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GEOLOGIC HISTORY INDICATED BY THE FOSSILIFEROUS DEPOSITS OF THE WILCOX GROUP (EOCENE) AT MERIDIAN, MISSISSIPPI

BY

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GEOLOGIC HISTORY INDICATED BY THE FOSSILIFEROUS DEPOSITS OF THE WILCOX GROUP (EOCENE) AT MERIDIAN, MISSISSIPPI.

By Edward Wilber Berry.

INTRODUCTION.

The presence of erosion intervals at several horizons in the Eocene of the Gulf States has been pointed out in a recent paper,[1] and the evidence of an erosion interval between the period of deposition of the sediments of the Wilcox group (lower Eocene) and that of the Claiborne group (middle Eocene) was reviewed in some detail in a general discussion of the extensive flora of the Wilcox group of that region.[2] This evidence was not entirely conclusive and was based on the littoral character of the basal Claiborne, the occurrence of autochthonous beds of lignite at the base of the Claiborne at certain localities in the northern part of the Mississippi embayment, the great change between the Wilcox and Claiborne floras and faunas, and the reported unconformities in western Georgia [3] and in southwestern Texas.[4] Recently E. N. Lowe,[5] State geologist of Mississippi, discovered a westward extension into that State of the glauconitic shell marl of the Bashi ("Woods Bluff") formation of southern Alabama. C. W. Cooke, of the United States Geological Survey, visited this region in the spring of 1916 and collected fossil plants at Meridian, Miss. This collection contained two new and important plants, and it is the purpose of the present paper to discuss briefly these additions to the flora of the Wilcox group and the new evidence of the unconformity between the Wilcox and the Claiborne groups afforded by this outcrop.

[1] Berry, E. W., Erosion intervals in the Eocene of the Mississippi embayment: U. S. Geol. Survey Prof. Paper 95, pp. 73–82, 1916.

[2] Berry, E. W., The lower Eocene floras of southeastern North America: U. S. Geol. Survey Prof. Paper 91, pp. 36–38, 1916.

[3] Veatch, Otto, and Stephenson, L. W., Preliminary report on the geology of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 26, p. 228, 1911.

[4] Dumble, E. T., Some events in the Eocene history of the coastal area of the Gulf of Mexico in Texas and Mexico: Jour. Geology, vol. 23, pp. 481–498, 1915.

[5] Lowe, E. N., Mississippi, its geology, geography, soils, and mineral resources: Mississippi Geol. Survey Bull. 12, p. 71, 1915.

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THE LOCALITY.

The outcrop from which the fossil plants were obtained is in the southeastern part of the town of Meridian, Miss., on a hillside immediately south of the Meridian & Memphis Railway, in an extensive excavation for the fill leading to the overhead crossing of the Mobile & Ohio Railroad, 200 yards east of that crossing. The section, for which I am indebted to Mr. Cooke, shows the following sequence:

Section at Meridian, Miss.

	Feet.
Fine yellow incoherent sand with flat, disklike pebbles of clay and thin beds of clay, some of which show apparent ripple marks	15–20±
Probable unconformity.	
Gray to brown and black hackly clay, very sandy in places, with much lignitic matter; impressions of leaves abundant near the top	30±
Greenish-yellow fine incoherent glauconitic sand with large spheroidal indurated masses crowded with fossil shells (*Venericardia planicosta, Pseudoliva petrosa tuomeyi, Solariella louisiana,* etc.), characteristic of the Bashi ("Woods Bluff") formation of the Wilcox group	12

The fossil plants were collected from the end of the cut nearest to the railroad crossing, and the base of the section is a little higher than the flood plain of Souwashee Creek. The basal member contains an abundant marine fauna, which Mr. Cooke states is characteristic of the Bashi formation of the Alabama section. The overlying member is packed with plant remains in its upper layers. The following table

enumerates those that are determinable and gives their known range:

Species of fossil plants occurring at Meridian, Miss.

