MIOCENE FOSSIL PLANTS FROM NORTHERN PERU.

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INTRODUCTION.

The present brief paper is based upon a small collection of fossil plants recently received in exchange from the Boston Society of Natural History through the courtesy of Dr. Joseph A. Cushman, and presented by me to the United States National Museum. This collection was made by C. F. Winslow early in the year 1875, and in an interesting letter dated the 3d of March of that year he states that it was made from a clay lens overlying a bed of lignite in the petroleum-bearing sands about 20 miles south of the town and river of Tumbez, and 200 or 300 feet inland from the shore of the Pacific.

In spite of the lack of geological work or satisfactorily accurate maps of this region it is fortunately possible to locate this plant bearing outcrop with sufficient precision to show that it is very near to, if not identical with, the locality from which the described section quoted on a subsequent page was made. The foliage of a luxuriantly wooded region was evidently accumulated in shallow pools, possibly continental, but more probably lagoonal in character, which seasonally, if not for longer intervals, received only very fine muddy sediments. The leaves are consequently in matted layers, with only thin films of mud between them, and hence no one except an experienced collector could be expected to obtain satisfactory material for study.

While the collection described in the following pages leaves much to be desired from the point of view of the correct botanical determination of the species, Mr. Winslow deserves great credit for his interest and for the enterprise with which he succeeded in preserving this material and thus bringing to light this page of geological history, and I can only hope that he is still alive and may see this belated appreciation of his efforts of over 40 years ago.

From the standpoint of the systematic botanist the present study is far from satisfactory, and the difficulty of identifying such fragmentary material has led me to accept the determinations of previous workers on the paleobotany of South America without attempting to revise their generic references, although I am fully conscious that some at least of these are faulty.

The principal interest in the present paper must be the decisive evidence which it furnishes of the very different climatic conditions formerly existing in this desert region and the rather far-reaching correlations which it is possible to make—results which in both cases are not at all dependent on the correct botanical determination of the species. Before discussing these results it would be profitable to consider briefly the present climatic and physiographic features of this section of Peru. Physiographically Peru may be divided into three well-defined longitudinal regions: (1) The Coast region of sandy arid desert or semidesert, crossed by rivers in narrow, more or less fertile valleys according to the water supply; (2) the Sierra or Andean region, which I need not stop to characterize; and (3) the Montaña, or region of tropical forests of the Amazon basin.

In northern Peru the Piura desert extends along the coast from the Gulf of Guayaquil southward to the Morrope Valley, a distance of about 200 miles. It is traversed by three rivers—the Tumbez, Chira, and Piura—the first two having their sources in the inner Cordilleras and hence not dry part of the time. The climate is less arid than farther south, fogs and garuas are more frequent, and at intervals of several years there are occasional heavy showers. The country is practically treeless. The valleys contain chaparral of *Prosopis*, and along the river banks willows and groups of palms; and the irrigated cultivation of cotton, cane, corn, alfalfa, and vineyards is possible where the streams are of sufficient size and not intermittent.

I might add that the entire sea border of Peru is a semidesert, Arica dividing the true rainless desert country of Chile from the sterile country extending northward from Arica (latitude 18° 30′) to north of Tumbez (latitude 3° 20′), which, though normally rainless, as just stated, receives the benefit of the drizzly garuas and sea fogs which are reflected in the less pronounced desert character of this northern country.

Beginning with John Ball[1] the flora of the Coastal zone of western South America has been discussed by von Eggers[2], Wolff[3], and Guppy[4]. The Strand is characterized as the Sesuvium zone, replaced some distance north of Tumbez by the Mangrove zone of the Gulf of Guayaquil.

The region immediately behind the beach from Tumbez southward is a typical desert or semidesert, consisting of sand-covered barren hill slopes with shifting dunes (mendanos) and varied only in the transverse valleys by vegetation more fitting to the latitude. About 25 or 30 miles northeast of Tumbez there is a remarkably sudden

[1] Ball, J., Notes of a Naturalist in South America, London, 1887.
[2] Eggers, H. von, Das Küstengebiet von Ecuador. Deutsche Geogr. Blätter, vol. 17, Heft 4, 1894.
[3] Wolff, T., Geografía y Geologia del Ecuador, 1892.
[4] Guppy, H. B., A Naturalist in the Pacific, vol. 2, pp. 474–501, 1906.

change in the coastal flora. At Puerto Bolivar, in the Ecuadorian Province of Eloro, the mangrove belt extends inland from the beach for about 2 miles. The "mangle chico" fronts the sea and passes gradually into the "mangle grande," where the Rhizophores are 70 or 80 feet tall and draped with *Tillandsia*. In the rear of the zone of tall mangrove the swamp becomes more open, with small trees of *Rhizophora*, *Laguncularia*, and *Avicennia*, and scattered areas of the shrubby *Salicornia peruviana*. At about 2 miles from the sea the swamp passes over into a region of naked, sun-caked, and salt-incrusted mud flats traversed by salt-water creeks bordered by low shrubby *Rhizophora*, *Avicennia*, and *Salicornia*. These mud flats, submerged only by the spring tides, form a belt here somewhat over a mile in width, and pass gradually into the sandy arid saliferous Machala plains with cacti, *Prosopis*, and scattered thorny shrubs and dwarfed trees.

