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TERTIARY PLANTS FROM VENEZUELA

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IN 1920 and 1921 I published brief papers on Tertiary Venezuelan plants¹ that had been collected by Charles F. Bowen in 1919. Subsequently I received collections from the same and additional localities made by Harold F. Crooks and R. A. Liddle in 1921, by Dr. L. W. Stephenson and Dr. James A. Tong in 1923 and 1925, and by H. G. Kugler in 1925. These received preliminary study and were reported upon at the time, but no mention of them has appeared in print. Although they do not add greatly to the Tertiary floras of Venezuela, they include a number of new and interesting forms, and since large or well-preserved collections of fossil plants from this region are not apt to be accessible in the near future, it is important that the known occurrences be available as an aid in solving the problems of correlation in this and other regions in northern South America and the Antilles.

In the present paper fossil plants are discussed from localities as follows:

EOCENE

In 1920 I described a remarkable fruit of *Entada*—the sea-bean—from dark shales. This was collected by C. F. Bowen at Mesa Pablo about 8 kilometers southwest of Escuque, State of Trujillo. Beds of similar age in the District of Sucre, State of Zulia, contain leaves

¹ Berry, E. W., Amer. Journ. Sci., vol. 50, pp. 310-313, fig. 1, 1920; Proc. U. S. Nat. Mus., vol. 59, pp. 553-579, 4 figs., 3 pls., 1921.

of several species of terrestrial plants preserved in a soft reddish sandstone. These are described herein; they were collected by Drs. L. W. Stephenson and J. A. Tong.

MIOCENE

LOCALITY 1: PALMAREJO

This locality is in the District of Mara, State of Zulia. It is on the west side of the lake, 20 kilometers north of the city of Maracaibo, the exposures being in the lake cliffs. The matrix is a somewhat sandy laminated clay. The collectors were H. F. Crooks and R. A. Liddle. The age of the plants is Miocene and is perhaps slightly younger than the others.

LOCALITY 2: ZAPAYARI-EL PLAN ROAD

About $1\frac{1}{2}$ kilometers south of Rio Grande, District of Bolivar, State of Zulia. Yellowish to red soft argillaceous fine-grained sandstone, often highly ferruginous. Collected by Dr. L. W. Stephenson, Dr. J. A. Tong, and W. D. Miller, December 5, 1923.

LOCALITY 3: RIO PALO NEGRO

North of Hato Venado, District of Bolivar, State of Zulia. Gritty yellowish sandstone. Collected by Dr. L. W. Stephenson, Dr. J. A. Tong, and W. D. Miller, December 3, 1923.

LOCALITIES 4 AND 5: LA VICTORIA

This covers two localities in the District of Miranda, State of Zulia, both in a yellowish to reddish sandstone matrix. One on the La Victoria-Catanaja Road, about $2\frac{1}{2}$ kilometers north of La Victoria (locality 4), and the other $3\frac{1}{2}$ kilometers south of La Victoria and half a kilometer southwest of El Rudal ranch house (locality 5). The age indicated is lower or middle Miocene. The collectors were Drs. L. W. Stephenson and J. A. Tong.

LOCALITY 6: EL MENE

This is in the District of Acosta, State of Falcon. The exact locality is 2 kilometers northeast of El Mene. The matrix is a slightly brownish, finely sandy, and relatively hard clay. The plant material is abundant and matted in certain thin layers and inclined to be fragmentary and poor. It was collected by H. G. Kugler in 1925. This horizon is said to belong to the sandy part of the lower Salada series of Wiedenmayer's paper of 1924 and is considered by Liddle (1928) a part of the Cerro Pelado formation and lower Miocene in age.

LOCALITY 7: BETIJOQUE

This is in the District of Betijoque, State of Trujillo. The exact locality is 100 meters east of the Sabana de Mendoza Road in the northern outskirts of the town and about 600 meters north 2° east of the main church steeple in Betijoque. The matrix is a soft light-colored clay, and the plants are on the whole well preserved. Nine species collected by Bowen were described from here in the 1921 paper, and the present contribution adds about as many more. There has been some difference of opinion regarding the age, but so far as I know it has not appeared in print, and there cannot be the slightest doubt that the plant horizon is lower or middle Miocene in age.

LOCALITY 8: LA SALVADORA

This locality is along the trail 4 kilometers northwest of La Salvadora and between 40 and 48 kilometers south of Betijoque in the State of Trujillo. The matrix is a yellowish sandy micaceous clay from which seven species were described in 1921 and is of approximately the same age as the preceding.

Of these eight localities in Venezuela from which determinable fossil plants of Miocene age have been collected, one is in the State of Falcon, two in Trujillo, and five in Zulia. None has yielded a prolific flora, the number of species varying from 2 at Rio Palo Negro and south of La Victoria to 12 at La Salvadora and 18 at Betijoque. The last is not only the most prolific but also represents the best preservation, and more extensive and careful collecting probably would at least triple the number of forms recognized.

Because the present collections do not represent a greater number of forms and so can not be considered a reasonable sampling, it is impossible to deduce any reliable ecologic considerations or to institute any adequate comparisons between localities. The only ferns recognized comprise two species, and these both come from Betijoque and have not been collected at any of the other Venezuelan localities, although one of these was first described from the Cauca Valley in Colombia.

The total number of species from the Miocene of Venezuela recorded herein is 40, and some of these are based on scanty and fragmentary material. Twenty-one, or more than half, of these have not been found outside of Venezuela. Of these 21 only the following are confined to a single locality in Venezuela:

SPECIES	LOCALITY
<i>Achras calcicolafolia</i>	4
<i>Antholithus venezuelensis</i>	8
<i>Bignonia zuliana</i>	4
<i>Blechnum betijoquensis</i>	7
<i>Burscrites venezuelana</i>	8
<i>Leguminosites entadaformis</i>	8
<i>Leguminosites venezuelensis</i>	8
Leguminous pod.....	2
<i>Pleonotoma miocenica</i>	7
<i>Poacites</i> sp.....	4
<i>Rhizophora boweni</i>	7
<i>Simaruba miocenica</i>	7
<i>Sophora salvadorana</i>	8
<i>Zamia</i> (?) sp.....	7

Of these 14 forms, several—such as the flower *Antholithus*, the fern *Blechnum*, the grass fragment *Poacites*, the leguminous leaflets *Leguminosites* and *Sophora* and pod, and the supposed fragment of a cycad pinnule (*Zamia*)—are the sort of things dependent for their presence as fossils largely on accidents of preservation, and therefore they are of slight value in questions of composition, ecology, or age.

