A PLEISTOCENE FLORA FROM THE ISLAND OF TRINIDAD

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The present contribution is based upon a considerable collection of fossil plants which I owe to the industry and kind cooperation of Dr. H. G. Kügler and the courtesy of the Apex Oilfields, Ltd., of Fyzabad, Trinidad. I am indebted for three additional specimens to Prof. Gilbert D. Harris. The latter were collected by G. A. Waring. The types have been presented to the United States National Museum.

Fossil leaves were reported from Trinidad in 1860 by Wall and Sawkins but no collections from the Island have been studied until recently. Doctor Kügler has made large collections for me which await description, and the New York Botanical Garden have also made collections which have been described by Dr. Arthur Hollick, whose account is now in press. All of these are from earlier beds than those which form the subject of the present paper.

This collection comes from strata known locally as the Oropouche formation, and comprise sands and horizontal, more or less lignitic, clays, that receive their name from outcrops near the village of Oropouche in the western half of the southern depression of the island. These sands and clays represent the erosion products of the folded areas of the central and southern ranges during the Pleistocene.

The collecton is of very great interest because, although the number of species is limited, they give clear evidence of the presence of mangrove swamps during the Pleistocene, and the fact that several of the forms cannot be positively identified with members of the existing flora of that region and have had to be described as new, and therefore extinct, indicates a considerable antiquity.

The species described number 9 and represent 7 orders and 8 families. With the exception of a single trace of a feather palm of

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unknown genus, all are rather coriaceous dicotyledons. By far the most abundant leaves are those of the white mangrove and the *Mimusops*.

At least three of the forms—the buttonwood (*Conocarpus*), white mangrove (*Rhizophora*), and black mangrove (*Avicennia*)—are members of the mangrove association, and indicate more or less tidal muddy coastal swamps. These were in all probability estuary in position which is where they usually find their optimum conditions of growth. The *Mimusops*, which is described as new, finds its closest living homologies in forest species. This might be taken to mean that their leaves were river borne, but since they are the most abundant forms in the Oropouche clays it would seem that they must have been growing near at hand in the beach jungle behind the mangrove swamps or in the lower valley of the supposed stream that made the estuary. Such an environment would be the natural one for the other members of this flora.

All of the plants are lowland humid tropical types. All the existing species recorded as fossils occur in the existing flora of Trinidad and those which are described as extinct, have closely related existing species in Trinidad and the adjacent coastal region of South America.

Class MONOCOTYLEDONAE

Order ARECALES

Family ARECACEAE

PALM RAY

Plate 1, figs. 1, 2

The single basal part of the ray of a fan palm is the only representative of this class of plants found in the Oropouche clays.

These rays are linear lanceolate, markedly inequilateral proximad, where they are contracted to a petiolar-like attachment on the rachis. The venation appears to be characteristic, consisting of 8 principal regularly spaced longitudinal veins with 3 or 4 thinner parallel veins in each interspace.

It might be possible to connect the fossil with some recent Trinidad palm, but in view of the fragmentary nature of the fossil and the uncertainties involved, it did not seem worth the labor of searching through herbaria in which palms are usually so incompletely represented.

Type.—Cat. No. 37017, U. S. N. M.

Class DICOTYLEDONAE

Order ROSALES

Family MIMOSACEAE

Genus PITHECOLOBIUM Martius

PITHECOLOBIUM UNGUIS CATI (Linnaeus) Bentham

Plate 3, fig. 4

A single leaflet, identical with those of this existing species has been found in the Oropouche beds. There is no necessity to describe it in detail. It is much like the smaller obtuse leaflets of *Pithecolobium dulce* (Roxburg) Bentham, but more exactly matches many of the leaflets of *Pithecolobium unguis cati*, and I have no doubt represents the latter species.

Pithecolobium unguis cati, or the Cats claw, sometimes referred to the genus *Zygia* of Patrick Browne is a rather small slender tree of sea coasts found from the Florida keys through the Antilles to Trinidad, Venezuela, and Colombia.

Fossil species are not uncommon in the warmer parts of the Tertiary of the western hemisphere. There are two well marked species in the lower Eocene Wilcox group and a third in the Oligocene of southeastern North America. There is a Miocene species in Colombia and a second from the Dominican Republic. There are 3 Pliocene species recorded from Bolivia.

Plesiotype.—Cat. No. 37018, U. S. N. M.