A good account of the estuary flora of the Santa Rosa River near Puerto Bolivar is given by Guppy.[1] From this point northward to the head of the Gulf of Guayaquil the vegetation passes by degrees into the normal tropical estuary flora. Villavicencio, Wolff, Webster, Guppy, and others believe that the costal region is still becoming progressively more sterile, and since Darwin's day we have had evidence of coral masses and elevated shell beds pointing to a former lower level of the land and, presumably to be correlated with this, a more humid climate. Suess suggested[2] that this might be due to the formation of the Isthmus of Panama and the appearance of the Humboldt current. Since, however, the waters of the Atlantic and the Pacific have freely mingled at many times during geologic history, and as we as yet know comparatively little of the Tertiary history of South America, it is not possible to discuss these interesting problems with profit.

Aside from the description of a few species of Tertiary marine fossils by d'Orbigny,[3] Nelson,[4] and Gabb,[5] the general work of Raimondi,[6] and incidental references in Darwin's Voyage of the *Beagle*,[7] the only detailed account of the geology of any locality in this part of Peru is based on a reconnoissance of Josef Grzybowski, of Cracow, who spent a week around Tumbez and Paita in 1898 and who sub-

[1] A Naturalist in the Pacific.

[2] Das Antlitz der Erde, vol. 2, p. 825.

[3] d'Orbigny, A., Palćontologie due Voyage l'Amerique méridionale, Paris, 1842.

[4] Nelson, E. T., On the Molluscan fauna of the later Tertiary of Peru. Trans. Conn. Acad., vol. 2, pt. 1, 1870.

[5] Gabb, W. M., Description of a collection of fossils, made by Dr. Antonio Raimondi in Peru, Journ. Acad. Nat. Sci., Phila., ser. 2, vol. 8, pp. 263–336, pls. 35–43, 1877

[6] Raimondi, A., El Perú, vol. 4, Estudlós mineralógicos, Lima, 1902.

[7] Although devoted to the region farther south, the recently published work by Bowman on The Andes of Southern Peru (Amer. Geogr. Soc., 1916) gives an admirable discussion of the broader aspects of the physiographic history and climatic features of the Peruvian region.

which is either uppermost Aquitanian or Burdigalian, and since one of the associated Mollusca is common to the Bowden beds of Jamaica, which are unquestionably of Burdigalian age, and others of the Mollusca are closely related to lower Miocene forms from Trinidad or from Chile, I am disposed to consider this Peruvian fossil flora as Burdigalian in age, and I would extend this correlation to the Navidad beds of Chile except for the reason that the latter beds appear to represent more than a single horizon, although they are in part of this age, and in part probably represent older Tertiary horizons.

I hope to publish an analysis of all of the South American Tertiary floras in the near future, and will only say at this time that the flora found in the Loja coal basin in the Ecuadorian Andes is also of Burdigalian age.

FOSSIL FLORA FROM PERU.

MONOCOTYLEDONAE:

Arecales-Arecaceae—

Iriartites tumbezensis Berry.

Arales-Araceae—

Stenospermation columbiense Engelhardt (?).

Poales-Poaceae—

Bambusium stübeli Engelhardt (?).

DICOTYLEDONAE:

Urticales-Moraceae—

Ficus winslowiana Berry.

Ranales-Anonaceae—

Anona winslowiana Berry.

Guatteria culebrensis Berry.

Geraniales-Malpighiaceae—

Banisteria incerta Berry.

Trigoniaceae.

Trigonia varians Engelhardt (?).

Vochysiaceae.

Vochysia retusifolia Engelhardt (?).

Sapindales-Anacardiaceae—

Tapirira lanceolata Engelhardt.

Thymeleales-Lauraceae—

Mespilodaphne tumbezensis Berry.

Persea macrophylloides Engelhardt (?).

Ebenales-Styracaceae—

Styrax lanceolata Engelhardt (?).

Rubiales-Rubiaceae—

Condaminea grandifolia Engelhardt.

Class MONOCOTYLEDONAE.

Order ARECALES.

Family ARECACEAE.

IRIARTITES, new genus.

This genus is proposed as a convenient-form genus for the remains of fossil palms that appear to belong to the tribe Iriarteae, but whose exact generic identity is uncertain.

Type of the genus.—*Iriartites tumbezensis*, new species.

IRIARTITES TUMBEZENSIS, new species.

Plate 14.

Description.—Feather palms with leaves of large size, the exact dimensions unknown. The fossil material shows much crowded linear-lanceolate rays attached to the upper surface of a stout prominently keeled rachis. The rays are slightly, if at all, narrowed at the base, and have a maximum width in the preserved material of 1.5 cm. Their estimated length is about 30 cm., although it may have been more than this, since no lengths of single rays have been preserved for a greater distance than 15 cm. In the latter, however, no diminution of width is shown in that distance. The rays have entire margins and a keeled and fairly stout midrib. There are about 25 fine, largely immersed, parallel laterals on either side of the midrib, three or four of which, equally spaced, are somewhat thicker than the intervening ones. The texture of the leaf is coriaceous.

No remains of fossil palm leaves exactly like these have heretofore been described. They are exceedingly abundant in the present collection, the clays being packed with broken fragments of rays, and the number of pieces of clay as large as one's hand that are covered with regularly arranged rays indicates that the greater part of leaves several feet in length were preserved and broken up in collecting them. The largest complete fragment that remains is shown on plate 14, two-thirds natural size.

