Rev. Biol. Trop., 19(1, 2): 121-132, 1971

Palmacites berryanum, a new palm fossil from the Costa Rican Tertiary

by

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(Recived for publication August 31, 1970)

The palaeobotany of Costa Rica has received little attention (BERRY 7, GÓMEZ 19). There is more published on the palaeobotany of other Central American countries: Guatemala (JOHNSON, 22, 23; SERRANO, 38; STEPHENSON and BERRY, 42); Honduras (HUMPHREY, 21; NEWBERRY, 32, 33; MALDONADO-KOERDELL, 29); Nicaragua (BROWN, 12). Undoubtedly, this remarkable lack of literature is in part due to the enormous amount of still unexplored territory and to the scanty development of mining and oil industries in the region, which usually provides scientists with otherwise unobtainable materials.

In some works of a more general character, some inferences on Middle American palaeobotany are discussed, mostly in connection with other floras (BERRY, 8, 9, 10; KNOWLTON, 26; MÜLLERIED, 31) or with other areas of the Americas (MALDONADO-KOERDELL, 28, 30; TOLMACHOFF, 43).

Palms play a definite and conspicuous role in the tropical landscape, both in past ages and in present times. Palm-like plants are found as early as the Jurassic and Triassic of some parts of the world (3) and definite representatives of the Palmae have been found in the Cretaceous and Tertiary beds of Europe, Asia, Africa and America (1, 2, 4, 5, 13, 14, 15, 35, 39, 46). Besides those records of foliage or trunk fossils of the Palmae, much fossilized pollen from many localities currently is referred to the organ genus *Monocolpites*, and still remains uncorrelated with indisputable representatives of the family (18). The actual distribution of the Palmae was probably determined by the shifting climatic conditions that took place during the Upper Eocene and continued throughout the Pliocene. These changes of the environment greatly increased the number of palms in the tropical areas of the modern world.

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The specimens here studied were found near Pozo Azul, at the junction of the Pirrís and Candelaria rivers, in the foothills above the plains of Parrita, Puntarenas, Costa Rica. Pozo Azul is a Tertiary deposit with numerous outcrops of clastic, volcanic, and lime rocks of the Eocene-Paleocene age (17). Some faults in the terrain show vestiges of Cretaceous volcanic and sedimentary materials prior to the so-called Upper Campanian, that are very similar or identical to the complex formation of Nicoya, a series of geological strata well known on the Pacific slopes of Costa Rica (20, 48).

MATERIAL AND METHODS

The specimens were cleaned and prepared for photographic work. A fragment was cut into transverse and longitudinal sections with a high speed diamond saw. The slices were polished by succesive exposures to carborundum of different grades of coarseness on plate glass until surfaces with a very fine grain were obtained. Several of these highly polished cuts were subsequently "etched" with 5% HF to bring out structural details. All sections were then washed in distilled water, dehydrated in absolute alcohol, bathed in acetone and permited to dry. Then cellulose acetate peels were taken, following the methods of DELEVORYAS (16) and STACE (40). The cellulose films were studied under the microscope and schematic reconstructions of the tissues were made with the aid of the camera lucida. For analytical purposes, cortical, medial and central samples of the petrification were taken and processed as dry samples with spectrophotographic equipment. The results of the analysis are given in Table 1.

TABLE 1

Values obtained from spectrographic analysis of dry samples (in parts per thousand unless otherwise indicated)

	Cortical	Medial	Central
SiO_2	approx. 160	approx. 660	approx. 65
Al_2O_3	traces	—	traces
FeO	6.25%	0.067%	1.25%
MgO	200	100	225
MnO	150	50	200
TiO_2	250	75	250
V_2O_5	230	—	250
Cu	10	15	10

MACROSCOPICAL DESCRIPTION: The petrified material represents trunk fragments subcylindric in transverse section. Longest fragment measuring 200 mm, widest diameter 250 mm. Dermis finely reticulated, reminiscent of that of *Roystonea* or *Cocos*. Subdermal region of a densely fibrous and vascularized tissue, heavily impregnated with iron oxides. Central region of silicified ground tissue, whitish in colour, in which numerous vascular strands are bedded. In longitudinal sections vascular bundles zig-zag and touch or fuse with one another.