Order PARIETALES

Family GUTTIFERAE

Genus CLUSIA Linnaeus

CLUSIA FOSSILIA, new species

Plate 3, fig. 3

Leaves of medium size, obovate in outline, coriaceous in texture and with entire margins. Length about 11 centimeters. Maximum width, about two-thirds of distance above the base, about 6 centimeters. The apex is broadly rounded and may even be very slightly retuse. The base is narrowly cuneate. The ascending margins are practically straight to the region of greatest width of the lamina where they curve around rather regularly without angular shoulders to the broad tip. The petiole is short and extremely stout. The midvein is characteristic of the genus, thin above, increasing rapidly

in size and prominence proximad, until at the base where it joins the petiole it is 3 millimeters in diameter. The secondaries are thin but well marked, closely spaced and ascending. They diverge from the midrib at angles of about 30 degrees, are relatively straight in their courses, although adjacent ones occasionally join on their way toward the margin, where their extremities are united by a looped marginal vein about 1 millimeter within the margin.

There cannot be the slightest doubt but that these leaves represent the genus *Clusia*, presenting as they do to the last detail the foliar characters of this genus. I have compared them with the leaves of all of the existing forms from equatorial America which are represented in the National Herbarium. There are 3 existing species in the Trindad flora whose leaves are extremely difficult to distinguish from the fossil. These are *Clusia martini* Sagot and *Clusia palmicida* L. C. Rich which are large trees of the forest (specimens from Balandra Bay), and the wide ranging *Clusia rosea* Linnaeus, a somewhat smaller tree of the rocky coasts, at least the specimens from Trindad are so labeled.

The foliar characters of these are very convergent. In general the leaves of *Cusia palmicida* are somewhat more elongated. I doubt if it is possible to certainly distinguish *Clusia rosea* and *Clusia martini* from the leaves alone. The fossil appears to be more nearly identical with latter than the former of these, but occasional leaves of the former are indistinguishable. This being the case the fossil form is described as *Clusia fossilia*, and it is suggested that it might very well represent the stock subsequently differentiated into the three living species mentioned above as recognized by modern systematists.

So far as I know this is the first fossil species of this interesting genus to be recognized, although I have a fine and much larger species from the later Miocene of Trinidad.

Holotype.—Cat. No. 37019, U. S. N. M.

Order THYMELEALES

Family LAURACEAE

Genus PERSEA Gaetner fils

PERSEA AMERICANA Miller

Plate 1, fig. 4

The single incomplete leaf figured is the only specimen of this species collected. It has the form and venation of various tropical species of *Phoebe* and *Persea* and appears to be identical with the leaves of the existing *Persea americana* Miller.

The genus has been present in equatorial America throughout the Tertiary and probably earlier. A very similar form occurs in the Miocene of Trinidad, and Engelhardt has described similar forms from the Miocene of Colombia.

Plesiotype.—Cat. No. 37020, U. S. N. M.

Order MYRTALES

Family COMBRETACEAE

Genus CONOCARPUS Linnaeus

CONOCARPUS ERECTUS Linnaeus

Plate 1, fig. 5

There is no necessity to present a detailed description of these leaves. I have seven specimens from the Oropouche beds all more or less broken or distorted, but clearly belonging to the existing species, with whose variations the agreement is exact.

The single existing species in several varieties is a widespread type of the mangrove association, as well as sandy shores on both coasts of Central and South America, extending northward through the Antilles to the Florida keys, and through the agency of ocean currents reaching Bermuda. It is also found on the west coast of Africa in Guinea and Senegambia.

The earliest apparent representative of the genus is a form from the Tuscaloosa formation of Alabama described as *Conocarpites formosus.*[1] A second fossil species is found in the coastal floras of the lower Eocene Wilcox group [2] and a third occurs in the upper Eocene Jackson group [3] in southeastern North America. A fruit compared with *Conocarpus* has been described by Menzel [4] from the lower Miocene of Europe.

Plesiotype.—Cat. No. 37021, U. S. N. M.

Family RHIZOPHORACEAE

Genus RHIZOPHORA Linnaeus

RHIZOPHORA MANGLE Linnaeus

Plate 2, figs. 2, 4

Leaves of the mangrove vie with those of *Mimusops* in the Oropouche clays, some scores having been collected. When fragmentary the two are distinguished with difficulty.