	Previously known range.		
	Lower Wilcox.	Middle Wilcox.	Upper Wilcox.
Lygodium binervatum (Lesquereux) Berry	×	.....	(?)
Zamia mississippiensis Berry, n. sp.	.....	.....	.....
Sabalites grayanus Lesquereux	.....	×	×
Ficus puryearensis Berry	×	×	×
Nelumbo protolutea Berry, n. sp.	.....	.....	.....
Gleditsiophyllum eocenicum Berry	.....	×	×
Dalbergites ellipticifolius Berry	.....	.....	×
Sapindus formosus Berry	.....	×	×
Sapindus mississippiensis Berry	.....	×	×
Mespilodaphne eolignitica Berry	×	×	×
Mespilodaphne pseudoglauca Berry	.....	×	×
Nectandra lowii Berry	.....	×	×
Combretum obovalis Berry	.....	.....	×
Aralia acerifolia Lesquereux	.....	.....	×

It will be seen that of the 14 species identified from Meridian, three occur in the lower Wilcox or Ackerman formation, eight in the middle Wilcox or Holly Springs sand, and twelve, or all but the two new species, in the upper Wilcox or Grenada formation. In addition it should be noted that several recorded from the middle Wilcox are found only near the top of that division, so that the present assemblage would be referred unhesitatingly to the upper Wilcox or Grenada formation even were its stratigraphic position unknown.

GEOLOGIC INTERPRETATION.

The Bashi formation of the Alabama section is overlain by the Hatchetigbee formation, which contains an obviously shallow-water marine fauna. It would seem indisputable that the lignitic sands overlying the glauconitic marl at Meridian correspond to the Hatchetigbee formation as it occurs to the southeast in Alabama and also to the Grenada formation as it occurs to the northwest. The Hatchetigbee fauna indicates the shallowest-water assemblage of Mollusca represented in the Alabama section of the Wilcox group.

This rather obvious correlation is not, however, the feature of especial interest in the Meridian section. The significance of that section lies in the facts that at the base the material is a glauconitic sand with an abundant fauna—obviously a shallow-water marine deposit—and that these marine sands pass imperceptibly upward into sandy lignitic clays which must be interpreted, in part at least, as true continental deposits, thus clearly presaging the withdrawal of the sea during the interval between the Wilcox and the Claiborne.

The presence of land plants and scattered lignitic material (allocthonous) in the sediments argues for the nearness of a vegetation-covered shore. The legitimate evidence in the Meridian locality, however, justifies more than this inference, for the upper layers of the middle member are not only filled with the remains of land plants but contain in addition the rootstocks and abundant leaves of what appears to be the Eocene ancestor of the American Lotus. This species (*Nelumbo protolutea*) belongs to a genus whose known living representatives are large perennial herbs growing exclusively in shallow and still fresh water, or occasionally in water that is only very slightly brackish. Were the leaves the only traces of this plant present in the deposits they might be interpreted as having been drifted into an estuary, although their great abundance in all sizes and the fact that the leaves are not deciduous but would have to be torn away from their stout petioles are opposed to such an interpretation. But inasmuch as the clays contain rootstocks which during life creep in the mud at the bottoms of ponds, and as a great abundance of rootlets permeate the clays in every direction, many of them with the root hairs preserved, it is obvious that these remains were not transported but grew on the spot where they are now found.

They thus afford a record for this locality of a period of changing conditions during which greensands carrying a marine fauna became replaced by littoral sands and muds and these in turn were overlain by the sandy muds of what was probably a shallow pond containing a vigorous growth of innumerable nelumbos or lotuses and receiving the leaves that fell from the trees along its shores.

The section at Meridian, as interpreted by Mr. Cooke, appears to show an unconformity above

the plant bed, and the uppermost member—a fine yellow sand—contains disklike pebbles of waterworn clay, of a type usually associated with rather quiet wave action on beaches, and thin beds of clay that appear to have been ripple marked. These clay beds and pebbles may be local in character or they may mark the beginning of the Claiborne transgression.

The conclusion seems justified that the upper Wilcox was a time during which the open sea became gradually smaller as the strand line moved southward, and that there was an interval of emergence between the deposition of the Wilcox and that of the Claiborne group, an interval whose considerable length is indicated by the great contrasts between the terrestrial floras and the marine faunas of the Wilcox and the Claiborne.