The following 21 species, or half the total number known from the Miocene of Venezuela, are not known from other regions:

SPECIES	LOCALITY
<i>Achras calcicolafolia</i>	4
<i>Anona sphaerocarpoidea</i>	2, 7
<i>Antholithus venezuelensis</i>	8
<i>Apocynophyllum salvadorensis</i>	1, 6, 8
<i>Bignonia zuliana</i>	4
<i>Blechnum betijoquensis</i>	7
<i>Burscrites venezuelana</i>	8
<i>Chrysobalanus venezuelanus</i>	6, 7
<i>Combretum stephensoni</i>	4, 5
<i>Inga</i> sp.....	1, 6
<i>Leguminosites entadaformis</i>	8
<i>Leguminosites venezuelensis</i>	8
Leguminous pod.....	2
<i>Persca</i> sp.....	1, 4
<i>Pleonotoma miocenica</i>	7
<i>Poacites</i> sp.....	4
<i>Rhizophora boweni</i>	7
<i>Simaruba miocenica</i>	7
<i>Sophora marana</i>	1, 6, 7
<i>Sophora salvadorana</i>	8
<i>Zamia</i> (?) sp.....	7

Some of these, as the *Inga*, *Persca*, *Poacites*, and *Zamia* (?), are of slight significance because of incompleteness, and the first three represent widespread types.

Twenty-three of the 40 species recorded from the Miocene of Venezuela have been found at but a single Venezuelan locality, al-

though 10 of these are known from localities in adjoining regions. Those from a single locality are distributed as follows: 1 each at localities 1 and 2; 2 at locality 6; 4 at locality 4; 10 at locality 7; and 5 at locality 8. The large number at locality 7 is due in part to the larger total of species from there and to the presence of rare things like the flower and small leaflets, which are in part due to the finer matrix. Five of those recorded from this locality have an outside distribution. Eleven are recorded from two Venezuelan localities, and six of these have an outside distribution. Four are known from three Venezuelan localities, and two of these have an outside distribution. One is recorded from four Venezuelan localities, and this is found also in Colombia and northwestern Peru. Two species are present at five Venezuelan localities; one of these, *Anona guppyi*, is also present in Colombia, and the other, *Trigonostemon varians*, is present also in Colombia and Peru.

There seems to be no question but that these Venezuelan floras are of Miocene age. Whether they are lower Miocene, as Dr. L. S. Stephenson and others believe, or whether they are slightly younger and possibly middle Miocene, as I have been inclined to think, or whether all eight localities are of the same or different ages is impossible to determine with the present material.

A glance at the accompanying table of distribution (table 1) shows that only 14 of the 40 species have been found at but a single locality. The other 26 occur at two or more Venezuelan localities, and 19 of them at localities outside of Venezuela. The details are given in the table, but a summary may be useful:

Eleven species are recorded from locality 1, and seven of these are known from Trinidad, Colombia, Central America, Ecuador, Peru, or Puerto Rico. Six species are recorded from locality 2, and four of these are known from Colombia, Central America, Ecuador, or Peru. Two species are recorded from locality 3, and both are known from Colombia and one from Peru. Nine species are recorded from locality 4, and three of these are known from Colombia and a fourth from Trinidad. Two species are recorded from locality 5, and one of these occurs in Colombia and the other at four Venezuelan localities. Twelve species are recorded from locality 6, and eight are known from Colombia, Ecuador, Trinidad, Peru, or Puerto Rico. Eighteen species are recorded from locality 7, and 11 of these are known from Central America, Colombia, Ecuador, Peru, or Puerto Rico. Seven species are recorded from locality 8, of which five are peculiar to this region, one is also from localities 1 and 6, and one occurs in Colombia and northwestern Peru.

Locality 8, therefore, is the only one in Venezuela that might be of different age from the other seven. My impression is, and in the absence of more data it can not be considered other than such, that

THE EOCENE PLANTS

The fossil plants from the Eocene of Venezuela, aside from the seed of *Entada* already mentioned, come from two outcrops close together about three-fourths of a kilometer south of Santa Barbara and 2½ kilometers east of Los Barrosos, District of Sucre, State of Zulia. In addition to undeterminable species of leguminous leaflets, a fan palm, a small lauraceous leaf, and a *Eugenia*, the following have been identified:

Apocynophyllum cf. *texensis* Berry.

Burserites fayettensis Berry (?)

Cedrela jacksoniana Berry (fig. 28, b).

Chrysophyllum precoliviforme Berry (?).

Ficus americanafolia, new species (fig. 28, a).

With the exception of the last, which is new, these are late Claiborne or Jackson species in southeastern North America and appear to indicate an upper Eocene age, probably corresponding with lower Jackson.

This Eocene florule is much more like that of North America than is the case with the Miocene flora of Venezuela. The obvious explanation is that in the upper Eocene there was a considerable extension of more equable and warmer climate north of the equatorial zone.

FICUS AMERICANAFOLIA, new species

FIGURE 28, a

This is based upon the single specimen figured, but this shows the complete leaf and lacks only the petiole. It is named from its great resemblance to the existing *Ficus americana* Aublet. Whether this specimen is typical of the botanical species represented cannot be determined from a single specimen. With this limitation it may be described as follows:

Leaves small, lanceolate or slightly ovate-lanceolate in outline. Apex somewhat more acute than base. Length about 8 cm. Maximum width about 2.25 cm. Texture coriaceous.

Petiole missing, obviously stout, presumably short. Mid vein stout and straight, prominent on under side of leaf. Secondaries numerous, rather thin, prominent on under side of leaf. There are about 15 pairs, opposite to alternate, more widely spaced and subtending a smaller angle in upper part of leaf; they diverge from the mid vein at angles of 55° to 70°, are relatively straight and subparallel, and are abruptly camptodrome in marginal region. The tertiary venation is obscured by the coarseness of the matrix; a few intermediate, rather thin veins can be seen diverging from the mid vein, subparallel with secondaries, and these appear to show

ficoid connections with secondaries, but these are not clear, probably because it is the upper surface of the leaf that is exposed.

