Various Observations on Ceroxylon klopstockia

AUGUST BRAUN
Instituto Botánico, Apartado 2156, Caracas, Venezuela

The southerly, precipitously sloping, evergreen forests of Avila, Federal District, Venezuela, are the natural habitat of a wax palm, *Ceroxylon klopstockia* Martius, where the author regularly sought to determine the life rhythm of this palm species over a period of 12 years. A strange accident in 1971 brought with it the loss of all documents and notes about studies accomplished in the preceding year. Thus, the author is no longer in a position to restore these data for the year-long study. Consequently, the other investigations that are remembered as well as the last data from 1973 and 1974 will be given on these pages.

The highest-situated specimen of this wax palm, a staminate plant, is found about 60 m. before the entrance to the mountain railway station at Avila, and the lowest-situated specimen, a pistillate plant, is found on the slopes of Los Venados at 1650 m. elevation. The investigations on seedling development, leaf development, and growth were made in this last forest at about 1850 m. in a place called Las Palmas. Stem measurements, ring measurements, and observations on the rhythm of flowering and fruiting were made on older plants found at a somewhat lower elevation of about 1650 m. between the western part of the forest at Guyabe Moche and the eastern part at Zamurero, a distance of about six kilometers.

All young palms are found without exception within the shaded forest belt and are not evident outside it. The old plants, in contrast, overtop the crowns of the rest of the tree flora and are visible from a distance, on the one hand because of their contrasting pinnate leaves, and on the other because of the grey color of their crowns. In all, there were 16 old plants as subjects for controlled investigation, of which nine were staminate and seven pistillate. The observation region at Las Palmas with its large stand of seedlings and young palms has become very much used by careless visitors to the forest; thereby more of the plants under observation were senselessly chopped off so that certain end results were frustrated.

Climatic Conditions of the Observation Zone

The wax palms occur in the evergreen forest region of the true cloud forest zone. The cloud forests are dependent on temperature and frequency of mists. The forest regions with the study palms were kept under daily observation by the author in 1973 and 1974 with reference to the state of their cloud cover. The results are indicated in Tables 1 and 2.

The annual precipitation is 1300–1700 mm. and falls, as Tables 1 and 2 show, mostly in the months from June to December. The humidity in these montane forests is very high even without the mists and drops to 60% only in the dry period from January to June during a few hours each day; otherwise the humidity is always between 70% and 100%.

The temperature is also more or less constant. The average daily temperature is between 14° C and 18° C. In the win-

Table 1. Mist cover and rainfall at observation site during 1973

Month	Type*	Days			
		Covered all day	Covered half the day	Bright and sunny	Rain fell
Jan	T	1	1	29	1
Feb	D	1	6	21	1
Mar	D	0	8	23	0
Apr	D	2	3	25	3
May	D	0	12	19	0
June	D	4	14	12	6
July	D	1	16	14	2
Aug	R	5	14	12	16
Sept	R	9	13	8	16
Oct	R	6	18	7	10
Nov	R	21	0	9	17
Dec	R	7	9	15	8
Totals		57	114	194	80

* T = transitional from rainy to dry; D = dry; R = rainy

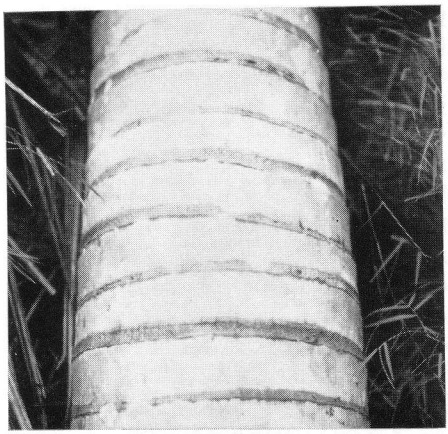
Table 2. Mist cover and rainfall at observation site during 1974