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[1] Berry, E. W., U. S. Geol. Survey Prof. Paper 112, p. 127, pl. 28, fig. 9, 1919.
[2] Berry, E. W., idem, 91, p. 325, pl. 95, figs. 1, 2, 1916.
[3] Berry, E. W., idem, 84, p. 147, pl. 29, figs. 4–7, 1914.
[4] Menzel, P., Beitr. Fl. Niederrhein Braunkohlenformation, p. 53, pl. 5, figs. 17–21, 1913.

These leaves show the characteristic form and venation of the recent leaves of the mangrove, from which they can not be differentiated.

On the whole the *Rhizophora* leaves may be distinguished from those of the associated *Mimusops* by their being less coriaceous, with slightly longer petioles, and by their regularity of form, being always at least pointed and never emarginate, and by their slightly more prominent venation. For the most part they are preserved as brownish impressions in the clays and not as black carbonaceous films as are the bulk of those referred to *Mimusops*. I have gone through all of the material of *Rhizophora mangle* in the National Herbarium and aside from minor individual variations the leaves are uniform in their characters, and never exhibit the peculiar variations shown in *Mimusops*.

In the modern flora this species ranges on muddy tidal shores from southern Florida and Bermuda through the Antilles and Central America to Brazil, and from lower California to Ecuador. It is the most specialized plant known for distribution by ocean currents.

The genus appears in the fossil record in the early upper Eocene in southeastern North America [5] and a second fossil species is known from the Miocene of Venezuela.[6] Two Oligocene-Miocene species have been recorded from southern Europe.

Plesiotypes.—Cat. Nos. 37022–3, U. S. N. M.

Order EBENALES

Family SAPOTACEAE

Genus MIMUSOPS Linnaeus

MIMUSOPS PREDUPLICATA, new species

Plate 2, figs. 1, 3, 5; plate 3, fig. 5; plate 4, figs. 2, 3 4

This is an exceedingly interesting species and vies with the leaves of the mangrove in its abundant representation in the Oropouche clays. A considerable number of leaves showing the variety and extremes of its mutations have been figured. In general the leaves are elliptical in outline, with broadly rounded, emarginate or retuse tips, and rounded slightly pointed or cuneate bases. The petiole is short and extremely stout. The margins may be evenly rounded but are very frequently emarginately incised into a greater or less number of

[5] Berry, E. W., U. S. Geol. Survey Prof. Paper 84, p. 144, pl. 29, figs. 1, 2, 1914.
[6] Berry, E. W., Proc. U. S. Nat. Mus., vol. 59, p. 576, pl. 109, fig. 4, 1921.

rounded lobes of varying sizes. The midrib is stout but not especially prominent. The secondaries are thin, largely immersed in the coriaceous leaf substance; they diverge from the midrib at wide angles at irregular intervals, and are abruptly camptodrome at a considerable distance inside the margins. The size varies from narrow elliptical leaves 3.5 centimeters long by 1.7 centimeters in maximum width like that shown in figure 3 on plate 2, to similarly shaped leaves 8 centimeters long and 5 centimeters in maximum width; from obcordate leaves 2.1 centimeters long and 1.7 centimeters wide like that shown in figure 4 on plate 4 to similar leaves 4.5 centimeters long and 3.4 centimeters wide like that shown in figure 2 on plate 4. Finally we have the large irregular leaves like those shown on plate 2, figure 1, and plate 4, figure 3, variously lobed and retuse, and without a parallel outside the family Sapotaceae in so far as I know. The more regular leaves of this species are distinguished with difficulty from the associated leaves of *Rhizophora* but as I have remarked under the discussion of the latter they are more coriaceous with more obsolete venation and with different tips. The petiole is shorter and stouter. and appears in the fossil material as more or less ribbed.

I have been to the pains of examining all of the material of the Sapotaceae preserved in the National Herbarium in my effort to absolutely connect the fossil with an existing species. Outside the genus *Mimusops* the only species showing variations in form comparable with the fossil is *Sideroxylon elegans* DeCandolle of the Guianas, in which the leaves are uniformly smaller and the venation is somewhat more prominent. In the genus *Mimusops* the two most similar species seen are *Mimusops duplicata* Urban, a common Antillean forest tree, and *Mimusops balata schomburghii* Pierre from the lower Orinoco region. In the latter the leaves average relatively longer and narrower and have longer petioles. In the former exactly the same variations in outline are shown, but such variants are usually smaller than the fossil, although specimens with regular leaves may be larger. On the whole the fossil is closest to *Mimusops duplicata* and I have described it as a possibly extinct form under the name of *preduplicata*, indicating a relationship, which may really amount to specific identity were all the facts known.