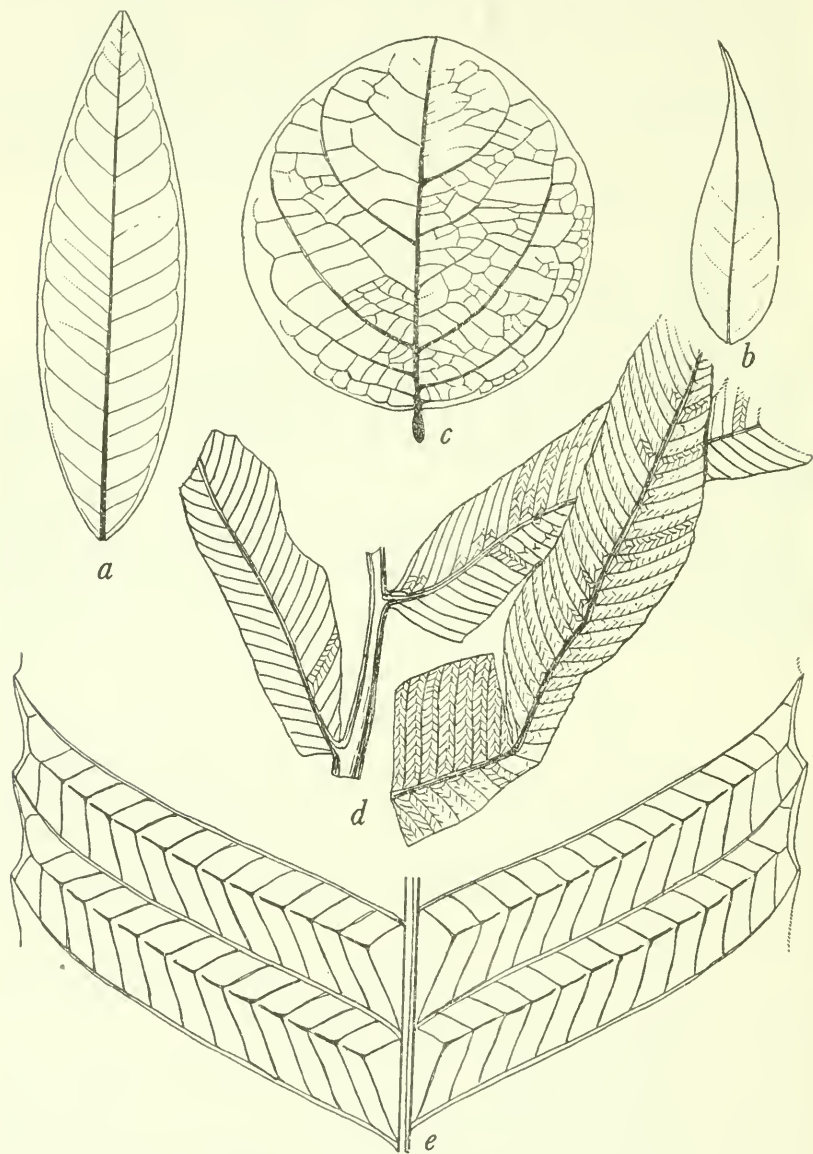


FIGURE 28.—*a*, *Ficus americanafolia*, new species (near Santa Barbara); *b*, *Cedrela jacksoniana* Berry (near Santa Barbara); *c*, *Chrysobalanus venezuelanus*, new species (Betijoque); *d*, *Meniscium wolfi* Engelhardt (Betijoque); *e*, same enlarged to show venation. Others about three-fourths natural size.

Among previously described fossil species the present form shows similarities to *Ficus laqueata* Engelhardt from Santa Ana, Colombia, which is a much younger form; and to *F. pseudomedialfolia* Berry

and *F. wilcoxensis* Berry from the lower Eocene of southeastern North America. It is also much like *F. jynæ* Unger from the Oligocene of the Tyrol in Europe.

Among recent species, as already stated, it is much like *F. americana* Aublet from equatorial America. It is also similar to the leaves of *Pseudolmedia* Trecul, a Caribbean genus of Moraceae.

Type.—Upper Eocene: About three-fourths of a kilometer south of Santa Barbara and 2½ kilometers east of Los Barrosos, District of Sucre, State of Zulia. U.S.N.M. no. 39282.

THE MIOCENE PLANTS

Phylum PTERIDOPHYTA

Order POLYPODIALES

Family POLYPODIACEAE

Genus MENISCIUM Schreber

MENISCIUM WOLFI Engelhardt

FIGURE 28, *d, e*

Meniscium wolfi ENGELHARDT. Abh. Senek. Naturf. Ges., vol. 19, p. 38, pl. 3, figs. 12-17, 1895.

This handsome species was described from the Cauca Valley, Colombia, by Engelhardt, who compared it with the living *Meniscium reticulatum* Swartz, a form that ranges from Jamaica to Peru and Brazil. After comparison with a large quantity of recent material, I am satisfied that Engelhardt's comparison is as good as any that could be made, although I find *M. palustre* Raddi to be equally close. The latter ranges from Central America through northern South America to Brazil.

There is considerable fossil material from Betijoque, and the accompanying enlarged sketch (fig. 28, *e*) shows clearly the venation and also the shallow marginal sinuses between the denticulations that mark the endings of the lateral veins.

The genus *Meniscium* is confined to the American Tropics. Systematic students of modern ferns usually follow Christensen's admirable monograph² in considering it a subgenus of *Dryopteris*. For geological purposes, where dependence has to be placed on form and venation, it is preferable to give generic rank to several of these subgenera, such as *Lastrea*, *Goniopteris*, and *Meniscium*, since they go back certainly to the dawn of the Tertiary and contain a large number of forms and are not a compact or closely enough related series either biologically or geographically to fall within

² Christensen, Carl, Saertryk af. Biol. Arbej. tilegnede Eug. Warming, 1911.

the limits of a single generic concept. Witness Diel's impossible treatment of them under *Nephrodium* in *Die Pflanzenfamilien*.

Occurrence.—Betijoque, District of Betijoque, State of Trujillo. U.S.N.M. no. 39283.

Phylum CYCADOPHYTA

Order CYCALES

Family CYCADACEAE

Genus ZAMIA Linnaeus

ZAMIA (?) species

What appears to be a fragment of a pinnule of *Zamia* is found in the collection from Betijoque in the State of Trujillo. The genus has been detected at a number of localities in the American Tertiary in recent years, and although the present specimen is wholly inadequate for purposes of characterization or comparison it probably indicates the presence of this type of plant.

Phylum ANGIOSPERMOPHYTA

Class MONOCOTYLEDONAE

Order ARECALES

Family ARECACEAE

Genus PALMOPHYLLUM Conwentz

PALMOPHYLLUM species

Fragments of palm rays are not uncommon in the Tertiary floras of equatorial America, but they are usually too incomplete for generic determination, as is the case with those found in the Venezuelan Miocene.

Occurrence.—Palmarejo, District of Mara, State of Zulia; El Mene, District of Acosta, State of Falcon; Betijoque, District of Betijoque, State of Trujillo.

Order POALES

Family POACEAE

Genus POACITES Brongniart

POACITES species

Fragments of a large grass too incomplete for identification and therefore referred to the form genus *Poacites*, but probably a species

of *Chusquea*, are present at the locality $2\frac{1}{2}$ kilometers north of La Victoria, District of Miranda, State of Zulia. An undoubted species of *Chusquea* has been described³ from La Virginia, about 15 kilometers from Girardot, Department of Cundinamarca, Colombia.

Class DICOTYLEDONAE

Order PIPERALES

Family PIPERACEAE

Genus PIPERITES Goeppert

PIPERITES CORDATUS Berry

FIGURE 29, *g*

Piperites cordatus BERRY, Proc. U. S. Nat. Mus., vol. 59, p. 171, pl. 22, fig. 1, 1921; Johns Hopkins Univ. Studies in Geol., no. 6, p. 85, pl. 13, fig. 9, 1925.

This species was described in 1921 from the middle Miocene of southern Costa Rica. Subsequently incomplete material from the Forest sand of the island of Trinidad, British West Indies, was tentatively referred to it.