Month	Type*	Days				
		Covered all day	Covered half the day	Bright and sunny	Not observed	Rain fell
Jan	T	6	13	12		5
Feb	D	1	12	15		1
Mar	D	2	19	10		2
Apr	D	1	16	13		2
May	T	1	17	13		12
June	R	8	0	22		6
July	R	4	11	16		12
Aug	R	8	12	11		12
Sept	R	2	14	13	1	15
Oct	R	3	16	12		16
Nov	R	3	17	10		10
Dec	R	6	13	12		7
Totals		45	160	159	1	98

* T = transitional from rainy to dry or dry to rainy; D = dry; R = rainy

1. An old fruiting plant of *Ceroxylon klopstockia* about 25 m. high.

ter months (December–February), the temperature can drop occasionally to 8° C during the early morning hours; it climbs, however, later in the day to 14°–18° C. In the hot and dry time of the year (February–May), the temperature during the day occasionally can exceed 20° C for a few hours. Climatically considered, the wax palms are decidedly montane palms bound to high atmo-



2. Rings more or less equally spaced on the trunk of a palm about 50 years old.

spheric humidity and moderate temperature.

The Rhythm of Flowering

In the course of the long years of investigation, special attention was paid to the flowering rhythm of the species. This palm forms new inflorescences always after a lapse of four to six months from the time the plant produced its last ripe seed. In two extreme cases, however, I can state that new inflorescences were already appearing on two pistillate individuals that still bore fruit. There were evidently no staminate plants blooming at that time and no pollination took place so there were no little fruits a month afterward. The flowering period lasts about one month so that an individual with four inflorescences produces one at weekly intervals until all inflorescences have reached anthesis. The flowering cycle is the same, of course, for both sexes. The number of inflorescences in each sex amounts to 3–4–5, seldom fewer, never more. The staminate inflorescences are of a violet color at anthesis; the pistillate, on the contrary, are more whitish-yellow.

3. A section of trunk of an old palm with unequally distant rings.

I have determined that plants do not come into bloom every year, though the pistillate plants as a rule come into flower almost every year and are interrupted only every four to five years. One staminate example, apparently an unusual exception, flowered only once during seven years.

Climatic influences of 1973 have clearly demonstrated that after a long dry period of seven months, the fewest palms come into flower. Of the 16 control plants, only a single pistillate individual flowered. Also, all the other palms of this forest section failed to flower in this year, or produced only very few

flowers. The last ripening of fruit on pistillate plants was in February 1973; from this time on no control plant flowered until September 1974, with the exception of a single pistillate plant. After this date, first most of the staminate plants followed in a surprising way and somewhat later the pistillate, but so that these were still pollinated.

I have not been able to determine with complete accuracy at what age this palm species comes into bloom for the first time. All the recorded flowering examples are already old plants at least 80–150 years old. I am at present convinced that *Ceroxylon klopstockia* does not come into bloom before 80 or probably 100 years.

The Rhythm of Fruiting

As a rule, it is 12 months from the time of pollination until full ripening of fruit. Without pollination, the pistillate flowers fall off one to two months after the flowering time. From the preceding year I was also able to determine that fruit ripened after ten months. Still a great exception occurred in 1974 in a pistillate individual situated at El Papelon. The plant produced ripe fruit eight months after pollination and these fruits began to germinate after seven months. The different infructescences of a plant do not ripen simultaneously but according to their dates of pollination. When the first infructescence of a plant, for instance, lets its seeds fall from over-ripeness, the slow ripening of the last infructescence, which also was pollinated some weeks later, is only beginning. The fruit of all pistillate plants of a forest region ripens more or less at the same time.

The Distribution of Sexes

The wax palms are dioecious plants; each plant produces either staminate or pistillate inflorescences. The sex of all the control plants was determined in the first years of observation. Likewise, plants not kept under observation over a wide forest region were also determined to sex so far as this was possible. So I believe I can say with some certainty that 60% of the existing plants are staminate and about 40% pistillate. The distribution of the sexes is unlike. At one place I checked a distance of about 600 m. and found almost exclusively staminate plants; I have not up to now found larger groups of pistillate plants. As a rule, however, the sexes appear rather mixed. In spite of the long distances between the two sexes, there is mostly productive pollination. The pollen is transported by the wind and reaches to almost hidden plants.