The genus *Mimusops* is a prolific and common tropical type in both hemispheres, reaching northward to the Florida keys in this hemisphere. In the fossil record it contains 3 lower Eocene species in southeastern North America and a fourth in the Miocene of Haiti. Several European species have been recorded, two coming from the late Eocene of Hesse.

Cotypes.—Cat. Nos. 37024–37030, U. S. N. M.

Order PERSONALES

Family VERBENACEAE

Genus AVICENNIA Linnaeus

AVICENNIA NITIDA Jacquin

Plate 3, figs. 1, 2, 6; plate 4, fig. 1

Leaves of the black mangrove of various sizes are common in the Oropouche clays. These agree perfectly with the leaves of the existing species, from which they can not be differentiated. In the modern flora the species is a widely distributed maritime form ranging from peninsular Florida through the Antilles to Brazil.

The only other fossil occurrence known to me is based upon leaves and fruits found in the lower Eocene Wilcox formation of southeastern North America.[7]

Plesiotypes.—Cat. Nos. 37031–33, U. S. N. M.

INCERTAE SEDIS

PHYLLITES OROPOUCHENSIS, new species

Plate 1, fig. 3

The present nominal species is based upon two specimens in which the carbonaceous film representing the leaf is more or less impregnated with salts of iron. These represent an oblong ovate leaf with a bluntly pointed tip and a cuneate base. The texture is coriaceous and the midvein very stout. The secondaries are thin, numerous, and subparallel, diverging from the midvein at a rather wide angle and running with but slight curvature toward the margins. Their endings or other details of the venation cannot be made out and it is therefore impossible to reach a decision as to whether the fossil should be referred to the Guttiferae or the Sapotaceae. It appears to be certainly referable to one or the other of these families and is particular suggestive of certain Caribbean species of the genera *Rheedia*, *Calophyllum*, and *Chrysophyllum*, to one or the other of which it, in all probability, belongs. Doubtless future collections will settle this point.

Holotype.—Cat. No. 37034, U. S. N. M.

EXPLANATION OF PLATES

PLATE 1

FIGS. 1, 2. Palm ray. Fig. 2 enlarged ×4 to show venation.
3. *Phyllites oropouchensis*, new species.
4. *Persea americana* Miller
5. *Conocarpus erectus* Linnaeus.

[7] Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 347, pl. 104, fig. 6; pl. 107, fig. 4, 1916.

PLATE 2

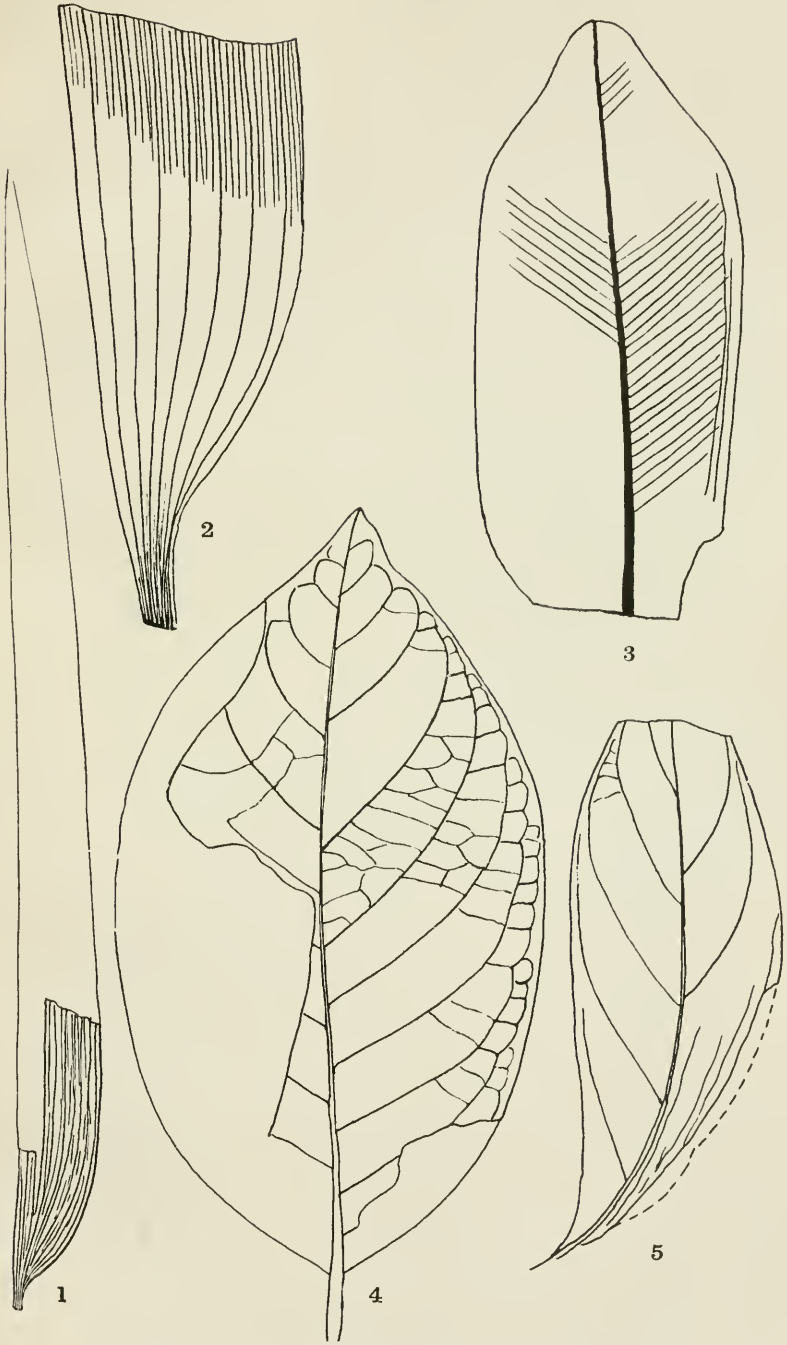
FIGS. 1, 3, 5. *Mimusops prepuplicata*, new species.
2, 4. *Rhizophora mangle* Linnaeus.

