on the upper side, unarmed. Leaflets about 20 on each side, rather crowded and mostly opposite, long lanceolate, straight or falcate, acuminate, tapering at the base to a 4-5 mm. insertion, margins revolute; 20-30 cm. long, 13-15 mm. wide; veins 9-11, very prominent below. Male cones narrow cylindric, tapering sharply at the apex, about 10 cm. long before the sudden elongation at shedding of pollen when length may become two or three times greater, 4 cm. in diameter, short stalked. Microsporophylls 7 mm. long, the upper half sterile; horns 2-3 mm. long. Female cones not available.

Geographic distribution: Known only from La Guazacana, Mexico.

9. ZAMIA L.

Linnaeus, C., Spec. Plant., 2nd ed., p. 1659 (1763); Miquel, F. A. W., Monogr. Cycad. 63-73 (1842), Prodr. Syst. Cycad. 11-15, 23-27 (1861); De Candolle, A., Prodr. 16[2]:538-546 (1868); Standley, P. C., Contr. U. S. Nat. Herb. 23[1]:49-50 (1920); Schuster, J., Pflanzenreich 4[1]:132-161 (1932).

Stem in most species small and tuberous, subterranean, generally smooth and unarmored but often with more or less conspicuous leaf scars; stem in some species aerial, up to 1 m. or more in height and with an armor of persistent leaf bases; branched or unbranched. Leaves generally few, developed singly, varying from less than 15 cm. in length (the smallest in the family) to more than 2 m. Petioles with more or less conspicuous stipules, unarmed or with scattered spines. Leaflets ovate to long linear, entire or serrate at least near the tip, jointed at the rachis, with "parallel" (dichotomous) venation. Vernation of rachis subcircinate, of leaflets straight or slightly curved.

Male cones frequently more than 1, cylindric or ovoid, generally long stalked. Microsporophylls peltate; the exposed top thick, truncate, hexagonal, flat or slightly raised in the center, broader than tall. Microsporangia nearly always in two groups separated by a sterile line, occasionally confluent at least in the middle of the cone. Female cones usually single or occasionally several together, cylindric or ovoid, generally long stalked. Megasporophylls peltate, the exposed top thick, truncate, hexagonal, flat or slightly depressed in the center, broader than tall. Both male and female cones terminating in a small solid body composed of united sterile sporophylls. Fertile sporophylls so regular in spiral arrangement that they seem to stand in

vertical rows. Seeds generally red or orange-red, sometimes yellow or white.

About 30 species, ranging from Florida to Chili and Brazil; especially abundant in Central America and the West Indies. Name used by Pliny, meaning loss or damage, and applied to barren pine cones. Type species: Z. pumila L.

Key to the Species

I. Stem subterranean and tuberous

A. Petioles unarmed

1. Leaflets not more than 7 mm. wide, with less than 10 veins, linear

a) Leaflets 4–7 mm. wide, denticulate near the apex . . . . . 1. *Z. floridana*

b) Leaflets 3–4 mm. wide, entire . . . 2. *Z. angustifolia*

c) Leaflets 1–2 mm. wide, entire . . . 3. *Z. angustissima*

2. Leaflets over 7 mm. wide (see no. 5), with more than 10 veins

a) Leaves mostly less than 50 cm. long

(1) Leaflets ovate or obovate, not over 15 cm. long

(a) Leaflets 8–14 cm. long, 11–16 mm. wide; female cones 7–11 cm. long. . 4. *Z. pumila*

(b) Leaflets 0.7–4.5 cm. long, 4–12 mm. wide; female cones 4–5 cm. long . . 5. *Z. pygmaea*

(c) Leaflets 3–8 cm. long

(i) Leaves 20–50 cm. long; leaflets 10–18 mm. wide; female cones 8–10 cm. long . . . . . 6. *Z. kickxii*

(ii) Leaves 10–20 cm. long; leaflets 7–14 mm. wide; female cones 4–6 cm. long. . . . . 7. *Z. silicea*

(d) Leaflets 6–8 cm. long, 25–28 mm. wide; female cones 7–10 cm. long . . . 8. *Z. ottonis*

(2) Leaflets linear-lanceolate, 20–30 cm. long, 10 mm. wide; female cones 14–18 cm. long . . . . . 9. *Z. boliviana*

(3) Leaflets ovate-lanceolate, up to 21 cm. long and 6 cm. wide; female cones 6 cm. long . . . . . 10. Z. cupatensis

b) Leaves more than 50 cm. long

(1) Leaflets serrate, mostly obovate, 10-45 mm. wide . . . . . 11. Z. latifoliolata

(2) Leaflets entire or nearly so

(a) Leaflets linear-lanceolate, 9-16 mm. wide . . . . . 12. Z. media

(b) Leaflets linear, 10-20 mm. wide. . 13. Z. portoricensis

B. Petioles spiny

1. Leaflets obovate-oblong, furfuraceous below, 4-6 cm. wide. . . . . 14. Z. furfuracea

2. Leaflets lanceolate, not furfuraceous

a) Leaflets not more than 30 cm. long and 3.5 cm. wide

(1) Leaflets 1.5-2.2 cm. wide, 20-25 on each side; female cones 10-14 cm. long . . 15. Z. sylvatica

(2) Leaflets 2 cm. wide, 14-24 on each side; female cones 5-6 cm. long . . 16. Z. mexicana

(3) Leaflets 2-2.5 cm. wide, 7-20 on each side; female cones 4-7 cm. long . . 17. Z. spartea

(4) Leaflets 3-5 cm. wide, 8-16 on each side; female cones 8-10 cm. long . . 18. Z. gutierrezii

b) Leaflets not more than 50 cm. long and 7 cm. wide . . . . . 19. Z. ulei

II. Stem aerial, creeping. . . . . 20. Z. poeppigiana

III. Stem aerial, erect, often up to 1 m. high

A. Petioles mostly unarmed

1. Leaves 1.7 m. long; leaflets 18–24 cm. long, entire . . . . . 21. *Z. tuerckheimii*

2. Leaves 60–90 cm. long; leaflets 10–18 cm. long, serrate . . . . . 22. *Z. obliqua*

B. Petioles spiny

1. Leaflets 1–1.6 cm. wide, subentire . . . 23. *Z. chigua*

2. Leaflets 2–4 cm. wide

a) Leaflets serrate

(1) Leaflets 15–20 cm. long, 6–11 on each side . . . . . 24. *Z. muricata*

(2) Leaflets 20–25 cm. long, 14–20 on each side . . . . . 25. *Z. monticola*

(3) Leaflets 20–$\frac{2}{7}$5 cm. long, 40 or more on each side . . . . . 26. *Z. lindenii*

b) Leaflets entire, 35–50 cm. long . . . 27. *Z. pseudoparasitica*

3. Leaflets 5–10 cm. wide, serrulate . . . 28. *Z. skinneri*

4. Leaflets 10–25 cm. wide, serrate . . . 29. *Z. wallisii*

1. Zamia floridana A. DC.

De Candolle, A., Prodr. 16[illegible]:544 (1868); Webber, H. J., U. S. Dept. Agric., Bur. Pl. Ind. Bull 2:7-92 (1901).

Stem tuberous, subterranean, seldom more than 20 cm. long, in large unbranched specimens 8-10 cm. in diameter, in branched specimens up to 12-16 cm. in diameter, tapering below, smooth or somewhat warty. Leaves seldom more than 12 in a crown, but subterranean branching of the stem may make the number seem much larger; 30-60 cm. long, glabrous above but with scattered hairs below. Petiole 10-30 cm. long, terete below but with two grooves higher up, not spiny, with scattered hairs; rachis longer or shorter than the petiole, rounded below, with two grooves above. Leaflets 14-25 on each side, often opposite near the apex, subopposite or alternate below, frequently twisted, more or less erect, linear, falcate, obtuse, narrowed at the base, minutely denticulate near the apex with 2-5 obscure blunt teeth on the lower margin and 2-4 on the upper, slightly revolute; usually not more than 10 cm. long but occasionally up to 14 cm., 4-7 mm. wide, rarely 9 mm.; veins 8-10, sometimes up to 14.

Male cones usually more than 1, often 3 or 4, cylindric, attentuate above, abruptly acute, dark brown, densely tomentose with dark reddish brown hairs, about 8 cm. long, occasionally up to 13 cm., 2.5 cm. in diameter; peduncle about 5 cm. long, densely tomentose with hairs lighter in color than those on the cone. Microsporophylls in average cones in 10-12 vertical rows, of 12-20 each. Microsporangia in two groups of 12 or 13 each with a sterile line between, in sori of 2 or 3, occasionally single. Female cones usually single but 2 or 3 not rare, ovoid or cylindric, with a blunt sterile tip, densely tomentose with dark rusty-brown hairs, 12-16 cm. long,

occasionally up to 20 cm.)
6-8 cm. in diameter; peduncle 5-9 cm. long, tomentose. Megasporophylls in 6-11 vertical rows, 6-11 in a row; top 2-3 cm. wide, 1.5 cm. high, flat or somewhat depressed in the center. Seeds orange-red, 2.2-2.5 cm. long, 1.3-1.6 cm. in diameter. Fleshy coat up to 8 mm. thick at the top but much thinner elsewhere; stony coat ellipsoid, 1.6-2 cm. long, 1.3-1.5 cm. in diameter, terminating abruptly in a small point about 1 mm. high, very smooth, with 8-10 bundles scarcely distinguishable except at the corona.

Geographic distribution: Very abundant on the southeastern coast of Florida below latitude 26° 30', with easily accessible stands at Miami and Homestead. Set out or grown from seed it thrives throughout Florida and the southern part of the Gulf States. Mature plants grown from seed also flourish in the open in southern California; in Sydney, Brisbane, and Rockhampton, Australia; and in Durban, Port Elizabeth, and Capetown, Union of South Africa.