In naturally decorticated segments, the vascular bundles of the cortical layers give the appearance of the adventitious roots of a royal palm, differing from them in the adpressed rather than oblique position as related to the stem.

MICROSCOPICAL DESCRIPTION: The dermal zone consists of closely packed parenchyma cells in combination with highly lignified fibrovascular bundles which show great development of angular sclerenchyma cells. The parenchyma appears compressed into tabular patterns of cells, suggesting lamellar collenchyma and runs between bundles in a somewhat ray-like fashion. Outermost vascular bundles differ from those in the central zone in width and in that the xylem elements are centered and surrounded by thicker layers of fibers and parenchyma.

The sub-dermal zone has fewer vascular bundles, oriented like those of the dermal zone. The sclerenchyma is less angular in transverse section. Ground tissue forms irregular patches that are gradually larger and more regular toward the center of the trunk. There are a few fibrous bundles, made up of small, rounded fiber cells. A few lacunar rounded spaces are evident in the ground tissue. SCHOUTE (36) states that in all palms these intercellular spaces are formed schizogenously, but certain spaces, of a prismatic shape (Fig. 6), suggest the dissappearance of larger cells, that is, they are of a lisogenic origin, a condition also encountered in *Chamaerops* by KAUL (25).

The central zone presents ground tissue which is made up of more regular and larger cells, with no vestige of any ray-like orientation. It is spongy and lacunar, of an apparently softer texture and little lignified, as evidenced by the thin cell walls. The vascular bundles are more distantly placed but keep the same atactostelic orientation as in the dermal and sub-dermal areas. They include an outer layer of sclerenchyma that surrounds the vascular tissues through fusion of the arms or wings of the dorsal and ventral sclerenchymatous arches, thus producing a fibrous sheath. The bundles are vaginate and like those found in fully grown palm stems. Nevertheless, it would be difficult to estimate whether this fossil is a young or a well developed specimen entirely on the occurrence of the vaginate type bundle, as in certain palms like *Loxoccocus* they are present even in early growth. Some bundles are cordate, the cleft or sinus being much reduced or almost flat, very much like the forms described by STENZEL (41) as the complanate type of bundle. According to KAUL (25), this structural condition is never found in modern palms, although the genera *Latania* and *Hyphaena* do come close to it. The phloem is located between the xylem elements and the sinus of the fibrous sheath, and shows no special characteristics. Protoxylem and metaxylem are present; the latter is more prominent and consists of two or rarely three large pores. A few layers of xylem parenchyma are present. In a majority of the bundles observed, the fibrous sheath seems to be thicker laterally (Fig. 6).

DISCUSSION

Anatomical evidence places the fossil within the Palmae (11, 16, 24, 25, 27, 34, 44, 45, 46, 49); bibliographical research indicates that it is a new addition to the Costa Rican palaeobotany. Further, the present material does not match, by original descriptions, any of the species of fossil palms ascribed to Tropical America. There is, nevertheless, a slight similarity between the Costa Rican material and that described by STENZEL as *Palmoxylon angiorhiza* (41) from Tlacolula, Mexico, in the nature of the outermost bundles. In geographical proximity, *P. palmacites* (Sprengel) Stenzel, from the Cucaracha Formation, Green Clays, Panama, is the closest congeneric specimen (6).

For these reasons, the fossil is described as a new species of the organ genus *Palmacites* (Schlotheim) Brongniart, as proposed by PRAKASH and BOUREAU (35).

Palmacites berryanum Gómez, sp. nov.

Palmae. Trunk segments subcylindric. Longest axis observed without signs of true segmentation 200 mm long, widest diameter 250 mm. No leaf traces or armature of any kind evident in the cortical layers. Epidermal tissue smoothly and finely striated, as in *Roystonea* or *Cocos*. Dermal zone densely vascularized, the vascular bundles are wider than those from sub-dermal or central areas. Fibrous bundles abundant. Sub-dermal zone with fewer fibrous bundles, vascular bundles not so compactly placed, subreniform to subelliptical, 2 mm or less in diameter, contained within a fibrous sheath composed of fibrosclerenchymatous cells so fused as to form a vaginate bundle. Conductive elements of the bundle in eccentric position. Parenchyma of central region formed by 4- to 8-sided, regularly shaped cells. (Figs. 1-6).