Among existing palms the fossil is most naturally to be compared with the various members of the tribes Geonomiae, Iriarteae, Morenieae, and Bactrideae, and of these I regard the Iriarteae and Morenieae, especially the former, as offering the most likely comparisons. As elaborated by Drude, the Iriarteae comprise five genera and 25 or more species, whose center of maximum development is the upper Amazon region and the Andean valleys in Colombia and Ecuador. Species of Iriartea extend northward to Costa Rica and southward east of the Andes to Bolivia and throughout the Orinoco and Amazon basins. The other existing genera of this tribe, except

the genus *Juania* of the Island of Juan Fernandez, are more particularly confined to the Colombian and Ecuadorian Andean valleys and the region of the headwaters of the Amazon.

Engelhardt[1] has described some fragments of a feather palm from beds in the Cauca Valley in Colombia that I regard as of approximately the same age as the Tumbez deposits as *Palmacites*, but these are so fragmentary that adequate comparisons with them are impossible.

Holotype.—Cat. No. 35329, U.S.N.M.

Order ARALES.

Family ARACEAE.

Subfamily MONSTEROIDEAE.

Genus STENOSPERMATION Schott.

STENOSPERMATION COLUMBIENSE, Engelhardt(?)

Stenospermation columbiense ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 26, pl. 5, fig. 2, 1895.

This species was based upon rather characteristic fragments of large, elliptical-lanceolate, leathery leaves with a very stout midrib and petiole and with a typical araceous venation. These were compared by Engelhardt with the leaves of the existing Peruvian species *Stenospermation matthewsii* Schott and S. *pompayense* Schott. as well as with the leaves in the genus *Aspidistra*.

The material from the locality south of Tumbez is less complete than the type material which came from Santa Ana, on the western margin of the Rio Magdalena Valley in Colombia, hence the Peruvian occurrence is queried, although in so far as the material goes it is identical with the type.

The genus *Stenospermation*, not otherwise known in the fossil state, comprises four or five existing species of the humid regions in the sub-Andean Tropics. It is closely related to the genus *Monstera*, whose pinnately divided leaves are familiar in our greenhouses.

Order POALES.

Family POACEAE.

Genus BAMBUSIUM Unger.

BAMBUSIUM STÜBELI, Engelhardt(?)

Bambusium stübeli ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 24, pl. 5, figs. 4, 5, 1895.

This species was based upon stems of a large grass of uncertain generic identity, described by Engelhardt from the Santa Ana lo-

[1] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 19, p. 40, pl. 4, fig. 8, 1895.

cality in Colombia. It is of slight value, and the similar but more fragmentary remains found at the locality south of Tumbez may or may not represent the same species.

Class DICOTYLEDONAE.

Order URTICALES.

Family MORACEAE.

Genus FICUS Linnaeus.

FICUS WINSLOWIANA, new species.

Plate 16, fig. 2.

Description.—Leaves of medium size, ovate in general outline, with a bluntly pointed apex and base. Length about 10 cm. Maximum width, in the lower half of the leaf, about 4.5 cm. Margins entire, evenly rounded. Texture subcoriaceous. Petiole missing. Midrib stout, prominent on the lower surface of the leaf. Secondaries thin, immersed in the leaf substance; about 9 alternate pairs diverge from the midrib at angles of 45 degrees or more, becoming less ascending toward the apex of the leaf. The secondaries are thin, almost straight, subparallel and subequally spaced. Their tips are joined by an acrodrome vein well within the margin of each side of the lamina. This vein arches slightly from tip to tip of the successive secondaries. The tertiaries are mostly obsolete; where preserved, they are thin, closely spaced, and percurrent.

This species is named in honor of the collector, Mr. C. F. Winslow. It appears to be new, although it is similar to many existing and fossil species of *Ficus*. It shows considerable resemblance to undescribed forms found in the middle and upper Eocene of the southeastern United States, but appears to be perfectly distinct from any fossil forms known from the Tertiary of Panama, Colombia, Ecuador, or Chile.

Several hundred existing species of *Ficus*, showing a wide range of form, are known, and they are especially abundant in the Amazon and the Orinoco basins and throughout the oriental tropics. The number of fossil forms that have been referred to this genus is large, including perhaps 300 species. None are certainly known from the Lower Cretaceous. In the Upper Cretaceous, however, *Ficus* is widespread and abundant, being represented by characteristic fruits as well as leaves, which seemingly indicate a Lower Cretaceous ancestry that is as yet unknown. The cosmopolitanism inaugurated during the Upper Cretaceous continues throughout the Tertiary, during which time there were many species.

Holotype.—Cat. No. 35337, U.S.N.M.

Order RANALES.

Family ANONACEAE.

Genus GUATTERIA Ruiz and Pavon.

GUATTERIA CULEBRENSIS Berry.

Plate 16, fig. 3.

Guatteria culebrensis Berry, U. S. Nat. Mus. Bull. 103, p. 27, pl. 13, fig. 2, 1918.

Description.—Leaves of large size, broadly ovate in general outline, with a narrowed slightly decurrent base and a narrowed and extended acuminate tip. Length about 20 cm. Maximum width, approximately midway between the apex and the base, between 6 cm. and 7 cm. Margins entire. Texture coriaceous. Petiole short and stout, enlarged proximad, about 2.25 cm. in length. Midrib stout and prominent. Secondaries mediumly stout and prominent; about ten opposite to alternate pairs diverge from the midrib at angles ranging from 45 to 60 degrees, sweeping upward in regular ascending subparallel curves and camptodrome in the marginal region. Tertiaries, where visible, percurrent.