This species grows in sandy soil in open places. Although often associated with palmettoes and pines, these do not make enough shade to be a factor in its distribution. In the hottest and driest places the leaves are shorter and the leaflets shorter and narrower. Plants begin to produce cones when the stems are 3-4 cm. in diameter, but coning is more frequent on stems 6-10 cm. in diameter. Branching is very common, at least one-half of the larger specimens showing one branch and sometimes 2 or 3.

2. Zamia angustifolia Jacq.

Jacquin, N. J., Coll. 3:263 (1789); Miquel, F. A. W., Prodr. Syst. Cycad. 14, 26 (1861); Marie-Victorin, Fr., and León, Fr., Contr. Inst. Bot. Univ. Montreal no. 41:67-72 (1942).

Stem tuberous, subterranean, cylindric, up to 30 cm. in length and 6 cm. in diameter in unbranched plants, sometimes with as many as five branches and a diameter of 10 cm. without any increase in length, smooth but marked transversely by leaf scars. Roots 5-10 mm. in diameter and longer than the stem. Leaves 5-10 in a crown, 50-90 cm. long, glabrous. Petiole 15-35 cm. long, terete, unarmed; rachis 20-50 cm. long, slightly grooved above especially in the upper half. Leaflets 25-45 on each side, opposite or alternate, narrowly linear, obtuse, base not narrowed, usually entire but often with 1-3 small blunt teeth close to the apex; 10-16 cm. long, 3-4 mm. wide, rarely up to 7 mm.; veins usually 3-6, rarely up to 8.

Male cones 1-3, cylindric, light brown with very short hairs, 4-6.5 cm. long, 1.5-2 cm. in diameter; peduncle slightly longer than the cone, tomentose. Microsporophylls in 9 or 10 vertical rows of 15-17 each, the top 5 mm. wide and 2.5 mm. high. Female cones cylindric, with prominent sterile tip, light brown with short hairs, 6-12 cm. long, 3-5 cm. in diameter; peduncle not as long as the cone, tomentose. Megasporophylls in 6 vertical rows of 5 or 6 each; top 18 mm. wide and 10-12 mm. high, with a slight transverse depression in the center. Seeds red, 12-17 mm. long, 7-12 mm. wide; stony coat very smooth, 10-15 mm. long, 8-9 mm. wide.

Geographic distribution: Cuba—southern Oriente, with good stands at Bayamo, in the Sierra Maestra, northeast of Santiago de Cuba, and west of Guantánamo. Also in the Bahama Islands.

3. Zamia angustissima Miq.

Miquel, F. A. W., Verh. Nederl. Inst. 3:4 (1851), Prodr. Syst. Cycad. 15, 27 (1861). [redacted]

Stem tuberous, subterranean, irregularly cylindric, 10-15 cm. long, 3-6 cm. in diameter, smooth. Leaves 3-10 in a crown, 25-50 cm. long. Petiole 15-25 cm. long, terete, unarmed, glabrous but pubescent at the base; rachis 10-20 cm. long, often twisted, rounded below, flattened above or elevated between the two rows of leaflets. Leaflets 15-30 or more on each side, opposite or alternate, very narrowly linear, often curved or twisted, apex pale tumid with a few hairs and occasionally notched, base also tumid and occasionally with a few hairs, entire, revolute; 8-15 cm. long, 1-2 mm. wide; veins 2 or 3. Male cones cylindric, brown, tomentose, lighter around the edges of the sporophylls, 1.5 cm. in diameter. Female cones cylindric, obtuse, brown, lighter around the edges of the sporophylls.

Geographic distribution: Cuba—southern Oriente, in the same general locality as Z. angustifolia Jacq., to which this species is closely related and with which it intergrades. Z. multifoliolata A. DC. is probably only a thrifty form of Z. angustissima.

4. Zamia pumila L.

Linnaeus, C., Spec. Plant., 2nd ed., p. 1659 (1753); Sims, J., Bot. Mag. 43: t. 1838 (1816) and 45: t. 2006 (1818); Webber, H. J., U. S. Dept. Agric., Bur. Pl. Ind. Bull. 2:7-92 (1901).

Stem tuberous, subterranean, in larger plants 20-30 cm. long and 10 cm. in diameter, in branching plants up to 15 cm. in diameter, tapering below, smooth or warty. Leaves usually not more than 10 in a crown, 30-60 cm. long, glabrous above but with reddish brown hairs below. Petiole 10-20 cm. long, rounded or almost angular below, somewhat flattened above with two shallow grooves near the rachis, not spiny, tomentose at the base. Rachis 20-40 cm. long, rounded below, flat above with two ridges at the edges, often hairy even to the top. Leaflets 10-24 on each side, occasionally opposite throughout, more frequently opposite above and becoming subopposite or alternate below, rarely twisted, not erect from the rachis, obovate, obtuse, narrowed at base to about 2 mm., entire in broader leaflets, in longer leaflets often with 7-9 minute blunt teeth on the lower margin and 4-6 on the upper, all near the apex; 8-11 cm. long, 14 16 mm. wide, with 20-30 veins, but many leaflets longer and narrower, 9-14 cm. long, 11-14 mm. wide, with 14-18 veins.

Male cones usually more than 1, often 3 or 4, or even 2; subcylindric, attenuate above, densely tomentose with deep brown hairs, about 8 cm. long and 2.5-3 cm. in diameter, occasionally up to 10 cm. long and 3.5 cm. in diameter; peduncle 5-10 cm. long, tomentose. Microsporophylls in 8-10 vertical rows of 8-12 each. Microsporangia in two groups of 15-20 each in the larger cones, in sori of 2, rarely 3, commonly single. Female cones usually single but occasionally 2 or 3, ovoid or cylindric, with an inconspicuous sterile tip, dark brown and densely tomentose, 7-11 cm. long, 5-8 cm. in diameter; peduncle about 10 cm. long, tomentose. Megasporophylls in 8-10

vertical rows of 8-10 each; [redacted] top thinner and flatter than in Z. floridana, 2.5 cm. wide, 1.4 cm. high. Seeds orange-red, 1.3-2 cm. long, 1-1.5 cm. in diameter; stony coat obovoid, 1.3-2 cm. long, 1-1.5 cm. in diameter, with a small papilla at the top, very smooth, with 10-12 bundles almost indistinguishable.

Geographic distribution: Abundant in central Florida, particularly near the eastern coast between latitude 28° 30' and 29° 30'; at its best in dense moist woods. Probably also in Cuba and other Caribbean islands.

5. Zamia pygmaea Sims

Sims, J., Bot. Mag. 42: t. 1741 (1815); Marie-Victorin, Fr., and León, Fr., Contr. Inst. Bot. Univ. Montreal no. 41:184-186 (1942).

Stem tuberous, subterranean, cylindric, 15-25 cm. long, 2-3 cm. in diameter, smooth. Leaves usually not more than 4-6 in a crown, 10-35 cm. long, glabrous. Petiole 3-15 cm. long, triangular with upper face flat and two grooves which continue to top of rachis, unarmed, tomentose at base; rachis 5-20 cm. long, rounded below, flattened above, slightly pubescent. Leaflets 5-15 on each side, opposite in upper part of leaf, then subopposite and alternate, ovate or obovate, serrulate with 6 or 7 blunt hairy teeth on the upper margin and 9-12 on the lower; 0.7-3 cm. long, 4-10 mm. wide, some even smaller but the largest 4.5 cm. long and 12 mm. wide, upper and lower leaflets about the same size as the rest; veins 15-17.

Male cones usually single, subcylindric, 3 cm. long, 1 cm. in diameter; peduncle up to 5 cm. long. Microsporophylls in 6 or 7 vertical rows of 5 or 6 each, the top 8 mm. wide and 3 mm. high. Microsporangia in two groups of 5-7 each (the lowest number in the family), single or in sori of 2. Female cones usually single, subcylindric, the sterile tip about 3 mm. long, greenish with grayish or brownish hairs, 4-5 cm. long, 2.5 cm. in diameter; peduncle 2.5-3 cm. long, tomentose. Megasporophylls in 7 or 8 vertical rows of 4 or 5 each; top 12 mm. wide, 7-8 mm. high, not darker in the center. Seeds red, 13 mm. long, 8 mm. in diameter; stony coat very smooth, 10 mm. long, 7 mm. in diameter.

Geographic distribution: An endemic Cuban species, widely distributed in Pinar del Río from San Diego de los Baños to Guane and beyond; very xerophytic.

6. Zamia kickxii Miq.

Miquel, F. A. W., Monogr. Cycad., p. 71 (1842), Prodr. Syst. Cycad. 14, 26 (1861).

Stem tuberous, subterranean, smooth. Leaves not more than 6-10 in a crown, 20-50 cm. long, flexible, pale green, glabrous. Petiole 10-23 cm. long, subterete, becoming somewhat flattened higher up, unarmed; rachis rounded below, flattened above with two grooves near the edge, smooth. Leaflets 10-33 on each side, usually opposite or subopposite but sometimes alternate throughout or at base of leaf, long ovate, upper margin nearly straight and the lower convex, obtuse, often emarginate, cuneate or narrowed at the base, terminal part of leaflet finely serrate with 7-16 blunt teeth on the upper margin and 9-20 on the lower, slightly revolute; 4-8 cm. long, 1-1.8 cm. wide, the upper and lower leaflets somewhat smaller than the rest; veins 13-30.

Male cones cylindric, tapering to a blunt apex, brownish yellow, 5-7 cm. long, 1.5-2 cm. in diameter; peduncle 4-6 cm. long, tomentose. Microsporophylls in 9 or 10 vertical rows of 10 each, top 8 mm. wide and 5 mm. high, brownish in center and yellow or green on the margins. Microsporangia in two groups of 7-9 each, single or in sori of 2. Female cones cylindric, 8-10 cm. long, 4-5 cm. in diameter; peduncle 9 cm. long. Megasporophylls in 8 vertical rows of 7 or 8 each.

Geographic distribution: Cuba—chiefly in Pinar del Río but also in Habana and Matanzas. Closely related to Z. pygmaea Sims.

