

## TERTIARY FOSSIL PLANTS FROM COSTA RICA.

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The present contribution is devoted to a small florule collected from the Tertiary of Costa Rica by Dr. Wendell P. Woodring in March, 1917, while in the employ of the Sinclair Oil Company, and now deposited in the United States National Museum.

The collection was made at the northeast border of Talamanca Valley on the west fork of Sheroli Creek, about one-half mile above the forks, there being a waterfall and conglomerate precipice about 100 feet high at the latter locality. In more general terms, the locality is on the southeastern frontier of Costa Rica along the left scarp of the Sixaola Valley, about 30 miles from the Caribbean.

The section at the plant locality comprises a thick basal steeply inclined series of marine fossiliferous shales with thin intercalated sandstones, which have been called the Uscari shales. Overlying these unconformably is a thinner series of sandstones and shales from which the fossil plants were collected, and these beds are overlain unconformably by a conglomerate (the Suretka conglomerate).

The Mollusca collected from the Uscari shales have not yet been studied, so that the lower limit of age of the deposit can not be stated. The flora itself is too small to throw any light on this point, as it is of a type that might well occur in the American Tropics at any horizon between the Oligocene and the Recent. Only one of the species, and that somewhat doubtfully, has been recorded from the Canal Zone, namely, *Hieronymia lehmanni* Engelhardt, of the Caimito formation, which is considered as of Upper Oligocene age. This same species was described originally from Loja, Ecuador, from a locality of unknown age, which I have considered as probably lower Miocene. Two other of the Costa Rican fossil plants have an outside distribution, having been described originally from Santa Ana in the Rio Magdalena Valley, Colombia, also from an unknown, probably Miocene, Tertiary horizon. The age of the Costa Rican plants is undoubtedly Miocene, and I would not be surprised if future work would show that it is younger rather than older Miocene.

At the present time the Caribbean coast is a region of swamps and coastal lagoons, with a heavy rainfall and dense forest cover. At Port Limon rain falls 265 days each year, and the annual rainfall amounts to about 170 inches. The existing flora is essentially the same as that of Panama, with a few Antillean and many South American elements. The virgin forests of the valleys, with their tall trees, many lianas, and epiphytes, have been called by Polakowsky the *Hylaea* association. It has much in common with Brazil, the Guianas, Venezuela, and Colombia and little with that of Ecuador and the Andean uplands or with that of Mexico and Guatemala. Above 8,000 feet the flora consists of a mixture of peculiar species and those common to the Central American uplands to the north.

The fossil florule—it is not extensive enough to merit the term flora—consists of 12 recognizable species. These comprise a *Heliconia*, two species of pepper (*Piperites*), a fig, an *Anona*, an *Inga*, a *Hieronymia*, a *Büttneria*, and three *Lauraceae*. The collection contains no palms, nor ferns, nor distinctively coastal types. While these peculiarities are believed to be due entirely to accidents of preservation and discovery, the assemblage does not indicate a strand flora but a noncoastal valley flora. It is perhaps needless to remark that it is a typically tropical assemblage, essentially South American in its facies. In addition to the named forms, which represent ten genera, nine families, and nine orders, the collection contains linear parallel-veined monocotyledonous leaves, fragments of undeterminable dicotyledonous genera, and a leafspot fungus. The scarcity of Leguminosae is remarkable, this alliance being represented by a single species of *Inga*—a genus still abundant in the region. The relative abundance of *Lauraceae* is also worthy of notice.

## Class MONOCOTYLEDONAE.

### Order PIPERALES.

#### Family MUSACEAE.

#### Genus HELICONIA Linnaeus.

##### HELICONIA, species.

The collection contains small fragments of a large leaf, which undoubtedly represents a Costa Rican Tertiary species of *Heliconia*. The venation is characteristic, but the material is unfortunately inadequate for specific description.

The genus *Heliconia* is exclusively American in the present-day flora, with between 30 and 40 species widely distributed in the American Tropics from the Antilles to Brazil. It is exceedingly common in Central America and the lower Montaña region of Peru

and Bolivia, where I have observed it, and probably elsewhere through out northern South America. *Heliconia* has not previously been recognized in the fossil state, but I have a species as yet unpublished from the late Tertiary of eastern Bolivia, and *Musophyllum elegans* described by Engelhardt from the Tertiary of Santa Ana, Colombia, is present in material collected by C. F. Bowen at Betijaque, Venezuela. The genus *Musophyllum* was founded by Goeppert in 1854 for fossil Musaceae from the Island of Java, and a number of European and American species have subsequently been described. Fossil forms are liable to be confused with the genera *Canna* and *Geonoma* and their allies, but undoubtedly the bulk of the fossil species actually represent the banana. There is no evidence that the existing cultivated species which flourish so prodigiously in the American Tropics were ever indigenous in the Western Hemisphere, and I can see no reason for not substituting *Heliconia* for *Musophyllum* in the Tertiary record of tropical America.

## Class DICOTYLEDONAE.

### Order PIPERALES.

#### Family PIPERACEAE.

##### Genus PIPERITES Goeppert.

##### PIPERITES CORDATUS, new species.

Plate 22, fig. 1.