PLATE 3

FIGS. 1, 2, 6. *Avicennia nitida* Jacquin
1. Recent leaf. 2, 6. Fossil leaves.
3. *Clusia fossilia*, new species.
4. *Pithecolobium unguis cati* (Linnaeus) Bentham.
5. *Mimusops preduplicata*, new species.

PLATE 4

FIGS. 1. *Avicennia nitida* Jacquin
2–4. *Mimusops preduplicata*, new species.



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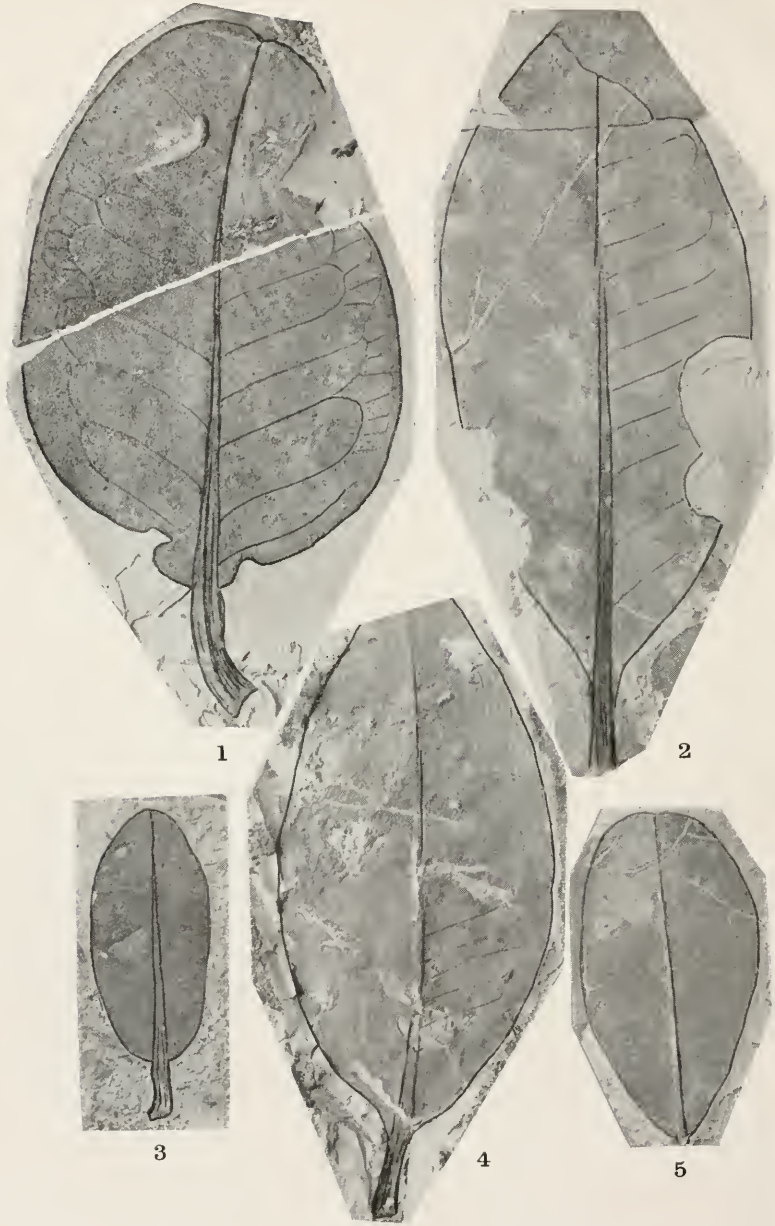