7. Zamia silicea Britt.

Britton, N. L., Bull. Torrey Bot. Club 43:462 (1916); Marie-Victorin, Fr., and León, Fr., Contr. Inst. Bot. Univ. Montreal no. 41:276-277 (1942).

Stem tuberous and subterranean, fusiform, 15-20 cm. or more in length, 3-3.5 cm. in diameter at top, 4-4.5 cm. at widest part. Leaves 2-7 in a crown, 10-20 cm. long, glabrous. Petiole 3-7 cm. long, unarmed, often villous at base; rachis 3-10 cm. long. Leaflets 3-14 on each side, opposite or subopposite, thick, mostly obovate but some long oval, many nearly straight along upper margin and very convex below, obtuse, often emarginate, narrowed at base to 1-2 mm., with 15-30 minute blunt teeth confined to upper third of leaflet and more numerous on lower than on upper margin; 3-7 cm. long, 7-14 mm. wide; veins 20-35.

Male cones 1-3, ovoid or cylindric, dark brown with short reddish brown hairs, 2-3 cm. long, 1-1.5 cm. in diameter; peduncle 1-4 cm. long, tomentose. Microsporophylls in 6 or 7 vertical rows of 5-7 each, the top 7 mm. wide and 2 mm. high. Microsporangia in two groups of 6-14 each, mostly in sori of 2. Female cones ellipsoid, with a short sterile tip, dark brown, densely tomentose with short reddish brown hairs, 4-6 cm. long, 3-4 cm. in diameter; peduncle 2-4 cm. long, pubescent. Megasporophylls is 6 vertical rows of 4 or 5 each, the top 15 mm. wide and 7 mm. high. Seeds red, about 12 mm. long, broadly grooved on the inner side, rounded on the back, obliquely and obtusely umbonate at the apex.

Geographic distribution: Cuba—Isle of Pines; frequent in pine lands and in white silicious sand.

8. Zamia ottonis Miq.

Miquel, F. A. W., Linnaea 17:740 (1843), Prodr. Syst. Cycad. 14, 26 (1861).

Stem tuberous, subterranean, 15 cm. long and 5-7 cm. in diameter when not branched, 8-10 cm. in diameter when branched. Leaves 2-4 in a crown on one axis, 25-50 cm. long, glabrous. Petiole 10-20 cm. long, subterete below, with two grooves above which become deeper near the rachis, unarmed, rachis slightly longer than the petiole, rounded below, deeply grooved above. Leaflets 5-7 on each side, mostly alternate, obovate; apex obtuse, irregular, or deeply notched; base cuneate; dentate above the middle with as many as 30 teeth on the lower margin and 20 on the upper; 6-8 cm. long, 2.5-2.8 cm. wide, the upper and lower leaflets about the same size as the rest; veins 35-45.

Male cones cylindric, reddish brown, tomentose, 4-6 cm. long, 1-1.5 cm. in diameter; peduncle 4 cm. long, tomentose. Microsporophylls in 9 or 10 vertical rows of 12-15 each, the top 5 mm. wide and 2-3 mm. high. Microsporangia in two groups of 7-9 each, single or in sori of 2. Female cones cylindric, tapering rather abruptly at the apex and base, the sterile tip small, dark brown, tomentose, 7-10 cm. long, 4.5-6 cm. in diameter. Megasporophylls in 6 vertical rows of 4-6 each; top 2.5 cm. wide, 1.4 cm. high, with a sharply marked depression 8 mm. wide and 2 mm. high in the center with sharp lines running laterally to the border and four fainter lines running to the other four angles. Seeds red.

Geographic distribution: Cuba—Cafetal Fundador; near San Diego de los Baños and at various places in the northern part of Pinar del Río.

9. Zamia boliviana (Brongn.) A. DC.

Z. brongniartii Wedd.

Brongniart, A., Ann. Sci. Nat. sér. 3, 5:9 (1846); Weddell, H. A., Ann. Sci. Nat. sér. 3, 13:249 (1849); Eichler, A. W., in Martius' Flora Bras. 4[1]:413 (1863); De Candolle, A., Prodr. 16[2]: 540 (1868).

Stem fleshy, subterranean, cylindric, 6-8 cm. thick, smooth. Leaves 3-5 in a crown, 40-50 cm. long, pale green, glabrous. Petiole about 30 cm. long, terete, unarmed, tomentose below; rachis slender, obtusely triangular, glabrous. Leaflets 10-18 on each side, alternate or subopposite, linear-lanceolate, straight or rarely subfalcate, acuminate, attenuate at the base, entire or denticulate above with 2-5 minute teeth on each margin, revolute, 20-30 cm. long, about 1 cm. wide, veins 10-12. Male cones single, cylindric, obtuse, tomentose, 5-7 cm. long, 10-13 mm. in diameter; peduncle 2.5-4.5 cm. long. Microsporophylls in 8 vertical rows, each with a transverse groove. Female cones single, oblong, acuminate, the sterile tip 2 cm. high, rusty green, tomentose, 14-18 cm. long, about 5 cm. in diameter; peduncle 8-10 cm. long. Megasporophylls in about 8 vertical rows of 14-18 each, the top 10-15 mm. wide, 8-10 mm. high, slightly depressed in the center. Seeds oblong-elliptic, scarlet, 12 mm. long.

Geographic distribution: Chiquitos, Bolivia, and Mato Grosso, Brazil.

10. Zamia cupatiensis Ducke

Ducke, A., Arch. Jard. Bot. Rio de Janeiro 3:20 (1922).

Stem subterranean. Leaves up to 6. Petiole up to 30 cm. long, unarmed, more or less flexuous; rachis up to 25 cm. long. Leaflets up to 9 on each side, subopposite, ovate-lanceolate, slightly falcate, acuminate, subpetiolate, entire in upper leaflets, toward the apex often unidenticulate on each side, revolute, up to 21 cm. long and 6 cm. wide; veins 34-40. Male cones yellow canescent, about 1.8 cm. in diameter. Microsporophylls in 10 vertical rows, the top about 4 mm. wide and slightly elevated. Female cones solitary, cylindric, the sterile tip conical, brownish purple tomentose, about 6 cm. long, 3.5 cm. in diameter; peduncle 4 cm. long, with dark purple hairs. Megasporophylls in 6-8 vertical rows, the top about 18 mm. wide and 8 mm. high.

Geographic distribution: Colombia, near the Brazilian border; on humus-covered rocks in the Cerro de Cupati.

11. Zamia latifoliolata Prenleloup

Z. integrifolia Ait.

Aiton, W. T., Hort. Kew, 1st ed., 3:478 (1789); Prenleloup, L. A., Bull. Soc. Vaud. Sc. Nat. 11:278 (1872); Britton, N. L., and Wilson, P., Sci. Surv. Porto Rico and Virgin Is. 6:329 (1926).

Stem tuberous and subterranean, cylindric but tapering toward apex and base, seldom more than 30 cm. long exclusive of the root, 10 cm. in diameter, simple or branched, smooth. Leaves seldom more than 6-10 in a crown but subterranean branching may make the number seem larger, 60-100 cm. long, glabrous. Petiole 30-45 cm. long, unarmed; with two grooves near the rachis, rachis about 40-55 cm. long, rounded below, with two grooves above even in living material. Leaflets, when large, 12-15 on each side, opposite or alternate, obovate, often with 1 or 2 deep notches at the tip, cuneate below; closely and finely serrulate near the apex, distantly serrulate farther back, entire in the lower half; serrulations often 30 on lower margin of broadest leaflets and about 15 on upper margin; 14-16 cm. long, 2.3-4.5 cm. wide, upper and lower leaflets not much smaller than the rest; veins 50-70. Many plants of coning age have smaller leaves with leaflets 15-25 on each side, linear-lanceolate, serrulations half as numerous as on larger leaflets, 10-20 cm. long, 1-1.2 cm. wide, and with 20-35 veins. All intermediate conditions occur between broadest and narrowest leaflets.

Male cones single or up to 60 on a much branched plant, cylindric, dark brown, tomentose, 7-10 cm. long, 1.3-2.5 cm. in diameter; peduncle 4-12 cm. long, often with several scales. Microsporophylls in 10-12 vertical rows of 15-20 each, the top 4-5 mm. wide and 2-3 mm. high. Microsporangia in two groups of about 15 each, nearly all in sori of 2. Female cones single or

2-5 on a branched plant, ovoid or cylindric, with a sharp conic sterile tip about 2 cm. high, dark, short tomentose, 8-10 cm. long, 5-8 cm. in diameter; peduncle usually 6-8 cm. long. Top of megasporophylls up to 3.5 cm. wide, 2 cm. high, with a slightly depressed area in the center. Seeds dark blood red, 2-2.5 cm. long, 1.3-1.7 cm. in diameter; stony layer 1.4-1.8 cm. long, 1.2-1.8 cm. in diameter.

Geographic distribution: Most abundant in Puerto Rico, where it appears west of San Juan, through Bayamón, Vega Baja, Manatí, and Arecibo, not growing far from the coast and always in a limestone region. In Cuba, rather abundant in the extreme eastern part of Oriente at Maisí. Also in San Domingo and Jamaica. The species is so variable that, under different names, it may be widely distributed throughout the Caribbean region.

12. Zamia media Jacq.

Jacquin, N. J., Hort. Schoenbr. 3:77 (1798); Miquel, F. A. W., Prodr. Syst. Cycad. 13, 25 (1861); Britton, N. L., and Wilson, P., Sci. Surv. Porto Rico and Virgin Is. 6[3]:530 (1926).

Stem tuberous, subterranean, subcylindric, 12-30 cm. long, 4-11 cm. in diameter, simple or branched, smooth. Leaves often only 5 or 6 on coning plants but as many as 18 on stems 30 cm. long, 0.5-1.5 m. long, glabrous. Petiole 20-80 cm. long, terete, somewhat flattened above near the rachis, unarmed; rachis 25-70 cm. long, rounded below, flattened above with two shallow grooves. Leaflets 12-35 on each side, opposite or alternate, linear-lanceolate, obtuse, seldom emarginate, narrowed at the base to 2-3 mm., sometimes entire but usually with a few blunt teeth, up to 6 on the lower margin and 4 on the upper, the lowest not more than 4 cm. from the apex; 12-18 cm. long, 9-16 mm. wide, the upper and lower leaflets not much smaller than the rest; veins 18-28.