This is one of the more abundant and better preserved forms in the Panama Canal Zone occurring in formations that are referred to the Aquitanian and Burdigalian stages by Invertebrate paleontologists. The large size of the leaves usually results in fragmentary specimens, the tip being almost invariably missing. The material from Peru is more broken than that from Panama but there can be little doubt of the identity of the two occurrences.

The present species shows similarities with various existing species of Anonaceae. It is much like *Anona macgravii* Martius of Brazil (Bahia and Pernambuco), Venezuela, French and Dutch Guiana. It is, however, among the various existing species of *Guatteria* that the closest homologies are to be seen. The latter genus contains about fifty existing species of shrubs and trees, exclusively American,[1] and found in Mexico, Central America, tropical South America, and in the northern Andes. The fossil may be compared with a number of the still existing species as, for example, *Guatteria ouregon* Dunal, a large Caribbean tree, and equatorial South American *Guatteria dolichopoda* De Candolle or *Guatteria grandiflora* De Candolle of Central America.

Plesiotype.—Cat. No. 35335, U.S.N.M.

Genus ANONA Linnaeus.

ANONA WINSLOWIANA, new species.

Plate 15, fig. 4.

Description.—Leaves broadly elliptical in outline, with possibly an obtusely pointed apex. Base broadly rounded. Margins entire.

[1] The Asiatic species of authors are referred to the allied genus *Polyalthia.*

Texture subcoriaceous. Length about 11.5 cm. Maximum width, midway between the apex and the base, about 6.25 cm. Petiole missing. Midrib very stout, prominent on the under surface of the leaf. Secondaries about eight subopposite pairs, stout, prominent, diverging from the midrib at subequal intervals, and wide angles approaching 90 degrees: they curve regularly upward in a subparallel manner and are camptodrome in the marginal region. Tertiaries obsolete.

This is a well marked leaf of a new species of *Anona* much like those found in the lower Eocene (Wilcox group) of southeastern North America, and somewhat similar to the upper Eocene *Anona texana* Berry[1] from the Fayette sandstone of Texas. It is still more similar to two species of *Anona* that have been described by Engelhardt[2] from the Navidad beds (Coronel) of Chile.

The geological history of the genus *Anona* has been reviewed recently[3] and need not be repeated in the present connection. The living species of *Anona* number about 75 forms and they are confined almost exclusively to tropical and subtropical America, although a few species are endemic in tropical Africa. Many of these have leaves almost indistinguishable from those of the present fossil species, although without more complete material of the recent species a detailed comparison is not worth much in the present connection. The bulk of the existing species occur in the northern half of South America, and there are several that are common along the Guayaquil River and in the rain forest country of eastern Peru.

Holotype.—Cat. No. 35330, U.S.N.M.

Order GERANIALES.

Family MALPIGHIACEAE.

Genus BANISTERIA Linnaeus.

BANISTERIA INCERTA, new species.

Plate 16, fig. 1.

Description.—Leaves oval or subelliptical in general form, widest in the middle, with a broadly rounded base and a more narrowly rounded tip. Length between 7 cm. and 8 cm. Maximum width about 5 cm. Margins entire, slightly undulate. Texture subcoriaceous. Petiole missing. Midrib stout, prominent, curved. Secondaries stout, fairly evenly spaced, all but the basal pair alternate; five or six pairs diverge from the midrib at wide angles, curve regularly upward in a subparallel manner and are camptodrome in the marginal region. Tertiaries obsolete.

[1] Berry, E. W., U. S. Geol. Surv. Prof. Paper 98M, p. 239, pl. 60, fig. 9, 1916.

[2] Englehardt, H., Abh. Senck. Naturf. Gesell., vol. 16, Heft 4, p. 663, pl. 7, figs. 2, 3, 11, 1891.

[3] Berry, E. W., U. S. Geol. Surv. Prof. Paper 91, p. 90, 1916.

This species suggests at first sight some short and broad leaved species of *Ficus*, but the venation is not that of *Ficus*. I am not at all certain that these leaves represent *Banisteria*, although they are very close to a number of existing South American species of that genus, as well as in the allied genus *Tetrapteris*. In addition to this foliar similarity I have been influenced by the presence of undoubted fruits of *Banisteria* in the synchronous and not very distant deposits at Loja in Ecuador.[1] It might be remarked that some of the Bignoniaceae have leaves of this sort as, for example, *Bignonia* and *Fridericia*.

The genus *Banisteria* contains over 70 existing species of climbing or scrambling shrubs, ranging from the Antilles throughout tropical South America and reaching their maximum of development in the rain forests of the Amazon Basin. At least two of the species, *Banisteria populifolia* and *B. caduciflora* are found in the Andean region of Peru,[2] where they inhabit humid valleys below 3,300 feet in elevation. The genus is represented by both leaves and fruits in the fossil state, and it was not uncommon in Europe and southeastern North America during the Tertiary.

Holotype.—Cat. No. 35333, U.S.N.M.

Family TRIGONIACEAE.

Genus TRIGONIA Aublet.

TRIGONIA VARIANS Engelhardt?

Trigonia varians ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 35, pl. 7, figs. 4–6; pl. 9, fig. 9, 1894.

This species was based on fairly complete material, not uncommon at the Santa Ana locality in Colombia, which Engelhardt compared with the existing species, *Trigonia pubescens*, *T. glazioviana*, *T. boliviana*, and *T. mollis*. Fragmentary and not certainly identical remains are contained in the collections from south of Tumbez.