The locality at Meridian is the southernmost point in the Wilcox outcrop where fossil plants have been found, and if this locality, so far to the south, thus clearly indicates the succession of events between the last Wilcox marine fauna and the transgressing sands of the lower Claiborne sea, it is obvious that a similar succession and a longer erosion interval characterized that great area of the Mississippi embayment which lies to the north of Meridian.

TWO NEW SPECIES OF FOSSIL PLANTS.

The two new species described below are of especial interest in that the *Nelumbo* adds an entirely new type to the Wilcox flora, representing a family hitherto unknown in that remarkable assemblage of between 300 and 400 species, and the second adds a new cycad (*Zamia*), represented by fronds, the only known cycad from the American Tertiary except a single piece of a pinnule of another species of *Zamia* from the Wilcox, previously described.[1]

Class GYMNOSPERMAE.
Order CYCADALES.
Family CYCADACEAE.
Genus ZAMIA Linné.

Zamia mississippiensis Berry, n. sp.

Although *Zamia*-like foliage is very common and widespread in Mesozoic deposits the world over and more than 30 species of *Zamia* still exist in tropical and subtropical America, including two that occur in the Floridian region, only a few cycads have thus far been discovered in Tertiary deposits anywhere. Much interest therefore attaches to the present discovery of a small-leafed form of *Zamia*.

Leaves elongate, slender, and linear. Rachis stout. Pinnules small, crowded, opposite or subopposite, bluntly pointed, constricted proximad to a relatively broad inequilateral base, attached to the sides of the top of the rachis. Length 1.25 to 1.50 centimeters; maximum width about 2 millimeters. Margins entire. Texture coriaceous. Venation consisting of eight to ten longitudinally subparallel veins, a few of them dichotomous proximad.

This characteristic *Zamia* is represented in the present collections by three specimens, two of which are shown in the accompanying

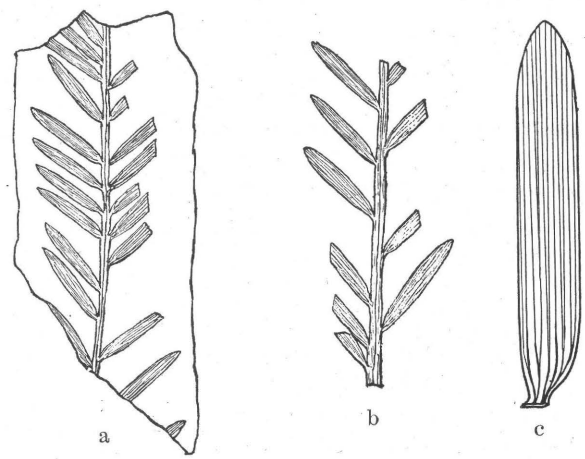


FIGURE 17.—*Zamia mississippiensis* Berry, n. sp. a, Specimen showing traces of 14 pairs of pinnules; b, specimen with slightly larger pinnules; c, pinnule enlarged 4 diameters to show form and venation.

figures. In the specimen represented in figure 17, b, which shows a portion of the pinnule-bearing part of a rachis 4.4 centimeters long, the pinnules are slightly larger than in the other specimen figured and are more scattered, but this is due to the loss of the intervening pinnules. In the other specimen (fig. 17, a) a similar pinnule-bearing part of the rachis 4.7 centimeters long shows traces of 14 pairs of pinnules. The rachis is somewhat more slender than in the specimen shown in figure 17, b, and the pinnules are slightly smaller. The unfigured specimen shows 5 centimeters of pinnule-bearing rachis with traces of 12 pairs of pinnules.

These remains evidently represent a *Zamia* with slender, graceful leaves and much reduced pinnules, somewhat suggestive of the

[1] Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 169, pl. 114, fig. 2, 1916.

existing *Zamia floridana* De Candolle, which inhabits the so-called flatwoods of the east coast of Florida south of New River.

In my account of the lower Eocene flora of southeastern North America[1] I described as *Zamia? wilcoxensis* a single broken pinnule of a cycad which I compared with the existing Floridian *Zamia pumila* Linné. It is interesting to find the remains of a second species somewhat resembling the only other living Florida species at a horizon as old as the lower Eocene. The two species, though based on a rather meager amount of material, are apparently distinct, for *Zamia? wilcoxensis* has pinnules with more than twice as many veins as the pinnules of *Zamia mississippiensis*. It is of course possible that the two occurrences represent the extremes of variation of a single lower Eocene species, but I do not regard this as probable.