Recently a somewhat similar form from the Miocene of the De Mares Concession in the State of Santander, Colombia, has been referred to *Dioscorea*. There is some doubt as to whether the present fossil is nearer to *Piper* or to *Dioscorea*, but there is not the slightest doubt of its botanical identity with the type of this species from Costa Rica.

Occurrence.—Betijoque, District of Betijoque, State of Trujillo. U.S.N.M. no. 39289.

Order ANONALES

Family ANONACEAE

Genus ANONA Linnaeus

ANONA GUPPYI Berry

Anona guppyi BERRY, Proc. U. S. Nat. Mus., vol. 59, p. 567, fig. 3, 1921.

This species was described from the Miocene of Betijoque, Venezuela, in 1921. Later collections have shown it to be present at additional localities in Venezuela and also in beds of approximately the same age on the De Mares Concession in the Magdalena Valley, Department of Santander, Colombia.

³ Berry, E. W., Proc. U. S. Nat. Mus., vol. 75, art. 24, p. 2, 1929.

Occurrence.—Rio Palo Negro north of Hato Venado, District of Bolivar; about 3½ kilometers south of La Victoria and half a kilometer southwest of El Rudal ranch, and La Victoria—Catanaja Road

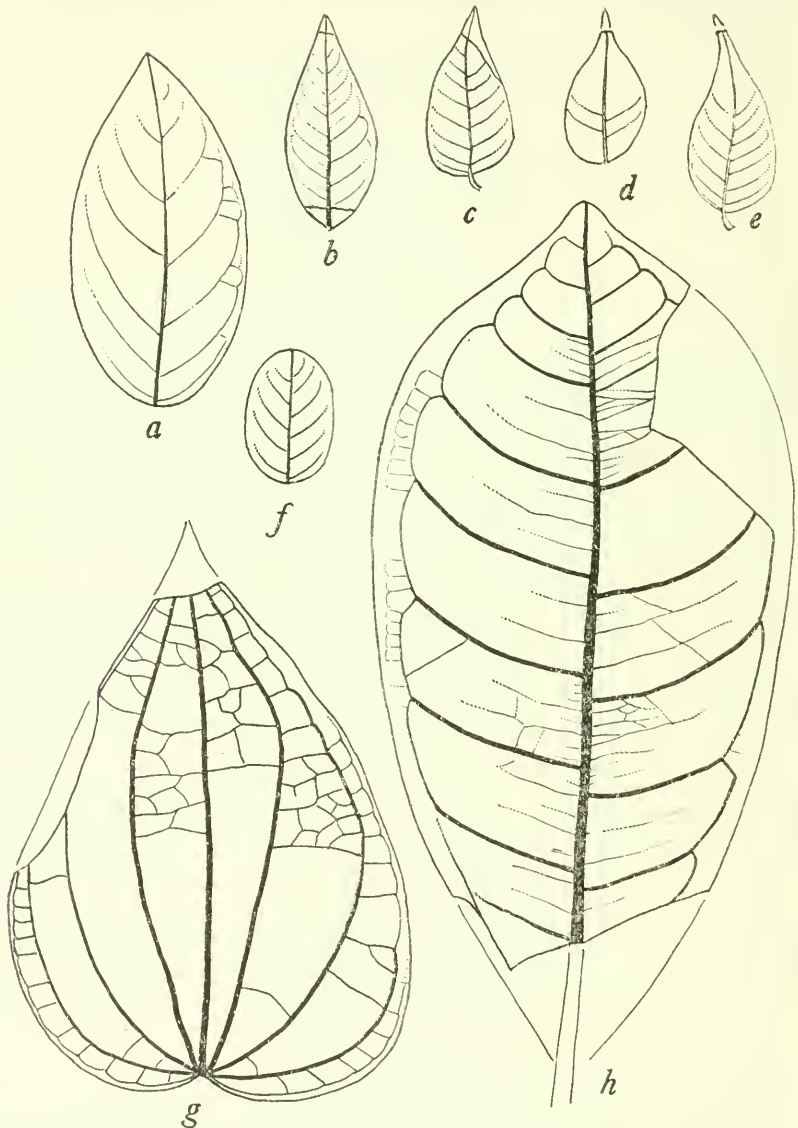


FIGURE 29.—*a*, *Inga reissi* Engelhardt (Palmarejo); *b-c*, *Cassia zuliana*, new species (*b*, Palmarejo; *c-e*, El Mene); *f*, *Sophora murana*, new species (Palmarejo) *g*, *Piperites cordatus* Berry (Betijoque); *h*, *Anona sphaerocarpoidea*, new species (Betijoque). All about three-fourths natural size.

about 2½ kilometers north of La Victoria, District of Miranda, State of Zulia; Betijoque, District of Betijoque, State of Trujillo; El Mene, District of Acosta, State of Falcon.

ANONA SPHAEROCARPOIDES, new species

FIGURE 29, *h*

Leaves of medium size, obovate in general outline. Apex narrowing abruptly and incurved, but instead of being acuminate or cuspidate it terminates in a bluntly rounded apiculation. Base cuneate or broadly acute. Margins entire. Texture subcoriaceous. Length about 14 cm. Maximum width, above the middle, about 6.5 cm. Petiole very stout, its length unknown. Mid vein stout, prominent on under side of leaf. Secondaries stout, prominent, about 10, mostly alternate pairs; they diverge from mid vein at angles approaching 90°, are slightly but regularly curved and subparallel, and are abruptly camptodrome well within the margins. Tertiaries thin, forming a transversely elongated mesh within the secondaries and regularly camptodrome arches outside the secondaries along the margins.

This handsome species is known from only fragmentary specimens. Among existing species of this large tropical and subtropical genus, it is much like *A. sphaerocarpa* Splitg. which ranges from Panama through northern South America to Brazil. The fossil is named from its resemblance to this existing species, both having the same form but differing slightly in venation. Another similar existing form with the same tip but otherwise less close is *A. montana* Macfadyen of Puerto Rico.

Still another similar form showing only slight differences in venation is *A. macgravii* Martius, which ranges from Venezuela to about Bahia, Brazil. Among previously described fossils the present species is something like a form from Santa Ana, Colombia, which Engelhardt called *Citharexylon retiforme*. A number of fossil species of *Anona* have leaves of this general type, especially as to venation, but they are either elliptical or broadly lanceolate in form and lack the apical features of *sphaerocarpoides*.

Occurrence.—Betijoque, District of Betijoque, State of Trujillo; Zapayari—El Plan Road, 1½ kilometers south of Rio Grande, District of Bolivar, State of Zulia.

Type.—U.S.N.M. no. 39295.

Order ROSALES

Family ROSACEAE

Genus CHRYSOBALANUS Linnaeus

CHRYSOBALANUS VENEZUELANUS, new species

FIGURE 28, *c*

Leaves of medium size, suborbicular in outline, the apex slightly less full and broadly rounded than base. Margins entire. Texture

subcoriaceous. Length about 6 cm. Maximum width about 5.4 cm. Unfortunately the material is limited to the type specimen, so that nothing can be said of the possible limits of variation of the species.