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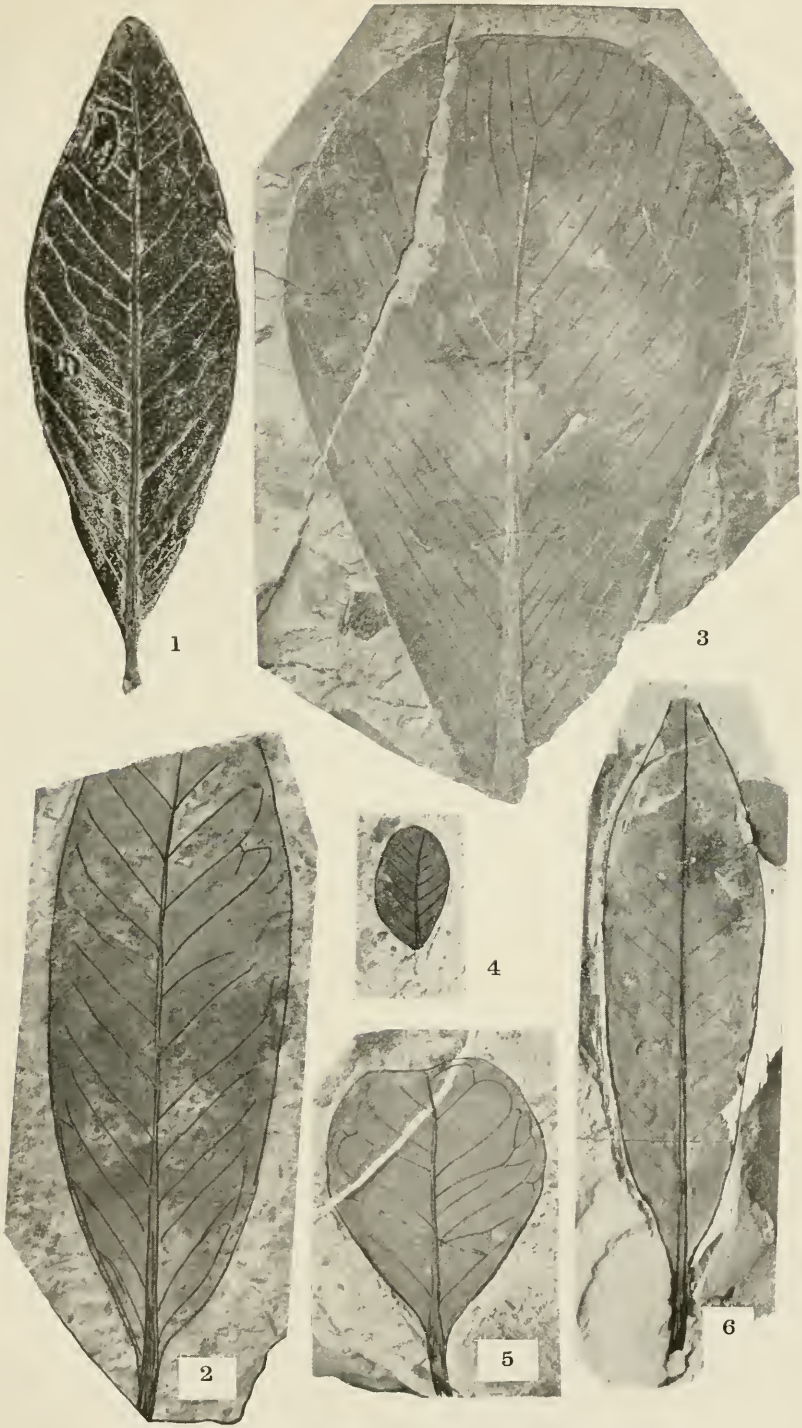

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