Male cones cylindric, light brown or gray, short tomentose, 5-7 cm. long, 1.5-2 cm. in diameter; peduncle 4-5 cm. long, tomentose. Microsporophylls in 8-13 vertical rows of 8-12 each, the top 6 mm. wide and 3 mm. high. Microsporangia in two groups of 10-14 each, mostly in sori of 2. Female cones cylindric, gray, tomentose, the larger ones 8-10 cm. long, 4-5.5 cm. in diameter; peduncle 4-6 cm. long. Megasporophylls in 6 vertical rows of 6 each; the top 3 cm. wide, 1.5 cm. high, depressed and slightly darker in the center. Seeds red, 2.5 cm. long, 1.3 cm. in diameter; stony coat ovoid, 2.2 cm. long.

Geographical distribution: The most widely distributed of all Cuban species of Zamia, more or less scattered from Matanzas to Oriente, as well as on small islands north of Cuba. Abundant around Coamo Springs, Puerto Rico, and extending northward to

13. Zamia portoricensis Urban

Urban, I., Symb. Antill. 1:291 (1899); Britton, N. L., and Wilson, P., Sci. Surv. Porto Rico and Virgin Iŝs. 6[3]:330 (1926).

Stem tuberous and subterranean, often branched in larger plants, in unbranched plants larger in the middle and tapering slightly toward both ends, 30-45 cm. long, 4.5-7.5 cm. in diameter, with sharp leaf scars. Leaves 5-7 in a crown on unbranched plants, occasionally up to 10, 0.5-1.5 m. long. Petiole 20-80 cm. long, unarmed; rachis 20-60 cm. long. Leaflets 15-35 on each side, opposite or alternate, linear, obtuse or sometimes emarginate, narrowed at the base, entire or minutely and bluntly serrulate near the apex with up to 12 teeth on the lower margin and up to 6 on the upper; 10-25 cm. long, 1-2 cm. wide; veins 20-30.

Male cones cylindric, rounded at the apex, light brown, tomentose, 5-8 cm. long, 1.4-1.8 cm. in diameter; peduncle 5-10 cm. long. Microsporophylls is 10 vertical rows of 17-19 each; [illegible] top 6 mm. wide, 3 mm. high, light brown in the center with a light gray border. Microsporangia in two groups of 10-15 each, nearly all in sori of 2. Female cones cylindric, light brown, the sterile tip slender and up to 1.5 cm. long, 6-11 cm. long, 4-5 cm. in diameter. Top of megasporophylls 3.2 cm. wide, 1.4 cm. high, slightly depressed and darker in the center. Seeds red, 2-2.3 cm. long, 1.5-1.7 cm. wide; stony coat 1.2-1.8 cm. long, 1-1.5 cm. wide, very smooth, usually with only 5 or 6 bundles distinguishable only at base and without a corona.

Geographic distribution: Probably confined to the dry southwestern part of Puerto Rico, at its best between Ponce and Penuelas and extending almost to Mayagüez; the most xerophytic of the three Puerto Rican species of Zamia.

14 Zamia furfuracea Ait.

Aiton, W. T., Hort. Kew, 1st ed., 3:477 (1789); Sims, J., Bot. Mag. 45: t. 1969 (1818).

Stem tuberous, subterranean, cylindric, up to 75 cm. long and 20 cm. in diameter. Leaves up to 40 in a branching plant, 1.5-2 m. or more in length, furfuraceous below with reddish brown hairs. Petiole 70-100 cm. long, rounded below, flattened above and in upper half with edges elevated, spiny, very rarely smooth. Rachis 75-125 cm. long in large plants, rounded below, flat above and with edges raised in lower half, considerably elevated between the two rows of leaflets in upper half, nearly free from spines except in lower part. Leaflets 10-15 on each side, opposite or alternate, very thick and rigid, obovate-oblong, upper margin rather convex, lower rather straight, obtuse or irregular at the rarely acute, apex, unequally attenuate at the base, the upper third with numerous small blunt teeth, as many as 30 teeth on the upper margin and a few less on the lower; largest leaflets 16-18 cm. long, 4-6 cm. wide, the upper and lower ones smaller; veins 60-90.

Male cones cylindric, light brown, densely tomentose, 7-10 cm. 1.8-2.2 cm. in diameter. Microsporophylls in 10-12 vertical rows of 18-20 each; the top flat, 5-7 mm. wide, 2-3 mm. high. Microsporangia in two groups of 15-19 each, single or in sori of 2. Female cones cylindric, gray, rufous tomentose, the sterile tip about 2 cm. long, 16-23 cm. long, 5 cm. in diameter; peduncle 30-37 cm. long, densely tomentose. Megasporophylls in 10-12 vertical rows of 14 or 15 each; the top 1.5 cm. wide, 1 cm. high, the upper edge projecting and both upper and lower edges slanting inward to a narrow and usually crescentic depression.

Geographic distribution: Mexico, near Veracruz; Honduras, along Atlantic coast; Colombia, Medellín and vicinity. Introduced into cultivation in England as early as 1691

15. Zamia sylvatica Chamberlain

Chamberlain, C. J., Bot. Gaz. 81:223 (1926).

Stem subterranean, 30 cm. long, 13 cm. in diameter. Leaves 2-4 in a crown, about 1 m. long, whitish puberulent below. Petiole 30 cm. long, spiny, especially below; rachis 60-72 cm. long, with a few spines on the lower third. Leaflets 20-25 on each side, long lanceolate, somewhat convex on the upper margin and concave on the lower, tapering to a sharp tip and to a cuneate base 4 mm. wide, with 15-20 serrations on each margin mostly above the middle of the leaflet; the largest 12-29 cm. long, 1.5-2.5 cm. wide, the upper and lower leaflets almost as large as the rest; veins 25-38. Male cones not available. Female cones cylindric, obtusely tipped, light gray, pubescent, 10-14 cm. long, 4-5 cm. in diameter, the peduncle about as long as the cone. Megasporophylls in 8-12 vertical rows of 10-14 each, the top 1.4-1.7 cm. wide and 7-9 mm. high, a transverse ridge sometimes extending nearly across. Seeds not available.

Geographic distribution: About 8 kilometers south of the Papaloapan River at Tuxtepec, Mexico, State of Oaxaca. Dioon spinulosum occurs in great abundance a few kilometers beyond.

The above description differs in several particulars from my earlier description, although both were made from the type plant, the only one yet known. In the former description the petiole is smooth, there are more and larger leaflets, more veins, and the top of the megasporophylls is quadrangular and the transverse ridge quite marked. In its native habitat, a swampy place in a dense tropical rain-forest, the temperature reaches 50 degrees Centigrade in March and 55 degrees in the summer. The plant has been growing under the usual greenhouse conditions for more than 30 years.

16. Zamia mexicana Miq.

Z. loddigesii Miq. (?)

Miquel, F. A. W., Tijdsch. Nat. Gesch. 10:73 (1843); Prod. Syst. Cycad. 12, 13, 24, 25 (1861).

Stem tuberous, subterranean, cylindric, 20-30 cm. long, 8-10 cm. in diameter in unbranched plants, greater in branched plants. Leaves 7-10 on each branch, up to 1 m. long, dark green, glabrous. Petiole 30-40 cm. long, broad at the base, rounded below, slightly depressed above near the base, higher up with two shallow grooves and a rounded elevation between them, spiny below, less spiny higher up. Rachis 35-55 cm. long, rounded below, with two grooves above and an elevation between the two rows of leaflets, with a few spines in the lower half. Leaflets 14-24 on each side, mostly opposite or subopposite, at least in the upper half of leaf, lanceolate, straight or nearly so, acuminate,. narrowed at base to 4 mm., with 10-15 teeth on each margin, generally with a few more teeth on the lower margin than on the upper and nearly all on the upper third of leaflet, slightly revolute; largest leaflets 27 cm. long, 2 cm. wide, and with 30-38 veins; the upper and lower leaflets shorter than the rest.

Male cones cylindric, grayish tomentose, 7-10 cm. long, 2-2.3 cm. in diameter; peduncle 5-7 cm. long, tomentose. Microsporophylls in 12 or 13 vertical rows of 18-20 each; the top 5-7 mm. wide and 3 mm. high, with a central transverse depression. Microsporangia in two groups of 15-20 each, nearly all in sori of 2. Female cones cylindric, the sterile tip about 5 mm. high, grayish tomentose, 5-6 cm. long; peduncle usually somewhat longer than the cone. Top of megasporophyll 8 mm. or more wide, transversely concave. Seeds red.

Geographic distribution: Introduced into cultivation from "near Veracruz, Mexico." The plant upon which most of the foregoing description is based is a male specimen in the Garfield Park Conservatory, Chicago. It is a vigorous plant and bears cones nearly every year. It has been under observation by the author for more than twenty years.

Miquel's descriptions of Zamia mexicana and Z. loddigesii are very inadequate and do not permit these species to be distinguished from each other or from certain others occurring in the same region. Z. loddigesii is described as having spiny petioles, leaflets 5-22 on each side, narrowly linear-lanceolate, straight or nearly so, acuminate, spinulose-serrulate in the upper fourth (rarely in the upper half or three-fourths), about 20 cm. long and 8-12 mm. wide. Paul C. Standley, in Contr. U. S. Nat. Herb. 23[V]:49-50 (1920), regards Z. mexicana and Z. loddigesii as the same, and states that the leaflets are 15-30 mm. wide and have 18-30 or more veins. He gives the distribution as "southern Mexico and Guatemala."