Only five or six other Tertiary species of cycads are known, and most of these are based on poorly preserved or unrepresentative material. The only non-European form is an undoubted species of *Zamia* from the Eocene of Coronel, Chile, described by Engelhardt.[2] The oldest known Tertiary species is *Zamites palaeocenicus*, from the Thanetian of Gelinden, Belgium, described by Saporta and Marion.[3] Meschinelli[4] described a species from the Stampian of Venetia, Italy, which he referred to *Ceratozamites*, and two species have been recorded from the lower Miocene (Aquitanian) of Europe—a *Zamites* from southern France[5] and a well-marked *Encephalartos* from Kumi, in Greece.[6] Heer[7] recorded a species of *Zamites* from the Helvetian of Switzerland and a species of *Cycadites* from the Tortonian of that country, but both of these are rather doubtful determinations.

The small amount of material on which the present species is based is nevertheless sufficient to establish the undoubted relationship of the fossil, as the accompanying text figures show, and it is quite possible that future research will reveal other members of this interesting family in the later Tertiary deposits of this region, as the plants thus far collected from the upper Eocene and lower Oligocene are more tropical in character than those from the lower Eocene.

[1] Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 169, pl. 114, fig. 2, 1916.

[2] Engelhardt, H., Ueber Tertiärpflanzen von Chile: Senckenberg. naturf. Gesell. Abh., Band 16, p. 646, pl. 2, fig. 16, 1891.

[3] Saporta, Gaston de, and Marion, A. F., Révision de la flore heersienne de Gelinden, p. 20, pl. 1, figs. 4, 5, 1878.

[4] Meschinelli, L., Studio sulla flora fossile di Monte Piano: Soc. veneto-trentina Sci. Nat. Atti, vol. 10, p. 276, pl. 6, Padua, 1889.

[5] Saporta, Gaston de, Sur la découverte d'une cycadée dans le terrain tertiaire moyen de Provence: Soc. géol. France Bull., 2d ser., tome 21, pp. 314–328, pl. 5, 1864.

[6] Saporta, Gaston de, Notice sur l' *Encephalartos gorceixianus*, cycadée fossile, du dépôt miocène de Koumi (Eubée): Soc. bot. et hort. Provence Bull., pp. 41–44, 1 pl., 1880.

[7] Heer, Oswald, Flora tertiaria Helvetiae, vol. 1, p. 46, pl. 15; pl. 16, fig. 1, 1855.

Class ANGIOSPERMAE.

Order RANALES.

Family NYMPHAEACEAE.

Genus NELUMBO Adanson.

Nelumbo protolutea Berry, n. sp.

Plates XXIV–XXVI.

Leaves of all sizes, orbicular or suborbicular in outline, peltate. Petioles stout, that of one of the smaller leaves being 5 millimeters in diameter. Margins slightly undulate. Texture coriaceous. Primaries numerous, radiating from the center of the leaf, about 25 in number (this is the number in the central fragment of the very large leaf figured in Pl. XXIV, fig. 2, as it is also in leaves not over half the size), stout, prominent on the under side of the leaves. Although all the primaries are approximately equal in size they appear to be more crowded in one-half of the leaf than in the other, as in the large leaf figured (Pl. XXIV, fig. 2), where the ratio in the one-half to the other is 10 to 15. They pursue rather uniformly straight courses but fork dichotomously three or four times; the first dichotomy is somewhat more than half the distance to the margin. The angles of the dichotomies are about 30°. In some specimens the primary remains straight and the secondaries are curved, as in the vertical primary shown in Plate XXIV, figure 2. The marginal dichotomy is tiny, and the ultimate parts of the forking of adjacent primaries are united by a broad loop or arch subparallel with the margin, as shown in Plate XXIV, figure 1, and Plate XXV, figure 2. The tertiaries are thin and percurrent, or they inosculate midway between adjacent primaries. Areolation very fine but well marked, forming isodiametric hexagonal meshes, well shown enlarged twice in Plate XXVI, figure 3.