Type from the Tertiary deposits of central southwestern slopes of the Pacific coastal ridge of Costa Rica, Pozo Azul de Parrita.

The species is named in honour of Dr. Edward W. Berry, author of the first survey of Costa Rican fossil plants. The type specimen is deposited in the herbarium, Departamento de Biología, Universidad de Costa Rica.

In the absence of remains of foliage, fruit or complete stems, no certain comparison of *Palmacites berryanum* with living plants can be succesfully attempted. On anatomical and gross morphological characters, a few suppositions of relation can be made. The apparent smoothness of the cortex, the lack of evident segmentation of the trunk, and the lack of cortical appendages such as leaf scars or spines, indicate a resemblance to the royal palms, which are of Caribbean origin. The inference that sometime during or before the Tertiary a roystonioid palm, close to or ancestral to today's *Roystonea,* radiated by means of Antillean ridges and land bridges and flourished in continental Middle America is for future findings to validate or reject. According to SCHUCHERT (37), this supposition is liable to turn into a geological possibility. On the other hand, *Rooseveltia,* which is to some authors a variant of *Cocos,* isolated on

Cocos Island, could be correlated with the presence of *Palmacites berryanum,* in past periods a palm of the coastal lowlands of Costa Rica and along the Osa Peninsula and the so-called Cocos Ridge (47). However, neither *Roystonea* nor *Rooseveltia* are the exclusive owners of such morphological characters, and the fossils of Pozo Azul might also be related to the modern coryphoid genus *Chryosophila,* relatively well represented in the area by *C. albida* Bartl., *C. cookii* Bartl., and *C. guagara* Allen, also with stems devoid of spines, leaf scars and/or marked segmentation of the trunk, and of a diameter very similar to that of *P. berryanum.* Should an attempt be made to compare this or other fossil Palmae to living genera, it would have to be based almost entirely on anatomical characters, a task that may very well prove to be inconclusive, since a number of structural conditions are shared by all palms, regardless of their subfamiliar levels as currently proposed.

ACKNOWLEDGEMENTS

I wish to thank Mr. Peter Kazan, Peace Corps Volunteer for his co-operation throughout the initial stages of this study, Mr. James Perry, Jr., for the photographic work, Prof. Enrique Malavassi, Departamento de Geología, Universidad de Costa Rica, for the facilities offered. Also Mr. Robert Stolze, Field Museum of Natural History, for his aid with rare literature, and Dr. David B. Lellinger, United States National Herbarium, for reading the manuscript and for his multiple suggestions.

SUMMARY

A fossil palm is reported for Costa Rica as a new species under the name of *Palmacites berryanum.* The fossil was found in the Tertiary deposits of Pozo Azul de Parrita, Province of Puntarenas. It is described entirely on the basis of anatomical characters which suggest possible relationships with modern genera of the Palmae.

RESUMEN

Se comunica el hallazgo de una palmera fósil en Costa Rica y se describe como nueva especie bajo el nombre de *Palmacites berryanum.* El fósil procede de los depósitos Terciarios de Pozo Azul de Parrita, provincia de Puntarenas. La descripción se basa en características anatómicas y se encontró una posible afinidad con géneros de palmas modernas.

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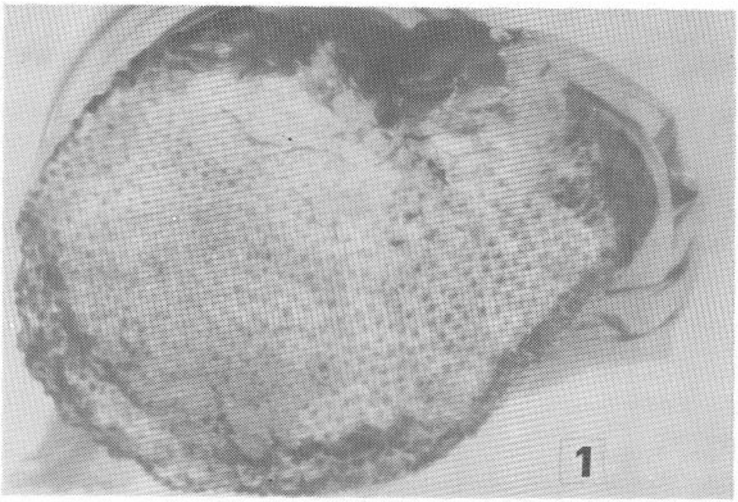
Fig. 1. Top view of fossil showing numerous vascular strands embedded in the silicified fundamental tissue. Note dark cortical layer densely impregnated with limonite.