The author and the editor have examined all the specimens, labeled Z. loddigesii, which are in the herbarium of the Chicago Natural History Museum. Practically all are sterile and consist of a single leaf or only part of a leaf. These represent collections from Mexico (Yucatan), British Honduras, Guatemala, and Honduras. Their range of variation is much too great for all to be included in the same species. Until more knowledge, based on careful field studies, is forthcoming, it would be futile to attempt to define Z. loddigesii or several other inadequately described species from the same region.

17. Zamia spartea A. DC.

De Candolle, A., Prodr. 16[2]:539 (1868).

Stem tuberous, subterranean, 12-30 cm. long, 6-8 cm. in diameter. Leaves 3-10 in a crown, 30-100 cm. long, glabrous. Petiole 20-50 cm. long, terete or sometimes slightly flattened above, spiny especially below; rachis 15-50 cm. long, rounded below, elevated between the two rows of leaflets, with a few spines on the upper side. Leaflets 7-20 on each side, opposite or rarely alternate, narrowly lanceolate, acuminate, closely serrulate in upper third and with not more than 2 or 3 teeth on each margin below the middle, revolute; leaf with a small number of large leaflets or a large number of smaller ones, the largest 14-22 cm. long and 2-2.5 cm. wide, the top and bottom leaflets smaller than the rest; veins 30-40.

Male cones solitary or 2 or 3 together, cylindric, light gray, densely tomentose with short reddish yellow hairs, 6-9 cm. long, 1.5-2.3 cm. in diameter; peduncle 5-10 cm. long, tomentose, often with a few scales. Microsporophylls in 9-11 vertical rows of 12-15 each; top 6-8 mm. wide, 3-5 mm. high, with a narrow transverse depression in the middle. Microsporangia in two groups of 10-20 each, mostly in sori of 2. Female cones usually solitary, ellipsoid, the sterile tip short and blunt or lacking, yellowish gray, densely tomentose with short hairs, 4-6 cm. long, 4-5 cm. in diameter; peduncle 4-6 cm. long, tomentose. Megasporophylls in 6-8 rows of 5 or 6 each; top convex above and concave below, 8-15 mm. wide, 8-10 mm. high, with a transverse depression in the middle. Seeds orange-red.

Geographic distribution: Abundant at Zacuapán and Huatusco, about 100 kilometers west of Veracruz, Mexico; also farther south near Acayucan, Verapa, and Chimalapa, and at Verapaz, Guatemala.

18. Zamia gutierrezii Sauv.

—— Z. lucayana Britt,

Sauvalle, F. A., Anal. Acad. Cienc. Nat. Habana 5:54 (1868); Britton, N. L., Bull. New York Bot. Gard. 5:311 (1909); Britton, N. L., and Millspaugh, C. F., Bahama Flora, p. 463 (1920).

Stem tuberous and subterranean, 20-30 cm. long, 6-10 cm. in diameter, often branched. Leaves 4-6 in a crown, about 1 m. long, glabrous. Petiole 40-60 cm. long, subterete, spiny; rachis 30-60 cm. long, rounded below, elevated above between the two rows of leaflets, with a few spines in lower part. Leaflets 8-16 on each side, opposite in upper half, subopposite or alternate below, lanceolate, abruptly acuminate, tapering at base to 3 mm., characteristically serrate, the teeth sharp and close together toward the apex, far apart toward the base, often with a toothed shoulder about 3.5 cm. from the tip; largest leaflets 20-25 cm. long and 3-3.5 cm. wide, the upper and lower ones about as large as the rest; veins 25-40.

Male cones cylindric, greenish, 5-6 cm. long, 1.4 cm. in diameter. Top of microsporophylls 5 mm. wide and 2 mm. high. Female cones cylindric, bluntly tipped, greenish, smooth, 8-10 cm. long, 3-4 cm. in diameter; peduncle 18 cm. long, smooth. Megasporophylls in 6 vertical rows, 7 in a row, the top rugose, 18 mm. wide and 7 mm. high.

Geographic distribution: Oriente, Cuba, near Baracoa; also in Pinar del Río, near Viñales; reported from Jamaica and the Bahamas. This species does not occur in Puerto Rico.

19. Zamia ulei Damm.

Dammer, U., Verh. Bot. Ver. Prov. Brandenburg 48:116 (1906); Ducke, A., Arch. Jard. Bot. Rio de Janeiro 1:9 (1915) and 3:19-20 (1922), Arch. Inst. Biol. Veget. Rio de Janeiro 2:27 (1935).

Stem tuberous. Leaves few in a crown, up to 1.5 m. long. Petiole 1 m. or more in length, terete, armed with numerous spines 1-4 mm. long; rachis 30-45 cm. long. Leaflets up to 18 on each side, subopposite or alternate, linear-lanceolate or ovate-lanceolate, subfalcate, acute or acuminate, narrowed at the base to 5 mm., with 12-15 teeth near the apical end, up to 50 cm. long and 7 cm. wide, often much narrower, veins up to 60. Male cones several, up to 10 cm. long, 1.5 cm. in diameter; peduncle 6-8 cm. long, with reddish brown hairs. Microsporophylls in 12-16 vertical rows, strongly elevated at the top, the dorsal face very small. Female cones single, cylindric, the sterile tip conical and 1.2 cm. high, 20 cm. long, 6 cm. in diameter; peduncle 3 cm. long. Megasporophylls in 9-15 vertical rows of 13 or 14 each; the top transversely concave, 22 mm. wide and 12 mm. high. Seeds ovoid-oblong, nearly triangular, red, 15 mm. long, 8 mm. in diameter.

Geographic distribution: Brazil—in western and central Amazonas near Cachoeira on upper Jurua River, Boca de Moa near Leticia and Jurimaguas, Tarapoto near St. Antonio with Z. lindenii Regel, Huallaga near Shapaga.

Ducke (1915, 1922) describes two new Brazilian species from the State of Pará—Z. lecointei, occurring among rocks in the falls of the "Cachoeira do Inferno," of the Erepecuru River, a tributary of the Trombetas; and Z. obidensis, growing in open woods on hills near the Branco River, northeast of Obidos. Later (1935) he makes

Z. lecointei a subspecies of Z. ulei, pointing out that it differs only in having very narrow leaflets (1-1.5 cm. wide). At the same time, Ducke regards Z. obidensis, previously described from a young plant, as identical with subspecies lecointei, when individuals of the same age are compared.

20. Zamia poeppigiana Mart. and Eichl.

Martius, K. P. F. von, and Eichler, A. W., in Martius' Flora Bras. 4[1]:414 (1863).

Stem creeping, usually on fallen trees. Leaves rich green and glabrous. Petiole acutely triangular, unarmed, glabrous. Leaflets 12-14 on each side, subopposite, lanceolate, broadly falcate, acute, narrowed at base to 8-10 mm., serrate, especially in upper part and along lower margin, 15-35 cm. long, 2-4 cm. wide, veins 30-40. Male cones solitary, long cylindric, about 25 cm. long and 4 cm. in diameter; peduncle 6 cm. long, puberulous. Microsporophylls in 14 vertical rows of more than 50 each, the top truncate conical. Seeds red.

Geographic distribution: Eastern Peru, on decaying tree stumps; southwestern Colombia—near Buenavista, Barbacoas, on rich humus in shady woods.

21. Zamia tuerckheimii Donn. Sm.

Smith, John Donnell, Bot. Gaz. 35:8 (1903).

Stem pendent at first, becoming erect, 1.5-3 m. long and 20 cm. in diameter, sometimes forked. Leaves about 1.7 m. long, dark green and glabrous above, paler beneath. Petiole and base of rachis sparsely and minutely spiny or unarmed; rachis triangular in transverse section, nearly 1 m. long. Leaflets about 14 on each side, subopposite, broadly oblanceolate, abruptly and shortly acuminate, narrowed at the base to 3-5 mm., entire 18-24 cm. long, 4-6 cm. wide, with about 40 veins. Male cones narrow cylindric, apiculate, pale brown, about 14 cm. long and 2.5 cm. in diameter, the peduncle half as long as the cone. Microsporophylls in about 24 vertical rows of about 36 each, the top about 4 mm. wide and 3.5 mm. high, with a truncate-pyramidal elevation square in outline. Microsporangia in two groups of 9-12 each separated by a narrow median line. Female cones cylindric, cuspidate-acuminate with a sterile tip about 3 cm. high, about 18 cm. long and 6 cm. in diameter, the peduncle about 2 cm. long. Megasporophylls in about 9 vertical rows of about 9 each, gray tomentose, about 3 cm. wide and 1.4 cm. high, with a narrow transverse groove. Seeds obovoid, scarlet, 2 cm. long, 13 mm. wide.

Geographic distribution: Alta Verapaz, Guatemala; also in British Honduras.

22. Zamia obliqua A. Braun

Braun, A., Monats. Akad. Wiss. Berlin, p. 376 (1875);
Hooker, J. D., Bot. Mag. [123] t. 7542 (1897).

Stem cylindric, erect, slender, up to 2.5 m. high, 30-60 cm. in diameter. Leaves 60-90 cm. long, shiny green. Petiole long, unarmed or with a few scattered spines, tomentose at first, becoming glabrous; rachis unarmed. Leaflets about 6 on each side; ovate, ovate-oblong, or ovate-lanceolate; with a petiolule up to 12 mm. long, usually caudate-acuminate, sharply subspinulosely toothed from middle to apex, 10-18 cm. long, 2-7 cm. wide; veins 20-50. Male cones not available. Female cones cylindric, the sterile tip conical and acute, pale brown, tomentose, about 15 cm. long, 6.5 cm. in diameter; peduncle up to 3 cm. long. Megasporophylls in 6 vertical rows of about 10 each, the top about 3 cm. wide and 1 cm. high, truncate or slightly concave.

Geographic distribution: Colombia--Cape Corrientes. Related to Z. furfuracea Ait. and Z. skinneri Warsz.

This is a form that is never used in taxonomic papers, and should be changed. The references should be associated with the binomials, for there are thre different names anderch has one reference. My suggestion in this and similar cases (if there are others) is as follows:

23. Zamia chigua Seem.

Bot. Voy. Herald, pp. 201, 253 (1854).