*Description.*—Leaves of medium size, approximately equilateral, cordate in general outline, with an acuminate tip, and a not deeply cordate base. Margins entire, full, and evenly rounded. Texture subcoriaceous. Length, about 10 cm. Maximum width, in the lower half of the leaf, about 8 cm. Petiole stout, expanded proximad, about 4.5 cm. long. Primaries seven, from the top of the petiole, diverging at acute angles, all curved including the midrib, stout, prominent on the lower surface of the leaf, acrodrome. Secondaries thin but well marked, arching along the margins and internally mostly transversely percurrent.

This is an exceedingly well-marked species of Piperaceae which finds many similar forms among existing tropical American species of *Piper* and related genera. Since its generic affinity can not be positively demonstrated, it is referred to the genus *Piperites* proposed by Goeppert for fossil leaves of the plants of this family.

This ancient and specifically abundant family has hitherto furnished but few fossil species, its past rarity being thought to be a matter of lack of preservation or discovery, since its extensive modern distribution would seem to indicate that its ancient history



was extensive. The fossil species comprise three from the Tertiary of Java, one from the Tertiary of Sumatra, one from the Tertiary of Australia, a sixth from the Upper Cretaceous of the Mississippi embayment region, and a seventh from the Denver formation (basal Eocene) of Colorado. It is apparent that the family has been present in America since Upper Cretaceous times, and the hosts of modern species of the American Tropics would seem to indicate a vigorous evolving Tertiary series of forms. The two species from the Tertiary of Costa Rica are the first later Tertiary forms found in this hemisphere, and I might add that collections made from the high Andes in Bolivia contained a variety and great abundance of leaves of fossil peppers.

Comparisons have been instituted with the leaves of various Menispermaceae, Tiliaceae, Leguminosae, Dioscoreaceae, etc., which suggested analogies with these fossils, and they are found to be clearly referable to the Piperaceae.

*Holotype*.—Cat. No. 35461, U.S.N.M.

**PIPERITES QUINQUECOSTATUS, new species.**

Plate 22, fig. 2.

*Description*.—Leaves of smaller size than in *Piperites cordatus* Berry, cordate in general outline, with an acuminate tip and a more deeply cordate base. Margins entire, full, and evenly rounded. Texture subcoriaceous. Length, about 7 cm. Maximum width, in the lower part of the leaf, about 6.25 cm. Petiole missing. Midrib stouter than the lateral primaries which are two on each side. All are fairly prominent on the under side of the leaf. The lateral primaries are not acrodrome as in the preceding species but join a branch from the upper secondaries. Secondaries thin but well marked, camptodrome. Tertiaries thin forming an open mesh.

The salient features of this species are well shown in the accompanying illustration. It is clearly distinct from the preceding and is less common in the collection. It also may be closely matched by several existing American species.

*Holotype*—Cat. No. 35462, U.S.N.M.

**Order URTICALES.**

**Family MORACEAE.**

**Genus FICUS Linnaeus.**

**FICUS TALAMANCANA, new species,**

Plate 23.

*Description*.—Leaves elliptical in general outline, with an apiculate acuminate tip and a decurrent base, of relatively large size but shorter and wider than the associated leaves of *Anona costaricana*. Margins entire and full. Texture subcoriaceous. Length, ranging

from 14 cm. to 16 cm. Maximum width, in the median region, ranging from 5.5 cm. to 7 cm. Petiole stout. Midrib very stout, prominent on the under surface, relatively narrow on the upper surface. Secondaries 8 or 9 subopposite to alternate pairs, diverging from the midrib at wide angles of about  $75^{\circ}$  to  $80^{\circ}$ , curving regularly but slightly, and camptodrome in the marginal region. Tertiaries thin, forming an open, prevailing quadrangular areolation, partly consisting of percurrent nervilles.

These leaves are slightly inequilateral and are readily distinguished from the associated fossil leaves by their general outline, shorter wider form, and apiculate tip. This large-leaved form is the only *Ficus* in the collection and may be readily matched among the very numerous existing species of this genus.

*Cotypes*.—Cat. Nos. 35463, 35464, U.S.N.M.

## Order RANALES.

### Family ANONACEAE.

#### Genus ANONA Linnaeus.

##### ANONA COSTARICANA, new species.

###### Plate 24.

*Description*.—Leaves of large size, somewhat inequilateral and elliptical in general outline, with a bluntly pointed apex and a full wide, eventually somewhat decurrent, base. Margins full, entire, slightly undulate. Texture subcoriaceous. Length, about 17.5 cm. Maximum width, in the median part of leaf, about 6 cm. Petiole short and stout. Midrib stout, curved, channeled above and prominent below. Secondaries stout, about 10 alternate pairs diverge from the midrib at wide angles ( $55^{\circ}$  to  $80^{\circ}$ ), ascending in full even curves and camptodrome in the marginal region. Tertiaries thin forming an open polygonal mesh.

This is an exceedingly well-marked species, comparable to a considerable number of existing American species, among which may be mentioned *A. lutescens* Safford of southern Mexico and Guatemala, *A. jahnii* Safford of Colombia and Venezuela, *A. paludosa* Aublet of French Guiana, *A. maregravii* Martius of Venezuela to Brazil, *A. montana* Macfadyen of the Antilles, *A. sphaerocarpa* Splitgerder of Panama, and the allied *Raimondia quinduenis* (Humboldt, Bonpland and Kunth) Safford of Colombia and Ecuador.