Except by floral characters, the sexes of plants cannot otherwise be determined. Once I thought I was sure that there were two to three more leaves on most staminate plants than on the pistillate plants standing nearby. Further investigation, however, showed a reduced number of leaves on staminate plants so that no attention can be given to leaf number. Likewise, I can find no real difference in their appearance at the somewhat drier edge of the forest region.

On the Germination of Ceroxylon Seeds

I can here only extrapolate germination results for these mountain palms from the palm culture of the botanical garden at Caracas. To be sure, I have followed the ripening of seed during many years at certain forest places in the mountains. Unfortunately, I was never able to follow germination in a natural habitat; all seeds disappeared after a certain time and I concluded that mice had removed them.

The germination of palm seed requires much patience and in addition good luck,

4. Seedlings of *Ceroxylon klopstockia* with undivided eophylls; the one with four leaves is 15 months old.

as well, in many cases. Whoever has to do with the sowing of palm seeds knows how important good fresh seed is for sucessful germination. Palm seeds which have lain about dry for a long time—I mean weeks and months—can fail to germinate. What happens, however, with the *Ceroxylon* seeds that lie about for months at a time in the mountains without rain falling? We might be justified in believing that only the seeds that were distributed during the rainy season (May–December) are able to germinate. That *Ceroxylon* seeds are able to pass through a long dry period, however, I was able to demonstrate in culture by sowing seed intentionally kept dry for a long time but which subsequently germinated, even though in reduced number. Seedlings in the mountains can manage for many months without rain. It appears to me that the nightly freshening of the forest in the dry season makes extensive survival possible.

5. Seedling with the first cleft leaf blades between three and four years old.

The end of February 1973 was the last great seed fall of this palm species in the coastal mountains. As already pointed out, 1973 was an extremely dry year in all Venezuela. Vainly I sought seedlings in these forests up to the end of 1974. Consequently, we must also accept that not every year are seeds able to germinate under limiting conditions as the preceding example has shown.

From the germination results of our own propagation I can here state that *Ceroxylon* seeds are slow to germinate. In previous years I noted the germination of this species from six to nine or ten to 16 months and more. Typically, the first flush of germination constitutes only a small percentage. The second flush of germination follows, mostly with greater numbers, and appears naturally about a month after the first. Delayed germination can also appear even after two years.

Leaf Development and Determination of Age

After germination, the seedling develops a first undivided eophyll, which in the course of months becomes many times enlarged. The seedling now develops three undivided blades in each of two successive full years; of these blades,

6. Two leaves of this young palm have developed pinnae.

the last three are somewhat longer than the first three. In the third year, three further blades unfold; these are not only much larger than the others but are also deeply cleft. In rare instances, the young palms form six cleft leaves, but usually the first pinnae appear on the fifth additional blade. The first pinnate leaf forms only 3–4 pinnae. Each successive new leaf doubles the number of pinnae. The pinnae at the tip remain united for many years. I have myself observed leaves on an old plant with pinnae united at the tip. In the fifteenth year, the palm forms leaves with the complete number of 120 pairs of pinnae. The number of leaves from this age on is between 9 and 18, the same as on an old plant; usually, however, the number of green leaves is between 12 and 15.

These *Ceroxylon* palms develop three leaves each year as a rule. Thus the age of these palms can be reckoned with considerable accuracy. I have already established the time from seedling to the first ring on the stem. Now it is only necessary to determine the total number of leaf rings. For this, the total height of the stem must be figured. Thereafter the number of meters must be multiplied according to the number of rings per

7. The pinnae at the tip of a leaf of a ten-year-old plant are still united.

meter. Here it is important to add that the distance between rings can differ from plant to plant. The lowest basal rings always stand closer than those which follow. The rings in the last two meters or more near the crown of an old plant (more than 100 years) also are closer.