Fig. 2. Lateral view of *Palmacites berryyanum* (Scale in cm).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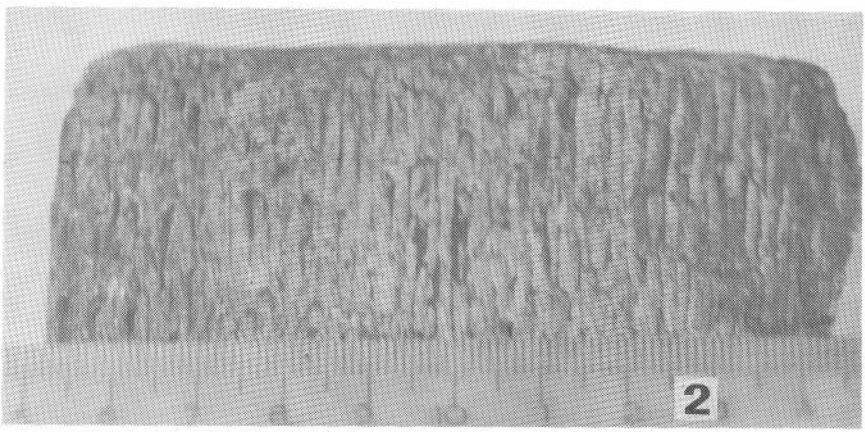
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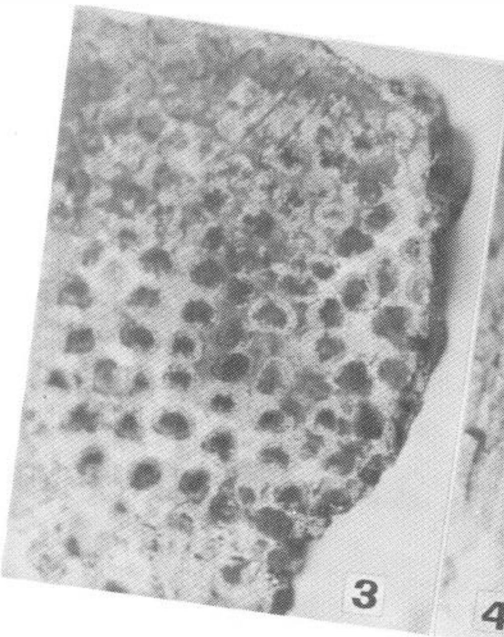
Fig. 3. Polished surface of transverse section showing atactostelic arrangement of the vascular bundles.

Fig. 4. Close-up view of adventitious root system.