None of the previously known fossil forms are as large as this species except certain forms from the Wilcox Eocene of the Mississippi embayment. Among these *A. ampla* Berry<sup>1</sup> resembles the Costa Rican species and shows the same open areolation.

*Holotype*.—Cat. No. 35465, U.S.N.M.

<sup>1</sup> Berry, E. W., U. S. Geol. Surv. Prof. Paper 91, p. 217, pls. 39, 40, 1916.

## Order ROSALES.

## Family MIMOSACEAE.

Genus *INGA* Willdenow.*INGA SHEROLIENSIS*, new species.

Plate 25, fig. 2.

*Description*.—Leaflets ovate and somewhat falcate, markedly inequilateral in outline, particularly proximad. Apex acute. Margins entire. Texture subcoriaceous. Length, about 6.5 cm. Maximum width, about 2.25 cm. Petiolule stout, about 6 mm. in length. Midrib curved, stout, and prominent. Secondaries thin, numerous, subparallel, and camptodrome. Tertiaries subparallel with secondaries, close set, connected by fine cross nervilles to form a close areolation.

This is a well-marked species of *Inga*, clearly differentiated from previously described fossil forms but showing considerable resemblance, particularly in the venation, to *Inga reissi* described by Engelhardt<sup>2</sup> from the Tertiary (probably Miocene) of Santa Ana in Colombia. The latter is, however, a somewhat more ovate and more nearly equilateral leaflet.

Several existing species show close similarities to the fossil.

*Holotype*.—Cat. No. 35466, U.S.N.M.

## Order GERANIALES.

## Family EUPHORBIACEAE.

Genus *HIERONYMIA* Allen.*HIERONYMIA LEHMANNI* Engelhardt (?).

*Hieronymia lehmanni* ENGELHARDT, Über neue Tertiärpflanzen Süd-Amerikas, Abh. Senck. Naturf. Gesell., vol. 19, p. 11, pl. 2, figs. 1, 2, 1895.—BERRY, U. S. Nat. Mus., Bull. 103, p. 36, pl. 16, fig. 3, 1918.

*Description*.—Leaves broadly elliptical or somewhat deltoid and inequilateral in outline, with a shortly acuminate tip and broadly rounded full lower lateral margins and a very wide, somewhat obliquely truncated base. Length, about 12 cm. Maximum width, in the lower half of the leaf, about 10 cm. Margins entire, full, and rounded. Texture thin but coriaceous. Midrib stout, curved, prominent on the lower surface of the leaf. Secondaries stout, 10 or 11 irregularly spaced pairs, prominent on the lower surface of the leaf; they diverge from the midrib at wide angles which become more acute in the apical part of the leaf; those on the narrower side are more ascending and somewhat straighter than those on the wide side; all are conspicuously camptodrome at some distance from the margin.

<sup>2</sup> Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 19, p. 36, pl. 8, figs. 1, 2; pl. 9, fig. 8, 1895.



Tertiaries thin, mostly percurrent. Areolation of small, isodiametric polygonal meshes well marked on the under side of the leaf.

This rather large leaf is unfortunately represented by fragmentary material just as it was to the southward in the Canal Zone. In some respects its characters suggest a broad *Ficus*, but it seems clearly identical with the species described by Engelhardt in 1895 from the Tertiary of Ecuador. I have, however, queried the determination because of the broken character of the material, although it is somewhat more complete than that from Panama and includes the terminal half of a leaf.

This species was described from the coal-bearing series of the Loja basin in the southern Ecuadorian Andes and was subsequently provisionally identified from the Caimito formation of Panama.

The genus *Hieronymia* comprises about a dozen existing species of shrubs and trees confined to tropical America and rather widely distributed from Mexico to Brazil as well as in the West Indies and is still represented in Central America.

## Order MALVALES.

### Family STERCULIACEAE.

#### Genus BÜTTNERIA Linnaeus.

##### BÜTTNERIA CINNAMOMIFOLIA Engelhardt (?).

*Büttneria cinnamomifolia* ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 32, pl. 7, fig. 9, 1895.

*Description*.—Leaves ovate in general outline, widest below the middle and with an acute apex and base, the latter slightly wider than the former. Margins entire, evenly rounded. Length, about 8.25 cm. Maximum width, about 4 cm. Petiole stout, about 1.5 cm. in length. Midrib stout, prominent. Basal pair of secondaries transformed into pseudoprimaries which diverge from the midrib at an acute angle at the top of the petiole and curve upward subparallel with the lateral margins, joining the normal secondaries about two-thirds of the distance to the apex of the leaf. Normal secondaries 3 pairs in the upper third of the leaf; they diverge from the midrib at a wide angle and are abruptly camptodrome. Tertiaries percurrent within and camptodrome outside the area inclosed by the basal secondaries. Areolation prevailingly quadrangular.

This species was described from the Tertiary (probably Miocene) of Santa Ana, Colombia, and compared with the existing *Büttneria elliptica* Pohl, *B. affinis* Pohl, and *B. laevigata* Schott. Fragments showing the characteristic areolation are contained in the present collection, but as no reasonably complete specimens have been found the identification is queried.

The genus contains about three score existing species of herbaceous or shrubby, mostly climbing, plants largely confined to tropical America but found also in Madagascar, the southeastern Asiatic region, and Malayanasia.