The generic identity of these forms is doubtful, and they suggest the genus *Myristica* to me rather than *Trigonia*. The latter genus has between 25 and 30 existing species, mostly shrubs, and, like the family to which they belong, confined to the equatorial region from Central America to southern Brazil.

Family VOCHYSIACEAE.

Genus VOCHYSIA Jussieu.

VOCHYSIA RETUSIFOLIA Engelhardt?

Vochysia retusifolia ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 34, pl. 7, fig. 3, 1895.

This species was based upon incomplete material from near Santa Ana, in Colombia. The Peruvian material is still more fragmentary,

[1] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 19, p. 14, pl. 2, figs. 18, 19, 1895.
[2] Weberbauer, A., Die Pflanzenwelt der peruanischen Anden, 1911, pp. 155, 282.

but exhibits a characteristic venation exactly like that of the type. Its reference to the genus *Vochysia* is questionable.

The family Vochysiaceae, like its principal genus, *Vochysia*, is confined to tropical America. *Vochysia* comprises about three score existing species of trees, shrubs, or rarely herbs, with coriaceous leaves, chiefly Brazilian and largely rain forest types, although one section of the genus has become specialized for the dry steppe-like country of the plateau of eastern Brazil.

Order SAPINDALES.

Family ANACARDIACEAE.

Genus TAPIRIRA Aublet.

TAPIRIRA LANCEOLATA Engelhardt.

Plate 15, fig. 1.

Tapirira laneeolata ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 15, pl. 9, fig. 4, 1895.

Description.—Leaflets apparently sessile, broadly lanceolate and somewhat inequilateral in outline, with an acuminate tip and a rounded or cuneate base. Length about 10 cm. Maximum width, midway between the apex and the base, ranging from 2.5 cm. to 3 cm. Margins entire. Texture subcoriaceous. Midrib stout and prominent, slightly curved proximad. Secondaries numerous, somewhat irregularly spaced, subparallel and camptodrome; angles of divergence, 50 to 60 degrees. Tertiaries thin, mostly immersed.

Material that is identical with that described by Engelhardt from the interandean basin of Loja, in Ecuador, is contained in the collection from the Peruvian coast south of Tumbez. The genus *Tapirira*, as restricted in Engler's revision of the Anacardiaceae,[1] contains 5 or 6 species of shrubs or trees with odd-pinnate leaves. They are confined to tropical South America and are chiefly Brazilian. Engelhardt has compared the fossil with the existing Pao pombo, *Tapirira guanensis* Aublet, which is widely distributed in the South American Tropics, and which has leaflets that are practically indistinguishable from those of the fossil. No other fossil representative of the genus is known.

Pleseotype.—Cat. No. 35331, U.S.N.M.

Order THYMELEALES.

Family LAURACEAE.

Genus MESPILODAPHNE Ness.

MESILODAPHNE TUMBEZENSIS, new species.

Plate 15, fig. 3.

Description.—Leaves of relatively small size, broadly lanceolate and somewhat falcate in outline, with an acuminate apex and base.

[1] Natürlichen Pflanzenfamilien, Teil 3, Abt. 5, pp. 138–178, 1896.

Length about 9 cm. Maximum width, slightly above the middle, 2.2 cm. Margins entire. Texture subcoriaceous. Petiole missing. Midrib stout, curved, prominent. Secondaries stout, but not prominent; about six opposite to alternate, irregularly and mostly widely spaced camptodrome pairs. Tertiaries mostly obsolete.

This species is based upon a small amount of material of a lauraceous leaf, apparently referable to *Mespilodaphne* and much like the leaves of a number of existing species in this genus—as, for example, the Brazilian species *Mespilodaphne brasiliensis* and *M. glauca*. These are much like the fossil, the first being relatively narrower and the second slightly wider. There are a considerable number of fossil forms that are of this type—as, for example, *Mespilodaphne pseudoglauca* Berry and *M. coushatta* Berry from the lower Eocene of southeastern North America, although such comparisons are of but slight value beyond corroborating the generic identity.

The present species is extremely close to, if not identical with, a form from the Navidad beds of Chile described by Engelhardt[1] as *Hoffmannia protogaea*. This genus of the Rubiaceae has about a score of existing species of herbs and shrubs that are chiefly Central American in range. Although there are minor differences in venation between this Engelhardt species and the present one from Peru, I am inclined to consider the two as identical, particularly as variants described from Chile under other names serve to render this comparison still more probable.

The existing species of *Mespilodaphne*, often included with *Oreodaphne* and *Strychnodaphne* in the composite genus *Ocotea*, are confined to Africa and tropical South America, attaining their maximum development in northern South America.

Holotype.—Cat. No. 35334, U.S.N.M.

Genus PERSEA Gaertner.

PERSEA MACROPHYLLOIDES Engelhardt (?)

Persea macrophylloides ENGELHARDT, Abh. Senck. Naturf. Gesel., vol. 16, p. 650, pl. 5, fig. 3, 1891; vol. 19, p. 27, pl. 5, fig. 3, 1895.

Material from near Tumbez, too poor for figuring, strongly suggests this species which Engelhardt has recorded from both the Navidad beds of Chile and from Santa Ana in Colombia. It appears to be correctly referred to *Persea* and is especially interesting in its bearing on the correlation of these remote Tertiary outcrops.

[1] Engelhardt, H., Abh. Senck. Naturf. Gesell., vol. 16, p. 657, pl. 5, fig. 1, 1891.