Zamia lindleyi Warcz. in Otto and Dietrich Allg. Gartenz. 19: 146. (1851)

Zamia lindleyana Warcz. in Wendl. Ind. Palm., p.35. (1854).

If this work be published with the citations confused as betwenn the accepted names and the synonyms it will raise a storm of protest. I suspect the strange form accepted (which is utterly foreign to this

over

type of botanical literature,was due to the fact that neither the author nor the editor was familiar with taxonomic usage. I feel very ~~xxxxxx~~ strongly indeed regarding this matter,for it is illogical,untrue,and utterly misleading. In this and and ~~xxx~~ all of the similar cases proper adjustment must be made and every taxonomist will agree with me. I suggest that you consult with Paul C.Standley at the Chicago Museum of Natural History,who could supervise the necessary changes in the manuscript or would know of someone,like Dr.Sherff, who could do so. Unless this be done I ,for one,would strongly recommend that publication be deferred. This type of citation simply does not occur in taxonomic literature,and should not be fostered for it is an utterly absurd innovation.

E.D.M

23. Zamia chigua Seem.

Z. lindleyi Warsz.

Z. lindleyana Warsz.

Seemann, B., Bot. Voy. Herald, pp. 201, 253 (1854); Warszewicz, M. von, in Otto and Dietrich Allg. Gartenz. 19:146 (1851); and in Wendland's Ind. Palm., p. 53 (1854).

Stem cylindric, [redacted] 20 cm. or more in height, 13 cm. in diameter. Leaves about 10 in a crown, 80-120 cm. long, vivid green. Petiole about 20 cm. long, terete, very spiny; rachis terete but with two grooves along the upper side, spines numerous near base, fewer near apex, tomentose at first, becoming glabrous. Leaflets up to 69 on each side, alternate, ovate-lanceolate, falcate, acuminate, contracted at base, the margins bearing a few teeth so small as to be almost imperceptible; 10-20 cm. long, 10-16 mm. wide; veins about 16. Male cones subcylindric, brown, tomentose, 9-13 cm. long, 2.5 cm. in diameter; peduncle 4-6 cm. long. Microsporophylls in 18-21 vertical rows of 27-32 each. Female cones not available.

Geographic distribution: Panama—islands at mouth of San Juan River, in Darien; also in western Veraguas, Colombia.

Panama ?

Ind. Guatemala: Chiapas.

24. Zamia muricata Willd.

Willdenow, K. L., Spec. Plant. 4:847 (1805); Karsten, H., Abhandl. Akad. Wiss. Berlin 193-219 (1856).

Stem cylindric or ovoid, low, rarely up to 15 cm. high and 12 cm. in diameter, sometimes once or twice forked at top. Leaves up to 6 in a crown, up to 2 m. long, glabrous. Petiole more than one-half as long as the rachis, nearly quadrangular, with a shallow groove along the upper surface and with small spines on the lower side, glabrous. Leaflets 6-11 on each side, alternate or suboppo-site, lanceolate or unequally oblong-lanceolate, acuminate, narrowed at the base, serrate in the upper half, 15-20 cm. long, 2-4 cm. wide, veins up to 50. Male cones usually 2-5 together, cylindric, 6-10 cm. long, about 1.5 cm. in diameter; peduncle 20-30 cm. long, tomentose. Microsporophylls in 8-13 vertical rows; microsporangia in two groups of 10-12 each. Female cones single, cylindric, brown, tomentose, with a sterile tip about 3 cm. high, 10-15 cm. long, 2.5-4 cm. in diameter; peduncle 6-8 cm. long, tomentose. Megasporophylls in 5-8 vertical rows; the top about 15 mm. wide and 6 mm. high, slightly depressed in the middle. Seeds ovoid, red, 3 cm. long, 2 cm. wide.

Geographic distribution: Colombia, between Santa Barbara and Puerto Cabello; Venezuela, Caracas; Mexico, Oaxaca; possibly also in Guatemala.

25. Zamia monticola Chamberlain

Chamberlain, C. J., Bot. Gaz. 81:219 (1926).

Stem an aerial, armored, branched trunk reaching a height of 80 cm. or more, 15 cm. in diameter. Leaves 20-30 in a crown, 1.3-1.7 m. long, glabrous. Petiole 50-60 cm. long, rounded below, somewhat flattened above and near the rachis depressed with ridges at the sides, very spiny near base, less spiny higher up. Rachis up to 1 m. long, rounded below near the petiole and on the upper side depressed in the center with ridges at the sides, nearer the apex becoming flattened and finally considerably elevated between the two rows of leaflets; somewhat spiny in lower half, smooth in upper half. Leaflets 14-20 on each side, mostly alternate, lanceolate, arcuate, the lower border concave and the upper convex, acuminate, narrowed at the base to 7 mm., revolute, some leaflets nearly entire but mostly with 4-10 blunt teeth on the lower margin and 2-6 on the upper; 20-25 cm. long, 3-3.5 cm. wide, the lower two or three leaflets smaller; veins 20-30.

Male cones 3-6, cylindric, tapering to a blunt top, 12-16 cm. long, occasionally up to 22 cm., 4 cm. in diameter; peduncle 10-17 cm. long. Microsporophylls in 16-18 vertical rows of 25-40 each; top 7 mm. wide, 5 mm. high, with distinct lines from the angles to an elevated central part. Microsporangia in two widely separated groups of 10-16 each, mostly in sori of 2. Female cones not available.

Geographic distribution: On mountain side near Jalapa, Mexico, opposite the extinct crater of Naolinco, associated with Ceratozamia mexicana. To date, only one specimen has been reported. It was raised from a seed picked up in 1906 in the locality mentioned. It has coned repeatedly and is now the largest plant in the University of Chicago collection of seventeen species of Zamia.

26. Zamia lindenii Regel

Regel, E. von, ex André, E., Illus. Hort. 22:23 (1875), Gartenfl. 25:141 (1876).

Stem cylindric, 1-2 m. in height, with prominent leaf scars. Leaves 10-15 in a crown, 1.5-2.5 m. long, glabrous or somewhat puberulous. Petiole up to 2 m. long, terete, spiny, sparsely tomentose at first, becoming glabrous; rachis terete, spiny except in upper one-third. Leaflets 40 or more on each side, opposite or subopposite, long lanceolate, subfalcate, acuminate, narrowed at base to about 5 mm., sessile, dentate-serrate in upper one-third, 20-30 cm. long, 2-4 cm. wide; veins 22-30 or more, distinct above. Male cones cylindric, yellow-brown, tomentose; top of microsporophylls 4 mm. wide and 5 mm. high. Female cones reddish, tomentose, about 35 cm. long and 8 cm. in diameter; peduncle 8 cm. long. Top of megasporophylls truncate-pyramidal, flat, 12 mm. wide. Seeds obovate, orange-red, 2.5-3 cm. long, 1.5-2 cm. in diameter.

Geographic distribution: Ecuador—coastal plain, foothills of Cordillera Occidental, El Entable near Naránjal, between Puente de Chimbo and Bambacagua, Pallatanga; Brazil—Amazonas, near St. Antonio.

27. Zamia pseudoparasitica Yates,

Z. roezlii Regel,

Yates, J., in Seemann's Bot. Voy. Herald 202, 253 (1854); Regel, E. von, in Linden's Cat. no 90:10 (1873), Gartenfl. 25: 141 (1876); André, E., Illus. Hort. 20:126 (1873).

Stem cylindric, robust, 1-3 m. high. Leaves up to 2 m. long, suberect, glabrous. Petiole 50 cm. long, terete, unarmed on young plants, later with scattered or crowded spines; rachis semiterete, rarely with scattered spines. Leaflets 25 or more on each side, opposite or alternate, lanceolate, sinuate-falcate, long acuminate, cuspidate, tapering at the base, entire, 35-50 cm. long, 3-4 cm. wide, with about 18 prominent veins. Male cones cylindric, light yellow-brown, pubescent, 18 cm. long, 5 cm. in diameter; peduncle about 10 cm. long, tomentose. Microsporophylls in about 35 vertical rows of 40-50 each; the top 4 mm. wide, 4 mm. high, with a truncate-conical raised center. Female cones cylindric, obtuse, 40 cm. long, 12 cm. in diameter. Seeds bright scarlet.

Geographic distribution: Chagres, Panama; Buenaventura, Colombia; Ecuador; also on eastern side of Andes in Peru. Growing epiphytically on tree trunks.

28. Zamia skinneri Warsz.

Warszewicz, M. von, in Otto and Dietrich Allg. Gartenz. 19: 146 (1851); Seemann, B., Bot. Voy. Herald 202, 252 (1854); Hooker, J. D., Bot. Mag. 87: t. 5242 (1861).

Stem ~~[illegible]~~ subterranean below, but often growing 60 cm. or more above the ground, usually 30-40 cm. long, 6-9 cm. in diameter, smooth but strongly marked transversely with leaf scars. Leaves 6-10 in a crown but often up to 15-17, up to 1.5-1.8 m. long, bright green and glabrous. Petiole 50-85 cm. long, subterete, grooved above, with many coarse spines; rachis less spiny than the petiole, sometimes nearly smooth in upper half. Leaflets 6-12 on each side, sometimes up to 16, opposite or subopposite, rather thin, broadly lanceolate, tapering to a slender sharp apex, narrowed at the base to 5-7 mm., sharply and distantly serrulate with 10-12 teeth on each border and not more than 1 or 2 of them below the middle of the leaflet; 20-35 cm. long, 5-10 cm. wide, veins 20-35, extremely prominent.[1]

---

[1] Probably no cycad has more conspicuous veins.