## Order THYMELEALES.

## Family LAURACEAE.

## Genus GOEPPERTIA Nees.

## GOEPPERTIA TERTIARIA, new species.

Plate 25, fig. 1.

*Description.*—Leaves of medium size, elliptical oval in general outline, widest below the middle, with an acute tip and a rounded base. Margins entire, full and evenly rounded. Texture coriaceous. Length, about 12 cm. Maximum width, about 5.75 cm. Petiole missing. Primaries 3, supra basilar, all prominent on the lower surface, midrib stoutest; the laterals diverge from the midrib about 5 mm. above its base at acute angles of about 25°, curving upward. Secondaries comprise a few camptodrome pairs in the tip of the leaf, several broadly curved ascending ones from the outer side of the lateral primaries and an opposite pair from near the base of the midrib. The tertiaries are thin and percurrent or inosculate midway between primaries or secondaries and primaries. Aerolation forms a fine polygonal lauraceous mesh.

This leaf is of a type that has uniformly been referred to the genus *Cinnamomum* except in a few instances in Engelhardt's work upon South American fossil plants. I know of no certain characters for distinguishing certain forms of *Goepertia* or *Cryptocarya* from *Cinnamomum* and am therefore inconsistent in not adhering to custom. It is a problem which paleobotanists will be obliged to face sooner or later in connection with a great many fossil species which have been referred to *Cinnamomum*. I am influenced by the large number of species of the almost exclusively tropical American tribe Cryptocaryeae which have leaves of the *Cinnamomum* type; in fact, the modern *Cinnamomum camphora* Nees has leaves very much like the present fossil species. It does not have the characters of *Strychnos* nor of the many American Melastomataceae, but is very similar to various species of *Goepertia*, a genus with numerous species of tropical America, to which region it is confined, and which is sometimes, as by Pax in Engler and Prantl, made a subgenus of *Ayden-dron* Nees. With the exception of a species from the Chattian of Bohemia, the only fossil forms that have been heretofore recognized comprise one from Colombia and two from southern Chile, and all probably of lower Miocene age.

*Holotype.*—Cat. No. 35467, U.S.N.M.



## Genus NECTANDRA Roland.

## NECTANDRA AREOLATA Engelhardt.

## Plate 27.

*Nectandra areolata* ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 29, pl. 6, figs. 1, 2, 1895.

*Description*.—Leaves of large size, elliptical, acute in general outline, widest in the middle and equally pointed at both ends. Margin entire, slightly undulate. Texture coriaceous. Length, about 18 cm. Maximum width, about 7.5 cm. Petiole short and stout, about 1 cm. in length. Midrib stout and prominent on the lower side of the leaf. Secondaries stout proximad, becoming thin distad, prominent on the lower surface of the leaf; eight to ten somewhat irregularly spaced pairs diverge from the midrib at angles of 45° or more and curve regularly upward, ending in camptodrome arches along the margin. Tertiaries well marked, percurrent. Areolation polygonal.

This species was described by Engelhardt from the Tertiary (probably Miocene) of Santa Ana, Colombia, and compared with the existing *Nectandra gardneri* Meissner. It was based upon rather imperfect type material, more complete specimens being present in the Costa Rica collection. In the account of the Colombian fossil plants, as well as in much of Engelhardt's paleobotanical work, there is an unwarranted differentiation of specific types, and it seems extremely likely that two additional nominal species which this author described from the same outcrop at Santa Ana, Colombia, should be united with his *Nectandra areolata*. These are *Nectandra Reissi* Engelhardt<sup>3</sup> and *Persea coriacea* Engelhardt.<sup>4</sup> Judging by the illustrations of these forms they are not to be differentiated, but as I have only actual specimens of the first I hesitate to go beyond suggesting such a change, which would, of course, require that the aggregate go by the name *coriacea*, which has priority of position in Engelhardt's discussion.

## NECTANDRA WOODRINGI, new species.

## Plate 26, fig. 1.

*Description*.—Leaves broadly lanceolate in general outline, widest midway between the apex and the base, narrowing upward to the acuminate tip and downward to the acute base. Margins entire, slightly undulate. Texture coriaceous. Length, about 15.5 cm. Maximum width, about 4.5 cm. Petiole short and stout. Midrib stout, curved, prominent on the lower surface of the leaf. Second-

<sup>3</sup> Engelhardt, II., Abh. Senck. Naturf. Gesell., vol. 19, p. 23, pl. 6, fig. 7, 1895.

<sup>4</sup> Idem., p. 26, pl. 6, figs. 3, 4.

aries stout, prominent; seven or eight alternate pairs diverge from the midrib at angles of about  $45^{\circ}$ , sweep upward in long ascending curves, and are camptodrome in the marginal region. Tertiaries comprise arches along the margins and prevailingly percurrent veins between the secondaries.

This exceedingly well-marked species is named for the collector, Dr. Wendell P. Woodring. It is most remarkably like the existing *Nectandra antillana* Meissner, a common woodland and river bank form throughout both the Greater and Lesser Antilles. A nature print of a leaf of the latter is introduced beside that of the fossil species for comparison. I have not searched herbaria to determine whether *Nectandra antillana* occurs on the mainland of Central America nor whether there are similar leafed *Nectandras* in the existing flora of Costa Rica, but presumably such is the case.