Petiole stout, somewhat inflated, and about 5 mm in length. Mid vein stout, very prominent on lower surface of leaf, and slightly curved. Secondaries three or four irregularly spaced pairs, stout and prominent; they diverge from mid vein at wide angles, sweep upward in regular curves, and have camptodrome endings. Tertiaries well marked and almost identical with those in the existing *Chrysobalanus icaco* Linnaeus.

C. icaco is a small coastal tree ranging from southern Florida to southern Brazil, and its leaves are scarcely distinguishable from those of the fossil species *C. venezuelanus*. Leaves of this type appear in fossil record as early as the lower Eocene in southeastern North America⁴, where they are accompanied by characteristic fruits. Two species have been described from the Pliocene of Bahia, Brazil, and one of these, *C. preicaco*, has been considered ancestral to the living *C. icaco*, fruits of which occur in the Pleistocene of Cuba.

The genus is a small one in the recent flora, confined to the Atlantic coastal regions of the Americas and West Africa. The present Venezuelan species is very similar to the Brazilian fossil species mentioned above, but it is relatively wider and rounder, the latter being almost identical with the leaf of the recent species.

Occurrence.—Betijoque, District of Betijoque, State of Trujillo; El Mene, District of Acosta, State of Falcon.

Type.—U.S.N.M. no. 39296.

Family MIMOSACEAE

Genus INGA Willdenow

INGA REISSI Engelhardt

FIGURE 29, a

Inga reissi ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, p. 36, pl. 8, figs. 1, 2; pl. 9, fig. 8, 1895.

This species was described by Engelhardt from Santa Ana, Colombia. Identical material is present in the collections from Palmarejo, Venezuela.

Leaflets sessile or short-petiolulate, variable in size, ovate in general outline, widest at or below middle, inequilateral. Apex acute, sometimes but rarely slightly produced. Base generally broadly rounded. Margins entire, evenly rounded. Texture subcoriaceous. Length 3.25 to 7 cm. Maximum width 1.5 to 3.25 cm. Mid vein stout, generally curved. Secondaries thin, five to seven subopposite to alternate pairs, diverging from mid vein at angles of over 45°,

⁴ Berry, E. W., U. S. Geol. Surv. Prof. Paper 91, p. 220, pl. 44, figs. 8-10, 1916.

regularly curved, subparallel, and camptodrome. Tertiaries more or less obsolete.

Although *Inga reissi* resembles the leaflets of various leguminous genera, as for example some species of *Andira*, *Erythrina*, *Pithecolobium*, and *Inga*, it is more entirely similar to the closely related genera *Pithecolobium* and *Inga*, which are abundant in the existing flora of tropical America. In general, *Pithecolobium* has smaller leaflets with less ascending secondaries, whereas a considerable number of modern species of *Inga* are very similar to the fossil. Among these may be mentioned *I. pinetorum* Pittier, *I. tetraphylla* Martius, and *I. flagelliformis* Martius. Engelhardt compared the fossil species with the existing *I. alba*, *I. fagifolia*, and *I. fastuosa*, of Willdenow.

Occurrence.—Palmarejo, State of Zulia. U.S.N.M. no. 39297.

INGA species

Fragments of what appear to be rather large and inequilateral leaflets of *Inga*, too incomplete for identification, are present at two localities in Venezuela. The genus is common in the Tertiary floras of equatorial America.

Occurrence.—Palmarejo, District of Mara, State of Zulia; El Mene, District of Acosta, State of Falcon.

Family CAESALPINIACEAE

Genus CASSIA Linnaeus

CASSIA LONGIFOLIA Engelhardt

Cassia longifolia ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, pp. 19, 24, pl. 2, figs. 14-16. 1895.—BERRY, Johns Hopkins Univ. Studies in Geol., no. 4, p. 123, pl. 5, figs. 2, 3, 1922.

Leaflets sessile, somewhat variable in form and size, relatively small. Apex and base nearly equally rounded, base tending toward cuneate in some specimens and generally more inequilateral than apex. Margins entire. Texture subcoriaceous. Mid vein stout and prominent, usually somewhat curved. Secondaries numerous, closely spaced, relatively stout, and camptodrome. Length 2 to 3 cm. Maximum width 0.75 to 1.1 cm.

This species was described by Engelhardt from the Loja and Tablayacu coal basins in southern Ecuador, and subsequently recorded from the lower Miocene of Lota and Coronel in Chile and the porcellanite at Siparia, Trinidad. Among recent forms it is much like certain species of *Sweetia*, *Cacsalpinia*, and *Cassia*, as for example *Cassia spectabilis* De Candolle and *Cassia excelsa* Schrad. It appears most like *Cassia* but may represent some other genus of the Caesalpinaceae. It is perhaps doubtful whether the recorded occurrences represent a single botanical species, although

the rather uniform climatic conditions in South America during the earlier half of the Miocene render such a conclusion not improbable, and certainly no criteria for differentiation are apparent.

The genus *Cassia* is a wide-ranging type in the existing flora of the warmer temperate and tropical regions of the world, with upward of 400 species. The geologic history of the genus goes back to the Upper Cretaceous, and more than 100 fossil species are known.

Occurrence.—Near Betijoque, State of Trujillo.

CASSIA ZULIANA, new species

FIGURE 29, *b-c*

Leaflets small, petiolulate, ovate, slightly inequilateral, widest below middle, tapering upward to acute tip which may be extended, and curving downward to the broadly cuneate to rounded inequilateral base. Margins entire. Texture subcoriaceous. Length 2.25 to 3.5 cm. Maximum width about 1.25 to 1.5 cm.

Petioclule stout, curved, about 3 mm long. Mid vein stout, prominent. Secondaries thin, about eight opposite to alternate pairs diverging from mid rib at wide angles, pursuing subparallel courses, and camptodrome in marginal region. There is considerable resemblance to the leaves of the rutaceous genus *Fagara*, but I have been unable to observe the punctations that would be decisive for the latter. Occurs also in porcellanite of Trinidad.

Occurrence.—Palmarejo, State of Zulia; El Mene, State of Falcon.

Types.—U.S.N.M. nos. 39298, 39299.

Family PAPILIONACEAE

Genus SOPHORA Linnaeus

SOPHORA MARANA, new species

FIGURE 29, *f*

Leaflets small, sessile, elliptical in outline, slightly inequilateral, widest in middle, with broadly rounded apex and base—the latter slightly more broadly rounded than former. Texture subcoriaceous. Margins entire, evenly rounded. Length about 2.1 cm. Maximum width 1.4 cm. Mid vein stout, mediumly prominent. Secondaries thin and largely immersed, five or six camptodrome pairs. Tertiaries obsolete.

This small leaflet is of a type commonly referred to *Sophora* and readily matched among existing species of that genus. There is no certainty, however, that it does not represent some other leguminous genus with similar leaflets.

Occurrence.—Palmarejo, State of Zulia.

Type.—U.S.N.M. no. 39300.