Male cones usually 3-5, cylindric, slightly tapering toward apex and base, light yellow-brown, tomentose, 5-9 cm. long, 1.5-2 cm. in diameter; peduncle 5-8 cm. long, somewhat angular, tomentose. Microsporophylls in 11-15 vertical rows of 22-30 each, ~~[illegible]~~ the top 4 mm. wide, 2 mm. high, with a truncate-conical raised center. Microsporangia in two groups of 6-8 each, usually in sori of 2. Female cones single, cylindric, with a rounded sterile tip 1.5 cm. high, orange-brown, 15-20 cm. long, 5-7 cm. in diameter; peduncle 10-13 cm. long, tomentose. Megasporophylls in 9-11 vertical rows of 8-11 each, ~~[illegible]~~ the top 2-2.5 cm. wide, 1.5-1.7 cm.

with a slight median depression and rather definite lines leading to it from the six angles. Seeds reddish with some orange, 2.5-2.8 cm. long, 1.2-1.4 cm. in diameter; stony coat 2.2-2.5 cm. long, 1-1.2 cm. in diameter, very smooth, with 4 or 5 bundles recognizable only at the chalaza.

Geographic distribution: Panama—Isthmus of Darien, ~~Promontory Corrientes~~, Providence Island, Boca del Toro, Santa Rita Trail. Costa Rica—Wet forests of the Atlantic Coast, ascending to 900 m. at Pejivalle and to 700 m. in the mountains of Guanacaste; along the Reventazón River at Las Ánimas, near Turrialba.

Use Liebmann's original figs plates, where possible!
Best pictures in Gerard acc's.
see Chamberlain collection in
Chicago Natural History
Museum!

- figs. from Chamberlain's
earlier books!

29. Zamia wallisii A. Braun

Braun, A., Monats. Akad. Wiss. Berlin, p. 376 (1875); Hooker, J. D., Bot. Mag. 116: t. 7103 (1890).

Stem about 15 cm. high, cylindric, partly subterranean. Leaves few, appearing singly, light green and glabrous. Petiole 60-90 cm. long, terete, spiny, sparsely pubescent, becoming glabrous. Leaflets 2-8 on each side, elliptic to oblanceolate, acute, cordate or acute at base, with a petiolule up to 7 cm. long, margins toothed in upper third; 30-50 cm. long, 10-25 cm. wide; veins up to 70. Male cones clustered, cylindric, 5-6 cm. long, tomentose; peduncle short. Microsporophylls with a concave top. Female cones not available.

Geographic distribution: Colombia. Related to Z. skinneri Warsz.

Fig. 5	Use Fig. 82 from Chamberlain's GYMNOSPERMS
Fig. 6	" " 83 " " "
Fig. 11	Use Fig. 67 from Chamberlain's GYMNOSPERMS or Fig. 23 from THE LIVING CYCADS
Fig. 17	Use Fig. 71 from Chamberlain's GYMNOSPERMS or Fig. 23 from THE LIVING CYCADS
Fig. 54	Use Fig. 109 from Chamberlain's GYMNOSPERMS
Fig. 85	Use Fig. 19 from THE LIVING CYCADS
Fig. 105	Use Fig. 110a from Chamberlain's GYMNOSPERMS

Fig. 1.—Encephalartos longifolius: at van Staadens, near Port Elizabeth, South Africa.

Fig. 2.—Cycas revoluta: unusually large specimen, about 10 meters tall, at Minè, Province of Izu, Japan.

Fig. 3.—Stangeria paradoxa: at East London, South Africa.

Fig. 4.—Zamia floridana: female plant, with seedlings growing at base of leaves, at Miami, Florida.

Fig. 5.—Dioon edule: photograph of surface view of apex of stem, showing a cone dome with its bundles going to a cone and, to the left of it, a similar series of bundles going to the new apex, which is producing leaves; below is a cone dome with some of the bundles cut across.—After Chamberlain.

Fig. 6.—Dioon spinulosum: photograph of surface view of top of a large plant cut longitudinally through the middle. The second cone dome from the top shows the peduncle of the cone, part of which can be seen in the cone dome just below it and in the lowest one; one-half natural size.—After Chamberlain.

Fig. 7.—Cycas circinalis: new crown of leaves growing up through crown of megasporophylls, in the University of Chicago greenhouse.

Fig. 8.—Encephalartos friderici-guilielmi: cluster of female cones at apex of stem; Queenstown, South Africa.

Fig. 9.—Macrozamia moorei: male cones borne in axils of leaves; Springsure, Australia.

Fig. 10.—Zamia silicea, from Isle of Pines, Cuba. Length of stem, 16.5 cm.

Fig. 11.—Dioon edule: portion of trunk of an old plant, showing armor of leaf bases. The trunk is smaller below than above. It shows three zones, marking prolonged dormant periods.—From Chamberlain, The Living Cycads (University of Chicago Press).

Fig. 12.—*Microcycas calocoma*, near Consolación del Sur, Cuba.

Fig. 13.—*Encephalartos friderici-guilielmi*, near Queenstown, South Africa.

Fig. 14.—*Dioon edule*: female plant, at Chavarrillo, near Jalapa, Mexico. The trunk is about 1.5 meters in height and about 1,000 years old.

Fig. 15.—*Cycas media*: transverse section of stem, showing growth rings. Diameter of stem, 19 cm.

Fig. 16.—*Cycas pectinata*: transverse section of stem, showing growth rings. Diameter of stem, 20 cm.

Fig. 17.—*Dioon spinulosum*: transverse section of stem, showing zone of wood the widest ever described in a cycad. Diameter of stem, 33 cm. The growth rings show faintly.—From Chamberlain, *The Living Cycads* (University of Chicago Press).

Fig. 18.—*Dioon edule*: new crown of twenty leaves, the longest, 45 cm. in length.

Fig. 19.—*Dioon spinulosum*: new crown of leaves nearly erect, the previous crown nearly horizontal.

Fig. 20.—Vernation in *Macrozamia denisonii* (A), *Cycas circinalis* (B), *Zamia floridana* (C), and *Stangeria paradoxa* (D).

Fig. 21.—*Dioon spinulosum*: juvenile leaves at left, adult leaves at right.

Fig. 22.—*Cycas revoluta*, at Huntington Botanical Gardens, San Marino, California. From a photograph by A. W. Haupt.

Fig. 23.—*Cycas revoluta*: male cone, 35 cm. long, at Los Angeles, California. From a photograph by A. W. Haupt.

Fig. 24.—*Cycas revoluta*: compact crown of megasporophylls, at Los Angeles, California. From a photograph by A. W. Haupt.

Fig. 25.—*Cycas revoluta*: expanding crown of megasporophylls, at Garfield Park Conservatory, Chicago.

Fig. 26.—*Cycas revoluta*: megasporophylls, about one-half natural size.

Fig. 27.—*Cycas pectinata*: microsporophyll, twice natural size.

Fig. 28.—*Cycas wadei*: megasporophylls and seeds.

Fig. 29.—*Cycas undulata*: leaflets near apex of leaf, about one-half natural size.

Fig. 30.—*Cycas undulata*: branching plant with crown of megasporophylls near base of main stem and new crown of leaves at top; in the Phipps Conservatory, Pittsburgh, Pennsylvania.

Fig. 31.—*Cycas undulata*: megasporophylls, natural size.

Fig. 32.—*Cycas circinalis*: male plant with cone, in the greenhouse of the University of Chicago.

Fig. 33.—*Cycas circinalis*: male cone, in the Garfield Park Conservatory, Chicago.

Fig. 34.—*Cycas circinalis*: new crown of megasporophylls above, older sporophylls hanging down below; in the greenhouse of the University of Chicago. The new crown is about 35 cm. high.

Fig. 35.—*Cycas circinalis*: crown of megasporophylls.

Fig. 36.—*Cycas rumphii*, in the Botanic Garden, Sydney, Australia.

Fig. 37.—Microsporophylls of *Cycas rumphii* (above) and *C. circinalis* (below), natural size.

Fig. 38.—*Cycas media*: branched plant with two male cones, near Freshwater, Queensland, Australia.

Fig. 39.—*Cycas media*: male cone.

Fig. 40.—*Cycas media*: female plant with crown of megasporophylls; at Frenchman's Creek, near Rockhampton, Australia.

Fig. 41.—Cycas media: cluster of megasporophylls, Frenchman's Creek, near Rockhampton, Australia.

Fig. 42.—Stangeria paradoxa, at Ngoye, Zululand, South Africa.

Fig. 43.—Stangeria paradoxa: leaflet with deeply incised margin.

Fig. 44.—Stangeria paradoxa: male plant, at Manubie, Kentani, Transkei, South Africa. From a photograph by Mrs. Sarah Van Rooyen Webster.

Fig. 45.—Stangeria paradoxa: female plant at Mubie, Kentani, Transkei, South Africa. From a photograph by Mrs. Sarah Van Rooyen Webster.

Fig. 46.—Stangeria paradoxa: male cone, about 14 cm. long, exclusive of peduncle.

Fig. 47.—Stangeria paradoxa: female cone, 21 cm. long.

Fig. 48.—Bowenia spectabilis: female cone, 14 cm. long.

Fig. 49.—Bowenia serrulata: fully grown plant at Byfield, near Rockhampton, Australia.

Fig. 50.—Bowenia serrulata: a stem, showing profuse branching.

Fig. 51.—Bowenia serrulata: male cone, natural size.

Fig. 52.—Dioon edule: two male plants, with cones shedding pollen; at Chavarrillo, near Jalapa, Mexico.

Fig. 53.—Dioon edule: male cone, at shedding stage; University of Chicago greenhouse.

Fig. 54.—Dioon edule: lateral and abaxial view of microsporophylls, slightly enlarged.—After Chamberlain.

Fig. 55.—Dioon edule: female plant, at Los Angeles, California, with an unusually large cone, which is 43 cm. long and 29 cm. in diameter. The leaves are 1.5 meters long. From a photograph by A. W. Haupt.

Fig. 56.—*Dioon edule*: female cone, at Huntington Botanical Gardens, San Marino, California. From a photograph by William Hertrich.

Fig. 57.—*Dioon purpusii*: a plant cultivated at Coronado Beach, California.

Fig. 58.—*Dioon pinoi*: leaf and seeds collected by C. A. Purpus near Monserrato, Chiapas, Mexico.