Among fossil forms the present Costa Rican species stands nearest to *Nectandra antillanifolia* Berry MSS., a rather common form of the Jackson Eocene deposits of Texas. It is also similar to two closely related species of the Wilcox Eocene of the Mississippi embayment region, namely, *Nectandra lancifolia* (Lesquereux) Berry<sup>5</sup> and *Nectandra glenni* Berry.<sup>6</sup>

*Holotype*.—Cat. No. 35468, U.S.N.M.

#### INCERTAE SEDIS.

##### PHYLLITES COSTARICENSIS, new species.

Plate 25, fig. 3,

*Description*.—It has been impossible to determine the botanical affinity of this very characteristic small leaf. It may be described as follows: Outline broadly spatulate, widest above the middle, with a rounded tip and a broad sessile sheathing base. Margins full and entire. Texture subcoriaceous. Length, about 5.5 cm. Maximum width, about 2.5 cm. Midrib extremely stout and prominent, expanded and flattened at the base. Secondaries subopposite, stout, numerous, and ascending except in the narrowed base, camptodrome. Tertiaries thin, but well marked, percurrent.

This form invites comparisons with a variety of recent forms. In the prominent venation it suggests a juvenile leaf or one in proximity to flowers. It is well marked and easily recognized, and should prove useful for purposes of correlation if subsequent collections are made. It suggests the family Moraceae to me, but I do not feel at all certain on this point.

<sup>5</sup> Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 308, pl. 85, fig. 2, 1916.

<sup>6</sup> Idem., p. 309, pl. 85, fig. 1.

Additional examination of recent material in the United States National Herbarium since the foregoing was written, suggests the probability that the present form should be referred to the genus *Castilloa* Cervantes or to an ancestral form. The modern genus consists of a small number of species of trees found from Mexico to Panama and in Cuba, in which the juvenile leaves frequently lack the cordate base of the mature leaves, and are extremely close to the present fossil form.

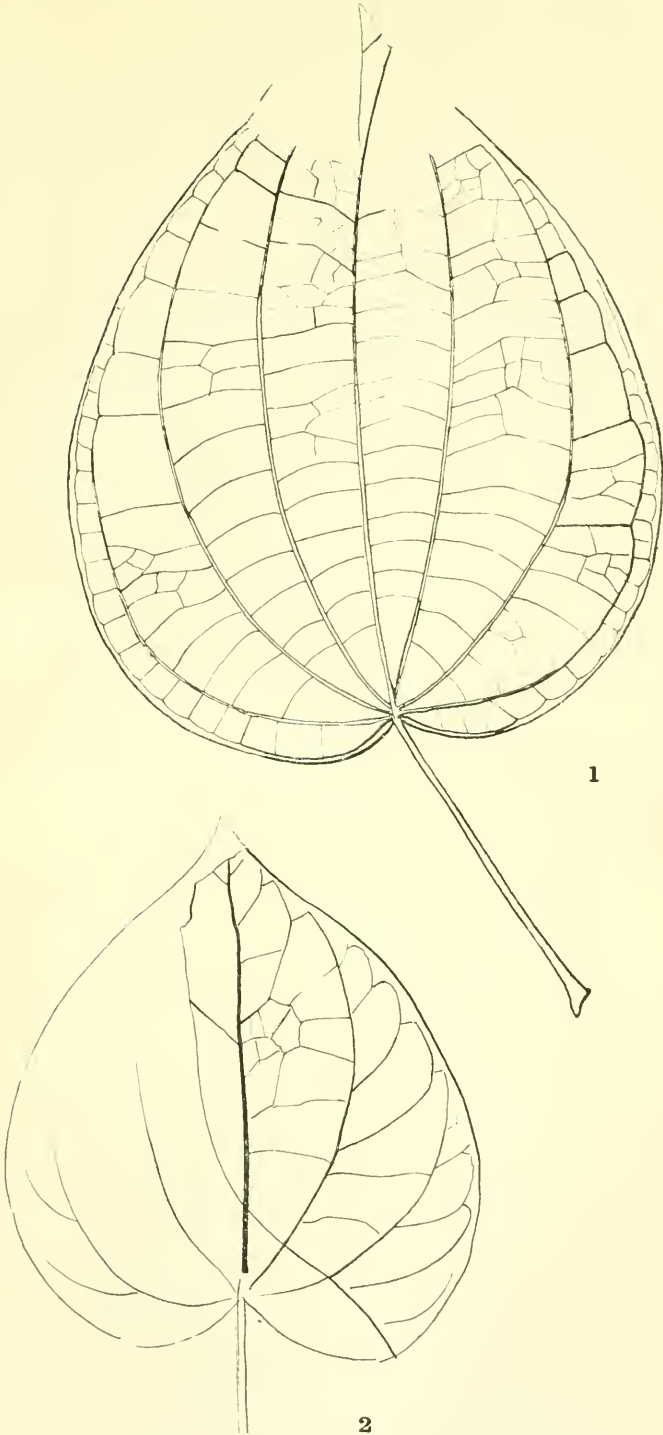
*Holotype*.—Cat. No. 35469, U.S.N.M.



EXPLANATION OF PLATES.

PLATE 22.