LEGUMINOSAE INCERTAE SEDIS

LEGUMINOUS POD

In the collection from locality 2 there is a specimen of a large pod obviously belonging to the leguminous alliance but not complete enough for identification. It is about 7 cm long, the proximal part missing, and about 3.5 cm in maximum width. The distal end is broadly rounded. The pod is compressed, shows no distinct outline of the contained seeds, and has a thickened margin and a faintly reticulate surface.

Occurrence.—Stream bank below the crossing of the Zapayari-El Plan Road, about 1½ kilometers south of Rio Grande, District of Bolivar, State of Zulia.

Order GERANIALES

Family TRIGONIACEAE

Genus TRIGONIA Aublet

TRIGONIA VARIANS Engelhardt

FIGURE 30, *a*, *b*

Trigonía varians ENGELHARDT, Abh. Senck. Naturf. Ges. vol. 19, p. 35, pl. 7, figs. 4-6; pl. 9, fig. 9, 1895.—?BERRY, Proc. U. S. Nat. Mus., vol. 55, p. 290, 1919; vol. 59, p. 575, pl. 107, fig. 8, 1921.

This species was described by Engelhardt from several different-sized specimens collected from tuffs near Santa Ana in the Magdalena Valley, Colombia. Rather poor material from the lower Miocene of northern Peru was tentatively identified as this species by me in 1919.

Leaves of variable size, ovate to obovate in general outline. Apex and base usually about equally pointed; sometimes apex is acuminate. Margins entire, slightly undulate. Texture subcoriaceous. Length 6 to 13 cm. Maximum width, at or slightly above middle, 3 to 5.25 cm. A maximum-sized specimen from Betijoque is shown in figure 30. Petiole stout, its length unknown. Mid vein stout, prominent on under surface of leaf, usually curved. Secondaries stout, prominent on under surface: 9 to 12 opposite to alternate pairs diverge from mid vein at fairly regular intervals and at angles of 55° or less, ascending subparallelly, becoming camptodrome in marginal region. Tertiaries thin but well marked on under side of leaf, consisting of rather closely spaced percurrent nervilles, which may be all that can be made out if the preservation is not good; these are connected by anastomosis, so that their course is usually not straight, the whole forming a relatively open, isodiametric areolation.

The genus *Trigonía*, not otherwise known in the fossil state, comprises about 30 existing species of reclined or climbing shrubs, which

are confined to the region between Central America and southern Brazil.

Occurrence.—Palmarejo, District of Mara; La Victoria-Catanaja Road about 2½ kilometers north of La Victoria, District of Miranda, State of Zulia; El Mene, District of Acosta, State of Falcon (doubtful material); Betijoque, near La Salvadora, District of Betijoque, State of Trujillo. U.S.N.M. nos. 39301, 39302.

Order SAPINDALES

Family ANACARDIACEAE

Genus TAPIRIRA Aublet

TAPIRIRA LANCEOLATA Engelhardt

FIGURE 30, *c, f*

Tapirira lanceolata ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, p. 15, pl. 9, fig. 4, 1895.—BERRY, Proc. U. S. Nat. Mus., vol. 55, p. 291, pl. 15, fig. 1, 1919.

The specimens from Palmarejo are slightly smaller and more acuminate than the type, but it is legitimate to expect such slight variations in size and form in the leaflets of pinnate leaves. The general form and venation are identical.

The species was described by Engelhardt from the inter-Andean basin of Loja in Ecuador and recorded by me from the Zorritos formation (lower Miocene) of the north Peruvian oilfield. It is also represented in collections from the De Mares Concession in Colombia.

Occurrence.—Palmarejo, District of Mara; Zapayari-El Plan Road 1½ kilometers south of Rio Grande, District of Bolivar, State of Zulia; El Mene, District of Acosta, State of Falcon. U.S.N.M. no. 39303.

TAPIRIRA TRINITIANA Berry

FIGURE 30, *d*

Tapirira trinitiana BERRY, Johns Hopkins Univ. Studies in Geol., no. 6, p. 163, pl. 14, fig. 4, 1925.

This species was described from the Forest sand of Trinidad, British West Indies. The genus is shrubby or arborescent, with not more than six or eight existing species confined to tropical South America. Miocene or Pliocene species have been recorded from Colombia, Ecuador, and Peru.

Occurrence.—La Victoria-Catanaja Road, about 2½ kilometers north of La Victoria, District of Miranda, State of Zulia. U.S.N.M. no. 39304.



FIGURE 30.—*a, b*, *Trigonía varians* Engelhardt (*a*, La Victoria; *b*, Palmarejo); *c*, *Hernandia tongi*, new species (2½ kilometers north of La Victoria); *d*, *Tapirira trinitiana* Berry (2½ kilometers north of La Victoria); *e, f*, *Tapirira lanceolata* Engelhardt (Palmarejo). All about three-fourths natural size.

Order LAURALES

Family HERNANDIACEAE

Genus *HERNANDIA* Linnaeus*HERNANDIA TONGI*, new species

FIGURE 30, c

Leaves of medium to small size for this genus, ovate in outline, with a broadly rounded base and an acuminate tip. Margins entire. Texture subcoriaceous. Length 10.5 to 17 cm. Maximum width, at or below middle, 4.5 to 9 cm. Petiole not preserved. Mid vein stout and prominent on under side of leaf. Lateral primaries one on each side, opposite, stout, and prominent, diverging from mid vein at acute angles at a greater or less distance above its base, ascending and dying out subparallel to lateral margins one-half to two-thirds distance to tip. Secondaries mediumly stout, alternate to subopposite, three to five pairs, diverging from mid vein at angles of 45° or less, ascending in regular sweeping curves, camptodrome.

From outer side of lateral primaries there are numerous stout, regularly and closely spaced, camptodrome secondaries, which diverge at acute angles and are subparallel. Tertiaries well marked, comprising closely spaced and mostly simple veins at right angles to primaries and secondaries.

This is a type of Tertiary leaf that has frequently been referred to the genus *Ficus*, as in the case of the *F. mississippiensis* group of the Eocene in the United States,⁵ but that probably is not related to *Ficus*. It is also very similar to the leaves of entire Sterculias. Several of these may profitably be compared with the modern species of *Hernandia*.

This species is present in the Miocene of the De Mares Concession in the Magdalena Valley, Department of Santander, Colombia.

Occurrence.—La Victoria-Catanaja Road, about 2½ kilometers north of La Victoria, District of Miranda; Zapayari-El Plan Road, 1½ kilometers south of Rio Grande, District of Bolivar, State of Zulia.

Type.—U.S.N.M. no. 39305.

Family LAURACEAE

Genus *NECTANDRA* Roland*NECTANDRA AREOLATA* Engelhardt

Nectandra areolata ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, p. 29, pl. 6, figs. 1, 2, 1895.—BERRY, Proc. U. S. Nat. Mus., vol. 59, p. 177, pl. 27, 1921; vol. 62, art. 19, p. 19, pl. 4, fig. 3, 1923; vol. 75, art. 24, p. 9, 1929.