Fig. 59.—*Dioon madrense*: male cone and microsporophylls, from Los Mochis, Sinaloa, Mexico. The cone is 21 cm. and the sporophylls 3.5 cm. long.

Fig. 60.—*Dioon spinulosum*, on the Hacienda de Joliet, near Tierra Blanca, Mexico.

Fig. 61.—*Dioon spinulosum*: leaflets from plant grown near Sarasota, Florida.

Fig. 62.—*Dioon spinulosum*: male cone, at shedding stage, on plant grown in the University of Chicago greenhouse. The cone is 54 cm. long, the peduncle 6 cm. long.

Fig. 63.—*Macrozamia denisonii*, on Tambourine Mountain, near Brisbane, Australia. From a photograph by Mrs. Hilda Geissmann Curtis.

Fig. 64.—*Macrozamia denisonii*; female plant with cone; Tambourine Mountain, near Brisbane, Australia. From a photograph by Mrs. Hilda Geissmann Curtis.

Fig. 65.—*Macrozamia denisonii*: male cone, shedding pollen, at Huntington Botanical Gardens, San Marino, California. From a photograph by William Hertrich.

Fig. 66.—*Macrozamia denisonii*: female cone. From a photograph by Mrs. Hilda Geissmann Curtis.

Fig. 67.—Macrozamia hopei: tall plant at Bellenden Plains, about 30 kilometers from Cardwell, Queensland, Australia.

Fig. 68.—Macrozamia hopei: male cone, 21 cm. long; Daintree River, Queensland, Australia. From a photograph supplied by Department of Agriculture and Stock, Brisbane.

Fig. 69.—Macrozamia moorei: male plant. From a photograph supplied by New South Wales Government Printer.

Fig. 70.—Macrozamia moorei; female cone, 70 cm. long; Clarence River, New South Wales. From a photograph supplied by New South Wales Government Printer.

Fig. 71.—Macrozamia reidlei:tall type, near Gibson's Soak, Western Australia.

Fig. 72.—Macrozamia reidlei: plant with three male cones beginning to shed pollen; Crawley, Western Australia. From a photograph by Miss Alison Baird.

Fig. 73.—Macrozamia spiralis: female plant.

Fig. 74.—Macrozamia spiralis: female cone. From a photograph by B. E. Dahlgren.

Fig. 75.—Macrozamia spiralis: male plant. From a photograph supplied by Department of Agriculture and Stock, Brisbane, Australia.

Fig. 76.—Macrozamia miquelii: male plant; Frenchman's Creek, near Rockhampton, Australia.

Fig. 77.—Macrozamia miquelii: female plant.

Fig. 78.—Macrozamia miquelii: female cone.

Fig. 79.—Macrozamia heteromera: female cone, 16 cm. long; Botanic Garden, Sydney, Australia.

Fig. 80.—Encephalartos brachyphyllus: male cone on left, 30 cm. long, without peduncle; female cone on right, 16 cm. long, without peduncle.

Fig. 81.—Encephalartos villosus: male cone, 55 cm. long, exclusive of peduncle; in the University of Chicago greenhouse.

Fig. 82.—Encephalartos villosus: female cone, 30 cm. long, exclusive of peduncle; at the Huntington Botanical Gardens, San Marino, California. From a photograph by A. W. Haupt.

Fig. 83.—Encephalartos villosus: three views of megasporophylls, natural size.

Fig. 84.—Encephalartos barteri: female plant with cone; from a photograph by B. E. Dahlgren.

Fig. 85.—Encephalartos horridus, near Port Elizabeth, South Africa.—From Chamberlain, The Living Cycads (University of Chicago Press).

Fig. 86.—Encephalartos horridus: male cone; at the Huntington Botanical Gardens, San Marino, California. From a photograph by William Hertrich.

Fig. 87.—Encephalartos horridus: female cone, at the New York Botanical Garden.

Fig. 88.—Encephalartos lehmannii, at Junction Farm, near Cathcart, South Africa. Aloe in center.

Fig. 89.—Encephalartos lehmannii: female plant with cone, Capetown, South Africa.

Fig. 90.—Encephalartos lehmannii: female cone at left, male cone at upper right, two microsporophylls at lower right.

Fig. 91.—Encephalartos latifrons, cultivated at Brisbane, Australia.

Fig. 92.—Encephalartos longifolius: male cone and microsporophylls.

Fig. 93.—Encephalartos altensteinii: male cone; at the Huntington Botanical Gardens, San Marino, California. From a photograph by William Hertrich.

Fig. 94.—Encephalartos altensteinii: plant with two female cones falling apart in liberating seeds.

Fig. 95.—Encephalartos hildebrandtii: female cone; at the Lincoln Park Conservatory, Chicago.

Fig. 96.—Encephalartos friderici-guilielmi: male plant with three cones; at the University of California, Los Angeles. From a photograph by A. W. Haupt.

Fig. 97.—Encephalartos friderici-guilielmi: male cone, 32 cm. long, and microsporophylls.

Fig. 98.—Encephalartos ghellinkii, at Drakensburg, Natal, South Africa. From a photograph by W. E. Marriott.

Fig. 99.—Microcycas calocoma; plant with branched stem, near Consolación del Sur, Cuba.

Fig. 100.—Microcycas calocoma: plant with male cone, near Consolación del Sur, Cuba.

Fig. 101.—Microcycas calocoma: plant with female cone.—After Caldwell.

Fig. 102.—Microcycas calocoma: microsporophylls (above) and megasporophylls (below), adaxial and lateral views; natural size.—Megasporophylls after Caldwell.

Fig. 103.—Ceratozamia mexicana, near Jalapa, Mexico, across from the extinct volcano Naolinco.

Fig. 104.—Ceratozamia mexicana: male cone, 22 cm. long without the peduncle.

Fig. 105.—Ceratozamia mexicana: two microsporophylls, twice natural size.—After Chamberlain.

Fig. 106.—Ceratozamia mexicana: female cone, 25 cm. long, exclusive of peduncle.

Fig. 107.—Ceratozamia purpusii: plant with male cone, at Doheny Conservatory, Los Angeles, California. From a photograph by A. W. Haupt.

Fig. 108.—Ceratozamia purpusii: male cone, 22 cm. long, exclusive of peduncle. From a photograph by A. W. Haupt.

Fig. 109.—Ceratozamia purpusii: plant with female cone, 39 cm. long, at Coronado Beach, California.

Fig. 110.—Ceratozamia purpusii: female cone, 20 cm. long, without the peduncle.

Fig. 111.—Ceratozamia miqueliana: plant with female cone, at Garfield Park Conservatory, Chicago.

Fig. 112.—Zamia floridana: plant with male cones, at Miami, Florida.

Fig. 113.—Zamia floridana: plant with female cone, at Miami, Florida.

Fig. 114.—Zamia floridana: female cone. From a photograph by W. J. G. Land.

Fig. 115.—Zamia angustifolia: male plant with two cones.—After Marie-Victorin and León.

Fig. 116.—Zamia angustifolia: female plants, at Pilón, Oriente, Cuba.

Fig. 117.—Zamia angustifolia: male cones (left) and female cone (right).—After Marie-Victorin and León.

Fig. 118.—Zamia angustissima, at Santiago de las Vegas, Cuba.

Fig. 119.—Zamia angustissima: stems and female cones, at Pilón, Ensenada de Mora, Cuba. Cones are 6 cm. long, without the peduncle.

Fig. 120.—Zamia pumila: male plant with two cones, these 7.5 cm. long, exclusive of peduncle.

Fig. 121.—Zamia pygmaea: female plant with cone 2.3 cm. long, exclusive of peduncle.

Fig. 122.—Zamia kickxii: male plant with cone 5.3 cm. long, exclusive of peduncle; University of Chicago greenhouse.

Fig. 123.—Zamia kickxii: female plant with cone 4.5 cm. long, exclusive of peduncle; University of Chicago greenhouse.

Fig. 124.—Zamia silicea: female plants, on Isle of Pines, Cuba.—After Marie-Victorin and León.

Fig. 125.—Zamia ottonis; female cone, 4 cm. long, at the left, the other cones male.

Fig. 126.—Zamia latifoliolata: male plants, with cones; near Vega Baga, Puerto Rico.

Fig. 127.—Zamia latifoliolata: female plant with cone; near Vega Baga, Puerto Rico.

Fig. 128.—Zamia media: female plant with cone 12.5 cm. long, exclusive of peduncle; University of Chicago greenhouse. Plant sent from Coamo Springs, Puerto Rico.

Fig. 129.—Zamia portoricensis: male plant with two cones, at the University of Chicago greenhouse.

Fig. 130.—Zamia portoricensis: male cones of various ages on one plant, at the University of Chicago greenhouse.

Fig. 131.—Zamia portoricensis: female plant with three cones; at Penuelas, Puerto Rico.

Fig. 132.—Zamia furfuracea: two female plants, each with a cone; Garfield Park Conservatory, Chicago.

Fig. 133.—Zamia sylvatica: female cones, 13 cm. long, exclusive of peduncle; at the University of Chicago greenhouse.

Fig. 134.—Zamia mexicana: male cones; Garfield Park Conservatory, Chicago.

Fig. 135.—Zamia spartea: male plant with three cones, from Zacuapan, Huatusco, Mexico; at the University of Chicago greenhouse.

Fig. 136.—Zamia spartea: female cones.

Fig. 137.—Zamia gutierrezii: female cone, 7 cm. long, on a peduncle 18 cm. long; at the University of Chicago greenhouse.

Fig. 138.—Zamia monticola: plant with six male cones.

Fig. 139.—Zamia skinneri: mature plant, near Turrialba, Costa Rica. From a photograph by A. W. Haupt.

Fig. 140.—Zamia skinneri: male plant with four cones; near Turrialba, Costa Rica. From a photograph by A. W. Haupt.

Fig. 141.—Zamia skinneri: female cone, 20 cm. long, exclusive of peduncle; near Turrialba, Costa Rica. From a photograph by A. W. Haupt.