Order EBENALES.

Family STYRACACEAE.

Genus STYRAX Linnaeus.

STYRAX LANCEOLATA Engelhardt (?)

Plate 15, fig. 2.

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

This species was based upon rather complete material of relatively small ovate-lanceolate coriaceous leaves from Santa Ana in Colombia. The Peruvian material is fairly satisfactory, but not positively identified.

The genus *Styrax* comprises about three score species of shrubs and trees, with two centers of distribution—northern South America (Amazon basin), extending northward through Central America and the Antilles and reappearing in the southern United States, and a second extending from China and Japan through the East Indies, with a few species extending westward to the Mediterranean region of Europe, apparently relica of a Tertiary cosmopolitanism.

About 16 fossil species have been recorded, some of which are of uncertain botanical affinity; others representing flowers and fruit as well as foliage are more convincing. Two species are recorded from the early Eocene of Colorado. There are three species in the Oligocene and eight in the Miocene of Europe, and characteristic seeds have been found in the late Pliocene of Holland. Still existing species occur in the Pleistocene of Japan. South America, in addition to the present species, has furnished two species from beds of approximately the same age in Chile.

Plesiotype.—Cat. No. 35336, U.S.N.M.

Order RUBIALES.

Family RUBIACEAE.

Genus CONDAMINEA De Candolle.

CONDAMINEA GRANDIFOLIA Engelhardt.

Plate 17.

Condaminea grandifolia ENGELHARDT, Abh. Senck. Naturf. Gesell., vol. 19, p. 34, pl. 7, fig. 2; pl. 9, fig. 1, 1895.

Description.—Leaves of large size, elliptical in general outline, but with an acuminate apex. Length about 24 cm. or 25 cm. Maximum width, midway between the apex and the base, about 12 cm. Margins entire, evenly rounded. Texture coriaceous. Petiole missing. Midrib stout, prominent. Secondaries stout, but not especially so for such large leaves; there are about 12 subopposite to alternate

pairs, approximately subparallel and regularly spaced; they diverge from the midrib at wide angles, becoming more ascending toward the apex of the leaf, curve regularly upward and are camptodrome. The Tertiary venation is fine but exceedingly well marked, and consists primarily of closely spaced and approximately straight percurrent nervilles.

This species is exceedingly common in the collections from near Tumbez, but because of the large size of the leaves they are usually much broken, particularly the ends and margins. One of the most perfect specimens is that shown in reduced size on plate 4. The Peru material is much more abundant and complete than the type material described by Engelhardt from Santa Ana, on the western margin of the Rio Magdalena Valley in the Colombian Andes. The general form and especially the venation are very characteristic, and there can be no doubt but that the present material is identical with that from Colombia. Regarding its botanical relationship, its reference to the genus *Condaminea* is uncertain, nor are specimens of the latter available for comparison. It suggests to me an entire leafed species of *Artocarpus*.

Engelhardt, who compared it with recent material in the German herbaria, is confident that it is a *Condaminea*, and writes that it is most similar to *Condaminea corymbosa* (Ruiz and Pavon) De Candolle, a tall shrub of the Colombian and Peruvian Andes, a reduced form of which is hardy at considerable elevations. The genus is a small one in the existing flora and comprises tall shrubs and small trees with corriaceous leaves, confined to the tropical Andean region, and not otherwise known in the fossil state.

Plesiotype.—Cat. No. 35332, U.S.N.M.

EXPLANATION OF PLATES.

PLATE 14.

FIG. 1. *Iriartites tumbezensis*, new genus and new species, fragment two-thirds natural size.

2. Same enlarged to show details of venation.

PLATE 15.

FIG. 1. *Tapirira lanceolata* Engelhardt.

2. *Styrax lanceolata* Engelhardt (?).

3. *Mespilodaphne tumbezensis* Berry.

4. *Anona winslowiana* Berry.

PLATE 16.

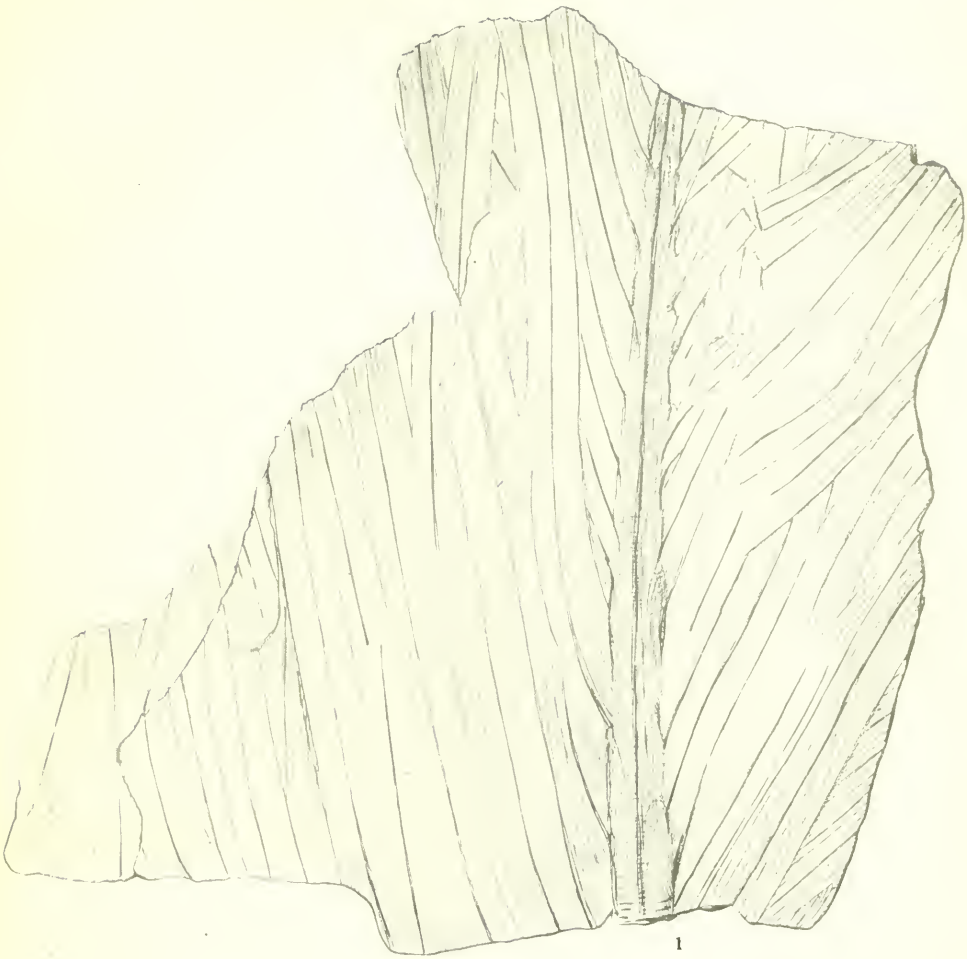
FIG. 1. *Banisteria incerta* Berry.