On a young example with a stem height of five meters, I counted 83 rings; measured from the stem base in units of a meter upwards, there were 26 rings in the first meter, only 16 rings in the second meter. On an old plant there were 19 rings in a length of 115 cm. (second meter from the base) with the following distances between successive rings: (in centimenters) 8, 14, 8, 5, 5, 3, 5, 4, 3.5, 4, 5.5, 5, 6, 6, 5, 9, 6, 5, 8.

Once the count of leaf rings is determined for a plant, then the number can be divided by three (leaves per year) to give the age of the stem, to which must

8. A stand of young *Ceroxylon klopstockia* at about 1900 m. elevation in the cloud forest of Venezuela.

be added 15 years of youth during which no visible rings are formed. At the last, come the five years for the formation of the crown which as a rule has 15 leaves. For one example of 30 m. height (and such a height occurs only exceptionally in the region of this investigation), I determined the age from the following measurements: the first 20 meters with about 12 rings per meter totalled 240 rings and 10 meters at 16 rings on the average totalled 160 rings, a grand total of 400 rings. These divided by three made 133; to which 15 years of youth and five years of crown formation can be added. Thus the age of the palm can be estimated with some certainty as 153 years.

Inventory of Some Young Palm Stands in a Natural Habitat

At Las Palmas, I selected a tract of 100 square meters on December 22, 1973, and made the following inventory:

Seedlings with only one undivided leaf blade—6

Seedling with the first three undivided leaf blades—9
Young palms with the first three cleft leaf blades—5
Young palms with the first pinnate leaf—1
Young palms with the first three pinnate leaves—3
Young palms with six pinnate leaves —3
Young palms with more than six pinnate leaves—13

There were also 41 young palms on the 100 square meters. Two of these had leaves with 80 pairs of pinnae. Also in the wider region of this investigation many young palms in older classes were found. It is still not clear how this rich distribution came about in this piece of forest. No mother plants were found in the immediate vicinity. I suppose that birds are responsible for the major part of this palm distribution. In previous years I have also investigated the emerald toucanet (*Aulacorhynchus sulcatus sulcatus* Swanson) and found that these hunted after these fruits the whole day when they were ripe. After the birds eat the fleshy pericarp they let the seeds fall. I can give mice only an unclear role in the distribution of the palm species. They search after the endosperm and in this case store the seeds. Only exceptionally, when mice leave the seeds, determining them green, can this be useful in reproduction.

Translated from the original German by the editor with approval of the author.

NEWS OF THE SOCIETY

For the May International Flower and Garden Show in the Miami Beach Convention Hall, jointly sponsored by the National Council of State Garden Clubs and the Miami Beach Parks Department, Alan Fernandez set up a very striking exhibit that won an honorable mention. Alan used quite a few specimen plants, including *Chamaedorea*, *Licuala*, *Howea*, *Chrysalidocarpus*, *Coccothrinax*, and others, but the thing that drew most attention was the background of two enormous fronds of *Orbignya* with a huge *Corypha* leaf in the center as a sort of roof over the plants below. These leaves had been donated by Fairchild Tropical Garden and were real show-stoppers.

The Southern California Chapter has again distinguished itself by winning a second place award in the society exhibits category in the Annual Exotic Plant & Fern Show at the Los Angeles County Fairgrounds in Pomona, California on July 31–August 1, 1976. The exhibit was directed by Lois Rossten, with plants or labor being donated by the Ketchums, Magnusons, Millikens, Hughes, Mark Foster, Jerry Goodman, Jim Benzie, Robert Greenberg, Pauleen Sullivan, and Kurt Rossten. Not only was the exhibit beautifully designed, but it contained specimen plants of *Phoenix roebelenii*, *Howea*, *Linospadix*, *Neodypsis*, *Chamaedorea*, *Licuala*, cycads, and many others.

Slide Collection

Mr. Jim Menge, 4608 Peachtree Circle E., Jacksonville, Florida 32207, has volunteered to take charge of the society's slide collection. Some slides have disappeared over the years and others are no longer in good condition. Jim would be happy to have copies of interesting slides that might be used to refurbish the collection so that it can be made available again. Anyone willing to share is urged to send slides to Mr. Menge.

TEDDIE BUHLER