- FIG. 1. *Piperites cordatus* Berry, new species.  
2. *Piperites binquecostatus* Berry, new species.

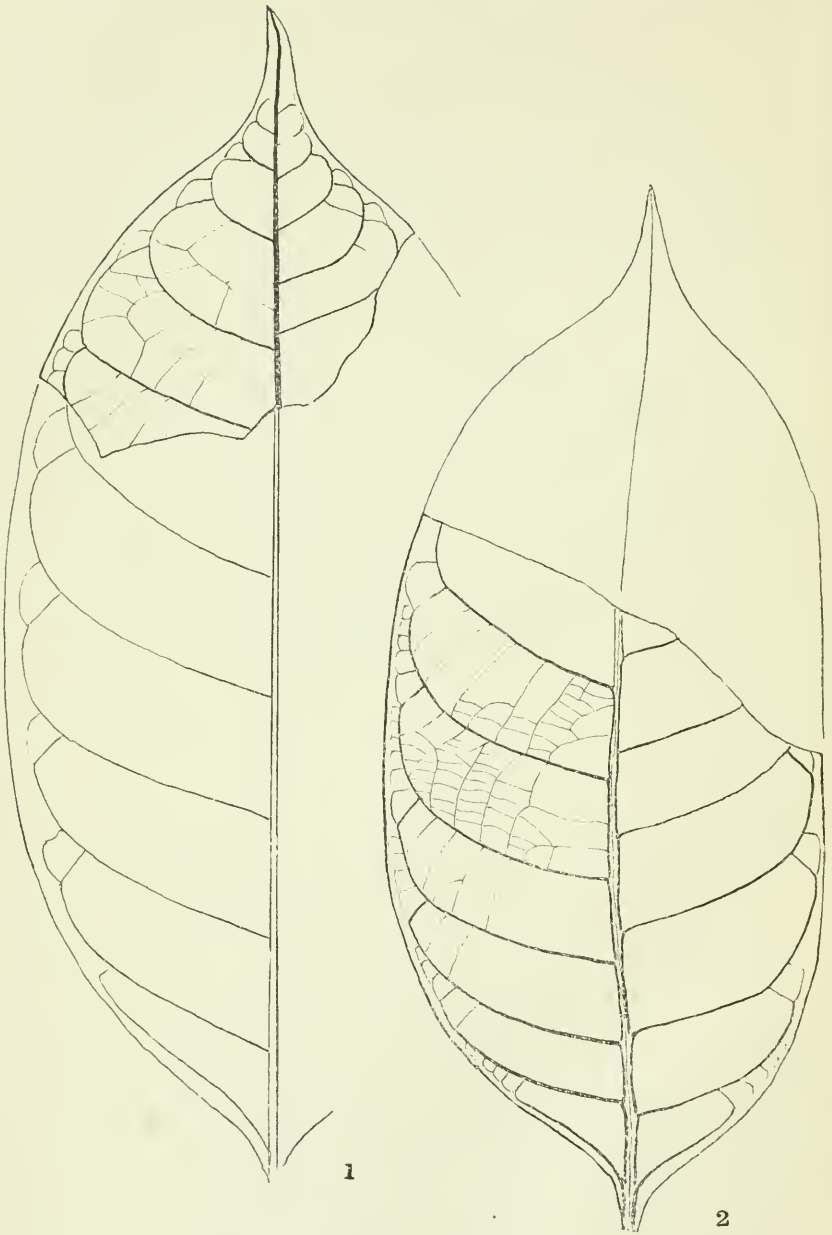


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2

TERTIARY FOSSIL PLANTS FROM COSTA RICA.

FOR EXPLANATION OF PLATE SEE PAGE 180.



TERTIARY FOSSIL PLANTS FROM COSTA RICA.

FOR EXPLANATION OF PLATE SEE PAGE 181.

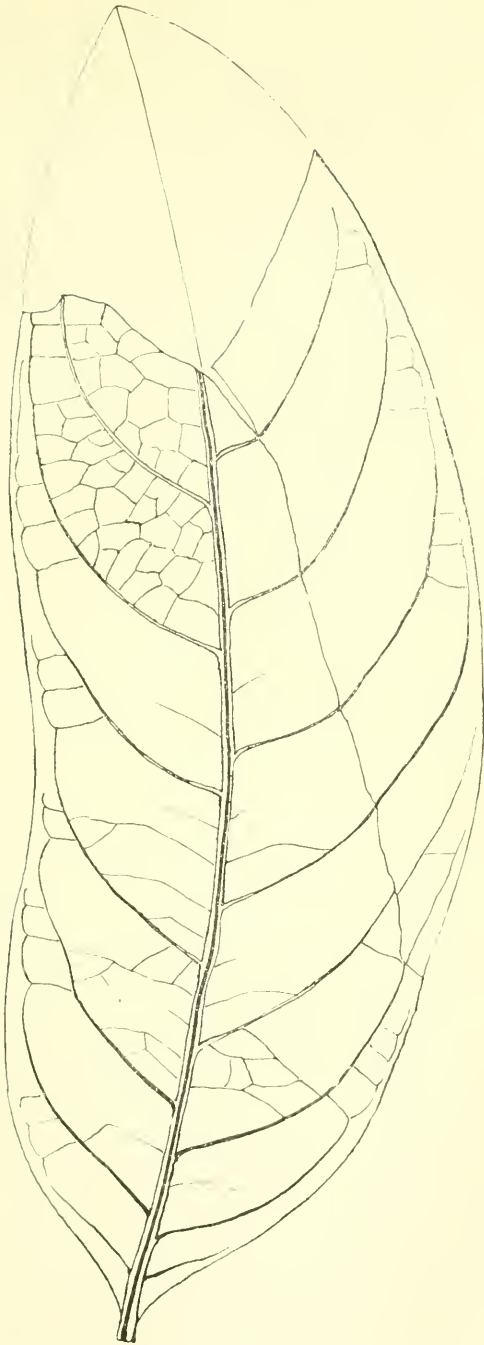


PLATE 23.

