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 Stangeria paradoxa has become fixed in the literature, we shall continue to use that name, following the practice of Pearson, who used Welwitschia, although technical taxonomy required Tumboa.

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

A very [illegible] … [illegible] … determinations [illegible] … name be used!