Fig. 5. Polished surface of longitudinal section showing disposition of fibrous sheaths.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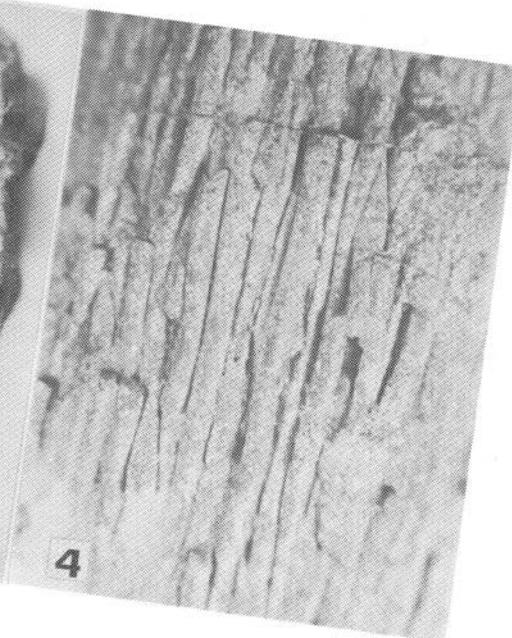
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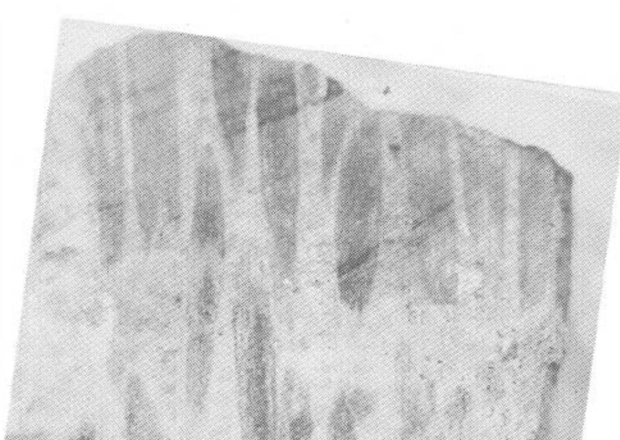
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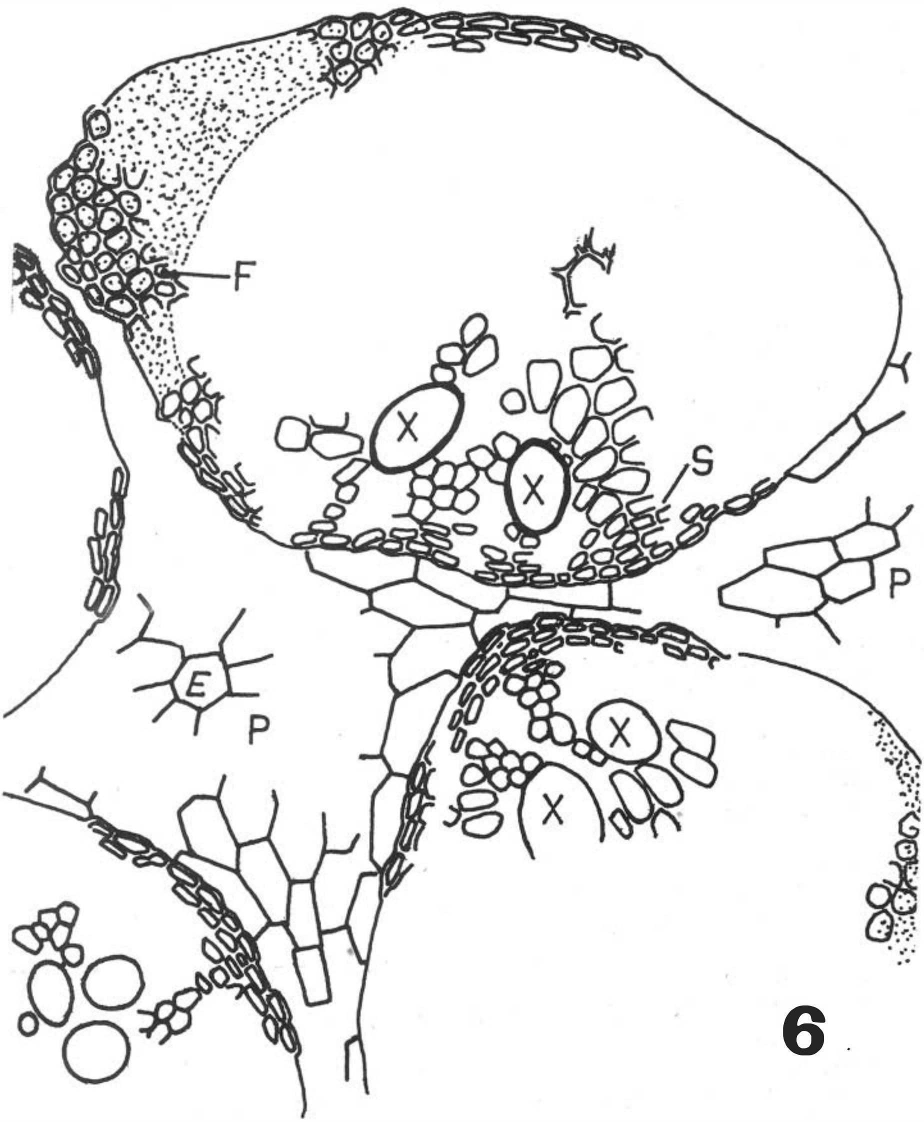
Fig. 6. Schematic reconstruction of vascular bundles and fundamental tissue.

E. intercellular schizogenous space
F. fibrous structures
P. parenchyma, ground tissue
S. fibrous sheaths of bundles
X. xylematic elements (metaxylem)



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