⁵ See Berry, E. W., U. S. Geol. Surv. Prof. Paper 131, pp. 9-12, 1922.

This rather large and coarse form was described originally from Santa Ana, Colombia, and has since been recorded from Leiva, Colombia; Oaxaca, Mexico; and Costa Rica.

Occurrence.—Palmarejo, District of Mara; Zapayari—El Plan Road, about 1½ kilometers south of Rio Grande (a doubtful specimen), District of Bolivar, State of Zulia.

Genus PERSEA Gaertner fils

PERSEA CORIACEA Engelhardt

Persea coriacea ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, p. 26, pl. 6, figs. 3, 4, 1895.—BERRY, Proc. U. S. Nat. Mus., vol. 75, art. 24, p. 9, pl. 5, fig. 3, 1929.

Another large and coarse lauraceous leaf, distinguished with difficulty from *Nectandra arcolata*. It was described originally from Santa Ana, Colombia, and has since been recorded from Leiva and the De Mares Concession of that country.

Occurrence.—El Mene, District of Acosta, State of Falcon.

PERSEA species

Similar to *P. coriacea* from El Mene in Venezuela and from Santa Ana and Leiva, Colombia, but somewhat less coarse, with more numerous secondaries.

Occurrence.—Palmarejo, District of Mara; La Victoria—Catanaja Road, about 2½ kilometers north of La Victoria, District of Miranda, State of Zulia.

Order MYRTALES

Family COMBRETACEAE

Genus COMBRETUM Linnaeus

COMBRETUM STEPHENSONI, new species

FIGURE 31, *d*

Leaves broadly elliptical or elliptical-ovate. Tip rounded. Base broadly cuneate to rounded. Margins entire. Texture coriaceous. Length about 11 cm. Maximum width about 6.5 cm. Petiole missing. Mid vein mediumly stout, channeled on upper surface, prominent on lower surface. Secondaries mediumly stout, numerous, mostly alternate, somewhat irregularly spaced; they diverge from mid vein at wide angles, are regularly curved and subparallel, and are camptodrome in marginal region. Tertiaries mostly percurrent, especially over short distances, mostly immersed in the leaf substance.

This species is represented by a considerable quantity of material, but all is in a much broken condition. It is, of course, hazardous to base species on limited material, since the leaves of existing species are inclined to variability, and in the only fossil species of which I have seen a large quantity of good material, i. e., *Combretum petraflumensis* Berry⁶ from the middle Eocene of the Mississippi embayment, the leaves are extraordinarily variable. There is, however, a generic facies not easily mistaken. Leaves of this type are not uncommon from the Eocene onward; indeed they are foreshadowed during the Upper Cretaceous. Among previously described forms the present species is much like *C. incertum* Berry⁷ from the Miocene porcellanite of Siparia, Trinidad, British West Indies.

The genus contains about 150 existing tropical and often coastal species, at least a third of which are natives of South America.

Occurrence.—La Victoria-Catanaja Road, about 2½ kilometers north of La Victoria, and 3½ kilometers south of La Victoria, one-half kilometer southwest of El Rudal ranch, District of Miranda, State of Zulia.

Type.—U.S.N.M. no. 39306.

Order EBENALES

Family STYRACACEAE

Genus STYRAX Linnaeus

STYRAX LANCEOLATA Engelhardt

Styrax lanceolata ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, p. 32, pl. 5, fig. 9, 1895.

This small leaf was described by Engelhardt from Santa Ana, Colombia, and has not been detected elsewhere until now.

Occurrence.—El Mene, District of Acosta, State of Falcon.

Family SAPOTACEAE

Genus ACHRAS Linnaeus

ACHRAS CALCICOLAFOLIA, new species

FIGURE 31, a

Leaves large, oblong, widest medianly and tapering about equally distad and proximad. Apex and base shortly obtusely pointed. Margins entire, full and evenly rounded. Texture coriaceous. Length about 20 cm. Maximum width about 7.5 cm. Petiole missing.

⁶Berry, E. W., U. S. Geol. Surv. Prof. Paper 92, p. 85, pls. 45, 58, 59, 1924.

⁷Berry, E. W., Johns Hopkins Univ. Studies in Geol., no. 6, p. 117, pl. 8, fig. 2, 1925.

Mid vein stout, channeled on upper surface, prominent on lower surface. Secondaries thin, immersed in the leaf substance; they are numerous and subparallel, diverging from the mid vein at angles of 70° to 80°, pursuing almost straight courses, and are abruptly camptodrome within the margins. Tertiary venation obsolete.

Leaves of this sort are represented in many families, notably in the Moraceae and Apocynaceae and by such genera as *Ficus*, *Allamanda*, and *Plumeria*. After extended comparisons with recent material I find the fossil leaves to be most like the leaves of *Achras*, especially *A. chicle* Pittier of Guatemala and *A. calcicola* Pittier of the rain forest of Panama. These two are much closer than the leaves of South American species of *Achras* that I have seen.

Occurrence.—La Victoria—Catanaja Road, about 2½ kilometers north of La Victoria, District of Miranda, State of Zulia.

Type.—U.S.N.M. no. 39307.

Order GENTIALALES

Family APOCYNACEAE

Genus APOCYNOPHYLLUM Unger

APOCYNOPHYLLUM SALVADORENSIS Berry

Apocynophyllum salvadorensis BERRY, Proc. U. S. Nat. Mus., vol. 59, p. 579, pl. 107, fig. 6, 1921.

This species was based upon three specimens collected by C. F. Bowen in 1919 from the sandy clays 2½ miles northwest of La Salvadora, Venezuela. It was described as follows:

Leaves linear-lanceolate in outline, about 13 cm in length and 2.4 cm in maximum width, with a somewhat narrowed rounded base. Apex missing, so that the total length as given may be slightly overestimated. Margins entire, even. Petiole missing. Mid rib thin on upper surface of leaf, stout and prominent on lower surface. Secondaries numerous, thin, regularly spaced, subparallel, and camptodrome.

This species is of a somewhat uncertain botanical affinity, since it exhibits no conclusive diagnostic characters. It approaches nearest to the various fossil species that have been referred to the form genus *Apocynophyllum* and that suggest various existing tropical genera of the family Apocynaceae, such as *Plumeria*, *Prestonia*, and *Thevetia*. This same species is contained in later collections from Venezuela.

Occurrence.—Palmarejo, District of Mara, State of Zulia; El Mene, District of Acosta, State of Falcon; near La Salvadora, State of Trujillo.

Order PERSONALES

Family BIGNONIACEAE

Genus PLEONOTOMA Miers

PLEONOTOMA MIOCENICA, new species

FIGURE 31, b

Leaflets small, subelliptical, slightly inequilateral, about equally narrowed and rounded at both ends. Margins entire. Texture subcoriaceous. Length about 4.5 cm. Maximum width about 1.8 cm. Apparently sessile. Mid vein stout, prominent, curved. Secondaries stout, prominent, four or five pairs, irregularly spaced, ascending, camptodrome, connected by mostly simple transverse tertiaries.