FIG. 1. Upper surface and, figure 2, lower surface of *Ficus talamancana* Berry,  
new species.

PLATE 24.

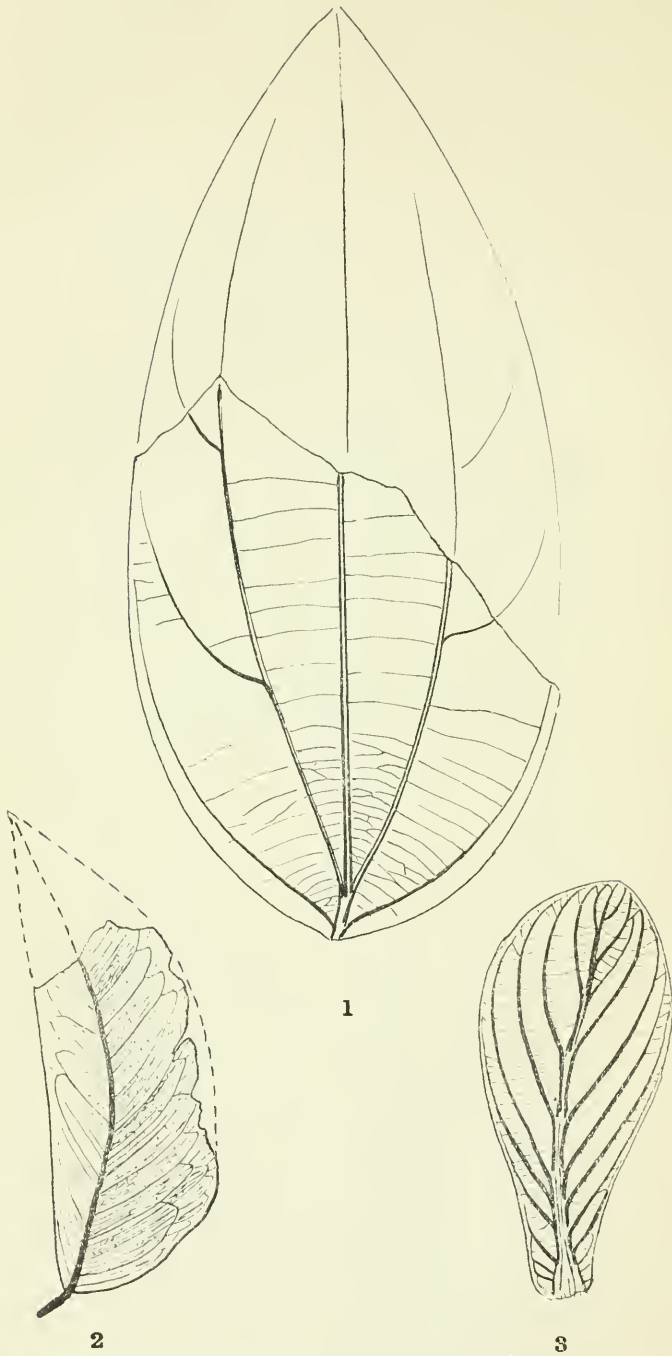
*Anona costaricana* Berry, new species.



TERTIARY FOSSIL PLANTS FROM COSTA RICA

FOR EXPLANATION OF PLATE SEE PAGE 182.





TERTIARY FOSSIL PLANTS FROM COSTA RICA.