2. *Ficus winslowiana* Berry.

3. *Guatteria culebrensis* Berry.

PLATE 17.

FIG. 1. *Condaminea grandifolia* Engelhardt, three-fourths natural size.

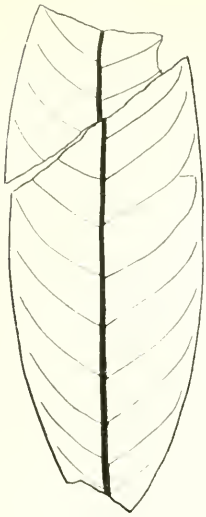


1

2

MIOCENE FOSSIL PLANTS FROM NORTHERN PERU.

FOR EXPLANATION OF PLATE SEE PAGE 294.



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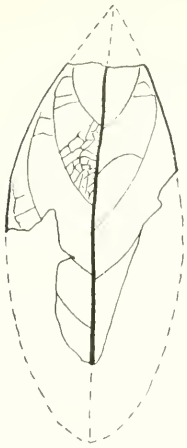

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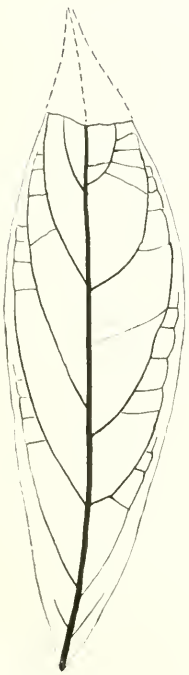

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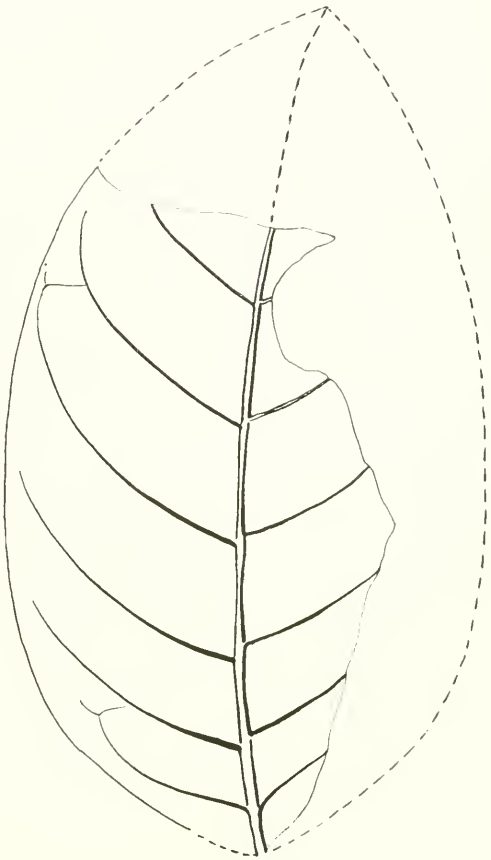

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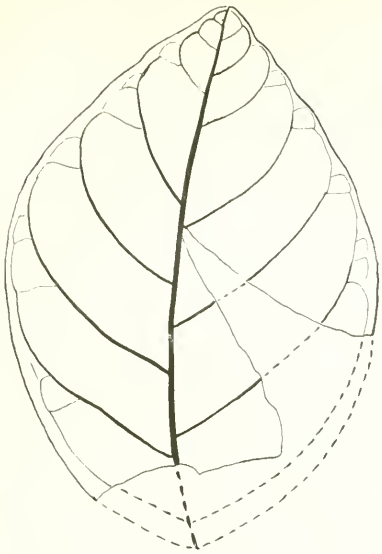
MIOCENE FOSSIL PLANTS FROM NORTHERN PERU.