This species appears to represent the genus *Pleonotoma*, not hitherto known as a fossil. The genus contains six or eight recent species of climbing shrubs in the region between the Caribbean and southern Brazil. Among these, *P. jasminifolium* (H. B. K.) Miers of the Venezuelan region appears to be most like the fossil. There is also considerable similarity to the Brazilian species *P. tetraquetrum*, the *Bignonia triphylla* of Miers. The first is bipinnate and the second trifoliate in habit.

Occurrence.—Betijoque, District of Betijoque, State of Trujillo.

Type.—U.S.N.M. no. 39308.

Genus BIGNONIA Linnaeus

BIGNONIA ZULIANA, new species

FIGURE 31, c

Leaflets petiolate, ovate, medium sized, widest medianly, sharply pointed but not extended distad, pointed and slightly decurrent proximad. Margins entire. Texture subcoriaceous. Length about 11.25 cm. Maximum width about 5.25 cm. Petiole mostly missing. Mid vein stout, prominent, slightly curved. Lateral primaries one on each side, suprabasilar, stout, diverging at acute angles and terminating camptodromely in upper half of leaflet. There are three or four regularly curved, prominent, camptodrome secondaries in upper half of leaflet. Tertiaries thin but well marked, numerous, and camptodrome within the margins, transverse, simple, and curved or sometimes inosculating. Ultimate areolation indistinct.

This species, which suggests comparisons with certain lauraceous forms, agrees more closely with various existing species of the large tropical genus *Bignonia* and is approximated by existing forms from various parts of South America. Among those seen the follow-

ing are the most similar: *B. barbinervis*, *B. eximia*, and *B. cujabamba*.

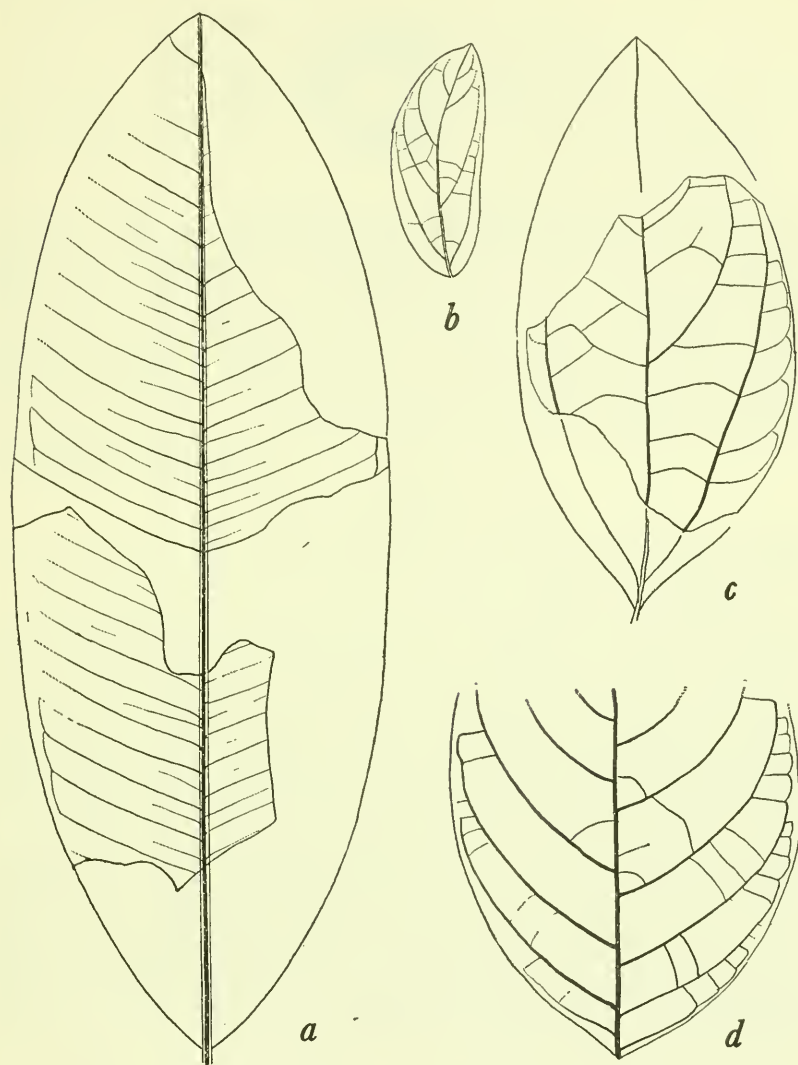


FIGURE 31.—*a*, *Achras calcicolafolia*, new species (2½ kilometers north of La Victoria); *b*, *Plconotoma mioccnica*, new species (Betijoque); *c*, *Bignonia zuliana*, new species (2½ kilometers north of La Victoria); *d*, *Combrctum stephensoni*, new species (2½ kilometers north of La Victoria). All about three-fourths natural size.

Occurrence.—La Victoria—Catanaja Road, 2½ kilometers north of La Victoria, District of Miranda, State of Zulia.

Type.—U.S.N.M. no. 39309.

Order RUBIALES

Family RUBIACEAE

Genus CONDAMINEA De Candolle

CONDAMINEA (?) GRANDIFOLIA Engelhardt

Condaminea grandifolia ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, p. 34, pl. 7, fig. 2; pl. 9, fig. 1, 1895.—BERRY, Proc. U. S. Nat. Mus., vol. 55, p. 293, pl. 17, 1919.

Fragments of a large leaf with the characteristic venation of this species occur at Palmarejo. I have no doubt that they represent the same species, which was described by Engelhardt from Santa Ana, Colombia, and which is abundant in the Zorritos formation (lower Miocene) of the north Peruvian oilfield. As I have previously stated (op. cit., p. 294), I much doubt their reference to this genus.

Occurrence.—Palmarejo, State of Zulia.

Genus SABICEA Aublet

SABICEA ASPERIFOLIA Engelhardt

Sabicea asperifolia ENGELHARDT, Abh. Senck. Naturf. Ges., vol. 19, p. 40, pl. 5, fig. 6; pl. 8, fig. 6, 1895.

This species was described by Engelhardt from the Tertiary of the Cauca Valley, Colombia. It is abundantly represented by leaves of various sizes in a somewhat fragmentary condition in the clays at Betijoque. The narrower forms are superficially like *Apocynophyllum salvadorensis* Berry from the Miocene of La Salvadora, Venezuela, but the leaves are less oblong and more ovate, the secondaries are less regular and stouter, the tertiaries are much more prominent, the areolation differs, and the base is more cuneate.

S. asperifolia is also something like *Tapiriva lanceolata* Engelhardt of the family Anacardiaceae, described from the Tertiary of Loja, Ecuador, and recorded from the Miocene of Peru (see p. 352). It is also much like the existing *S. aspera*, which resemblance has suggested the name of the fossil species.