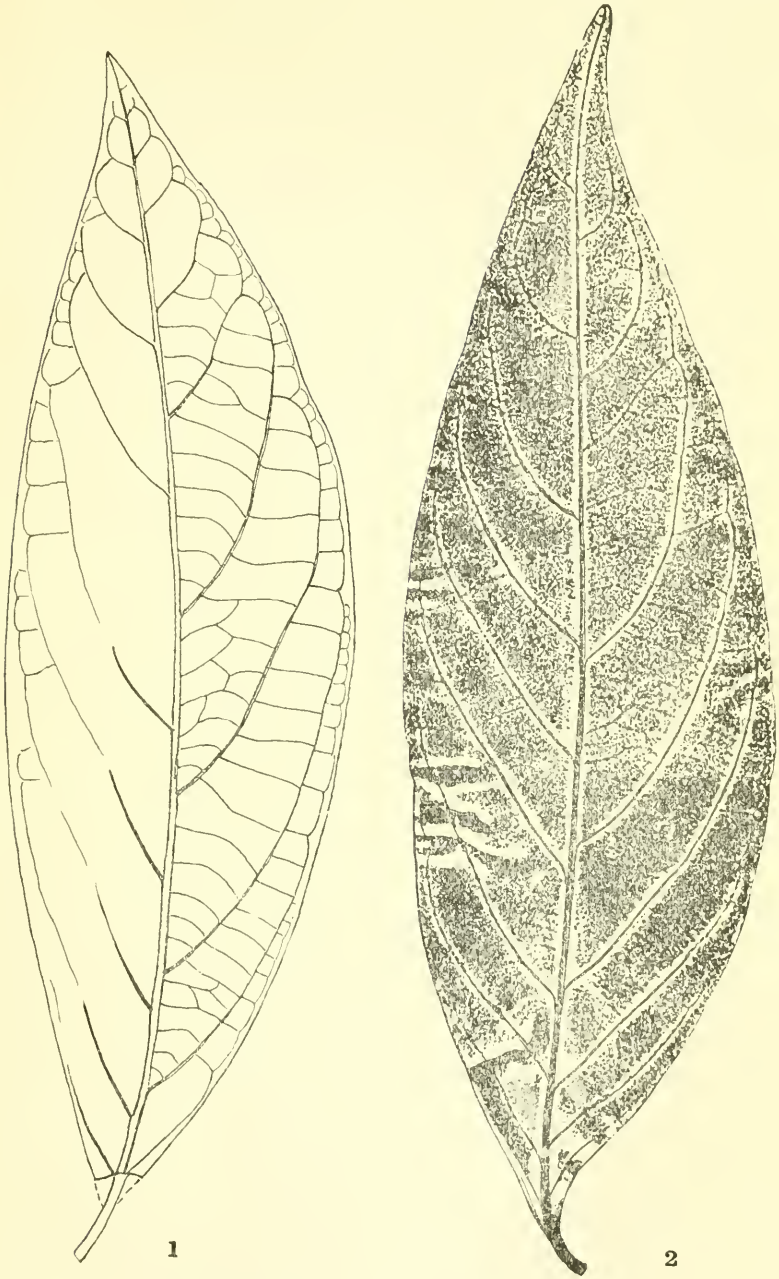
FOR EXPLANATION OF PLATE SEE PAGE 183.

PLATE 25.

- FIG. 1. *Goepertia tertiaria* Berry, new species.  
2. *Inga shrolicensis* Berry, new species.  
3. *Phyllites costaricensis* Berry, new species.

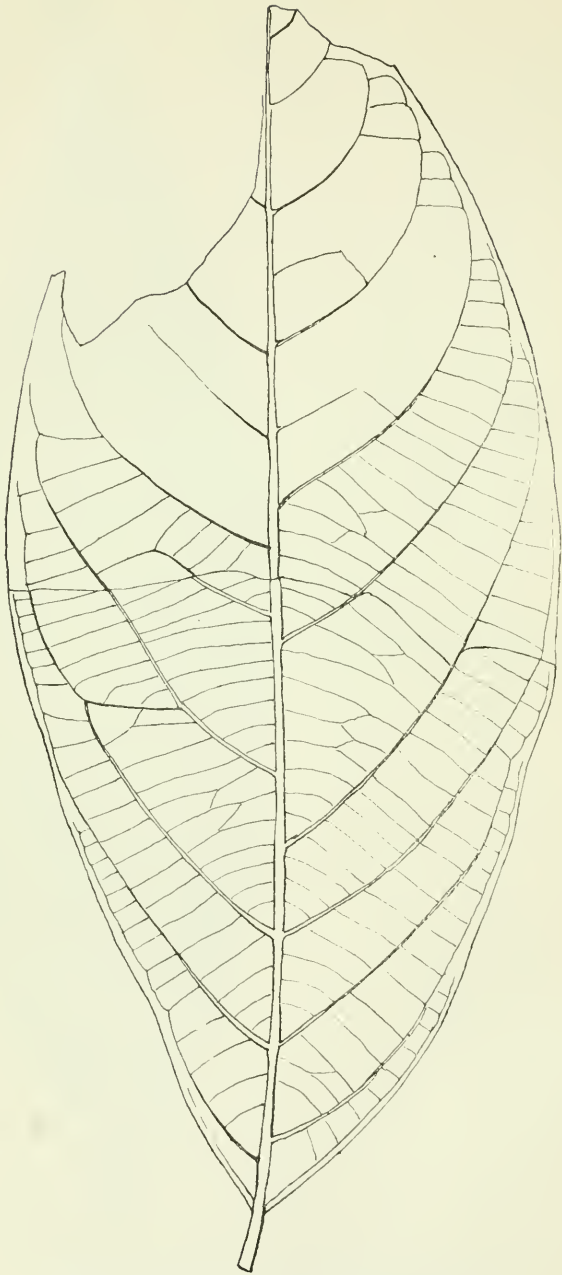
PLATE 26.

- FIG. 1. *Nectandra woodringi* Berry, new species.  
2. *Nectandra antillana* Meissner, existing species introduced for comparison.



TERTIARY FOSSIL PLANTS FROM COSTA RICA.

FOR EXPLANATION OF PLATE SEE PAGE 184.



TERTIARY FOSSIL PLANTS FROM COSTA RICA.

FOR EXPLANATION OF PLATE SEE PAGE 185.



PLATE 27.

*Nectandra areolata* Engelhardt.