FOR EXPLANATION OF PLATE SEE PAGE 294



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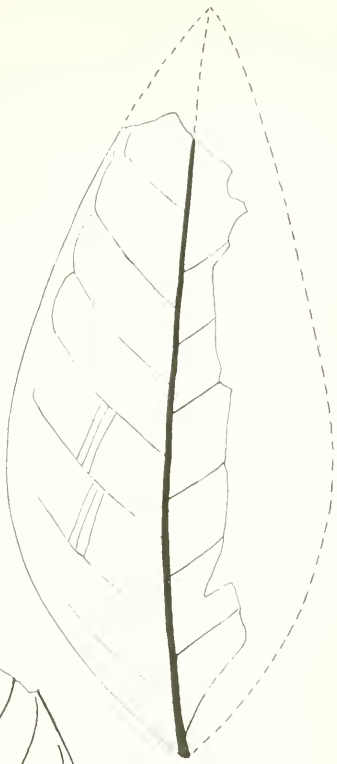

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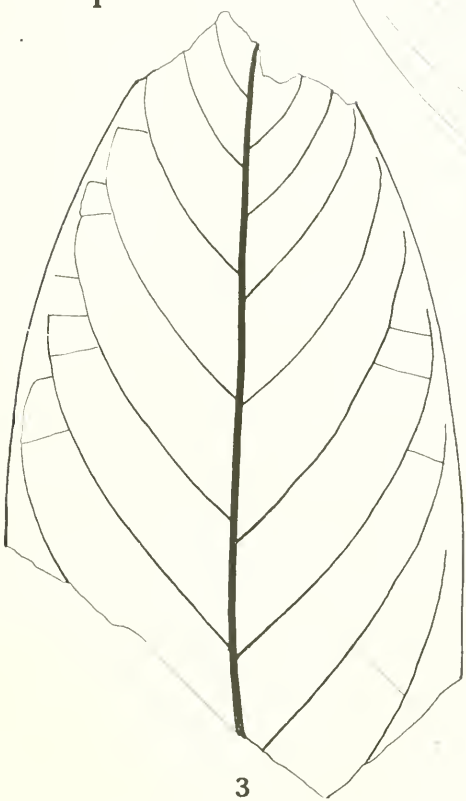
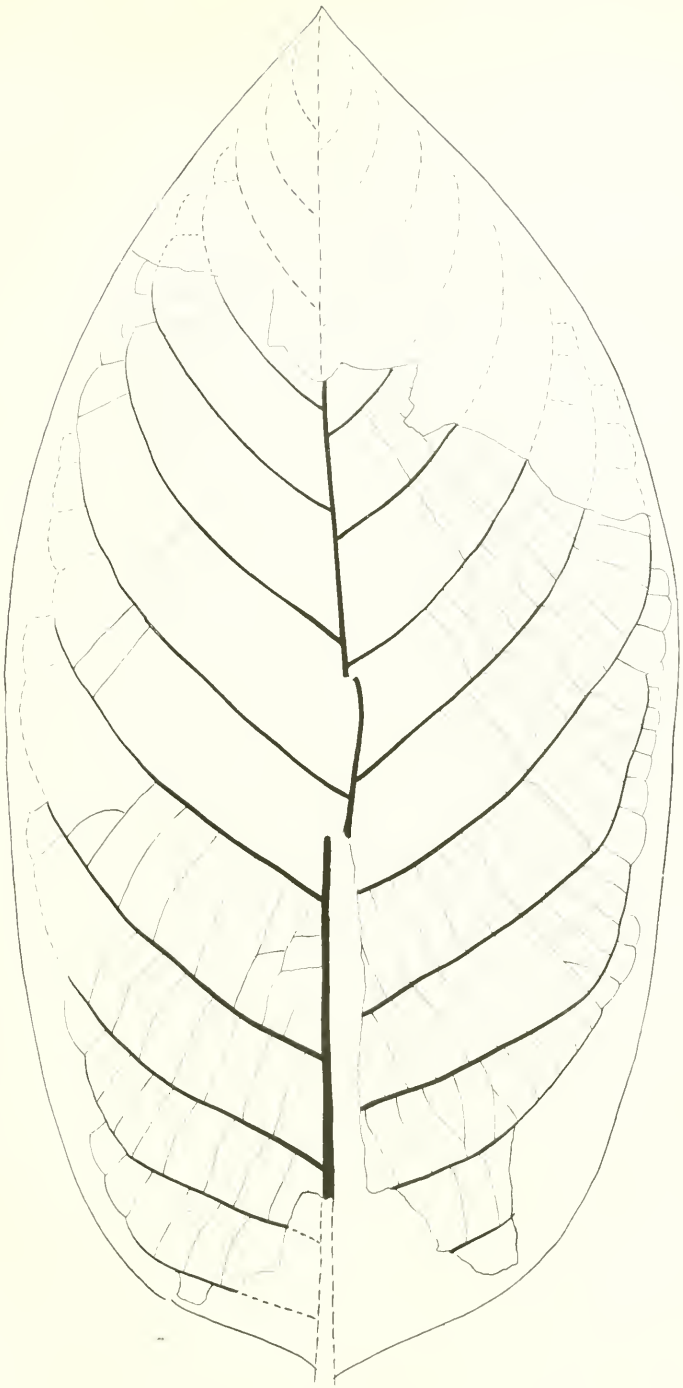


3

MIOCENE FOSSIL PLANTS FROM NORTHERN PERU.

FOR EXPLANATION OF PLATE SEE PAGE 294.



MIOCENE FOSSIL PLANTS FROM NORTHERN PERU.

FOR EXPLANATION OF PLATE SEE PAGE 294.