The diameter of the larger leaf figured (Pl. XXIV, fig. 2) is estimated as 32 centimeters; that of the leaf shown in Plate XXV, figure 2,

at 28 centimeters; that of the leaf shown in Plate XXV, figure 4, at 15 or 16 centimeters; and that of the small leaf shown in Plate XXV, figure 3, at 7 centimeters. The clays at this locality are packed with fragments of large leaves, so that the normal diameter seems to have been between 25 and 35 centimeters. The leaves were probably normally concave, as in the existing species, and several are preserved with the two halves of the upper surface in apposition. A fragment showing this method of preservation is shown in Plate XXV, figure 1.

Associated with the leaves are fragments of the rootstock, most of them poorly preserved but showing traces of nodes with leaf cushions and rootlet scars. In Plate XXVI, figure 2, are shown the flattened rootlets radiating from a node, and figure 1 on the same plate shows the rootlets and root hairs. Traces of rootlets are very common in the clays and serve to indicate that this species grew at the exact locality where it was preserved, as might also be inferred from its great abundance. Associated with these remains are a few rather poorly preserved oblate-spheroidal seeds, about 1.3 centimeters long and 0.8 centimeter in diameter, which I consider as representing the seeds of this species, although they are too poorly preserved for exact diagnosis. No traces of the characteristic large torus of this genus have yet been discovered at this locality.

This new species is wholly unlike any American Tertiary species heretofore known and is larger and much better preserved. Among the considerable number of European Tertiary forms it resembles somewhat *Nelumbo buchii*, from Monte Promina, in Dalmatia, as figured by Ettingshausen,[1] and *Nelumbo protospeciosum* from the Aquitanian of southern France, described by Saporta.[2] The latter is one of the most completely known fossil forms. It is represented by large and small leaves showing the details of areolation, by traces of flowers (stigmatic disks), and by seeds. Saporta considers it in the direct line of descent to the existing sacred lotus of India (*Nelumbo nelumbo*), which it certainly resembles very much. This French species is more like the Wilcox form than any other previously described, and if the two occurred at the same horizon it would be impossible to distinguish them by their foliage alone. *Nelumbo protospeciosum* is probably descended from *Nelumbo provinciale*, from the Upper Cretaceous lignites of Fuveau, in Provence, referred by Saporta to the Campanian stage but now usually considered as forming a part of the Aturian stage.

The existing species of Nelumbo are two in number, both magnificent plants. One, the Indian lotus, *Nelumbo nelumbo* (Linné) Karsten, is found in the southeastern Asiatic region from southern Japan to northern Australia and ranges westward as far as the Caspian Sea. The other, the American lotus or great water lily, *Nelumbo lutea* (Willdenow) Persoon, is found in eastern North America from Ontario and Michigan to Florida and Louisiana and southward in the West Indies and northern South America, extending as far as latitude 7° S. in Brazil.

Any genus of plants represented by but two closely related existing species, each with a comparable habitat and distribution and separated by the breadth of the Pacific Ocean, is sure to have had a long geologic history during which the ancestors of the existing species occupied the intervening land areas. That *Nelumbo* had such a history has long been known, and a considerable number of fossil species have already been described. The oldest are forms with small leaves for which I have proposed the generic term *Nelumbites*[3] and which are common in the Patapsco formation of the Potomac group in Maryland and Virginia (late Lower Cretaceous or Albian in age) and occur also in the earlier Upper Cretaceous of North America. Of about the same age or somewhat younger are *Nelumbium lusitanicum* and *Nelumbium choffati*, reported by Saporta[4] from the supposed Albian of Portugal, neither of which has been figured or adequately described.

A species of especial interest in the present connection is *Nelumbo kempii* Hollick,[5] which occurs in the Magothy formation of Long Island and New Jersey, for it appears to be

[1] Ettingshausen, Constantin von, Die eocenel Flora des Monte Promina in Dalmatien: K. Akad. Wiss. Wien Denkschr., Band 8, p. 36, pl. 10, figs. 2, 3; pl. 11, fig. 1; pl. 12, 1855.

[2] Saporta, G. de, Recherches sur la végétation du niveau aquitanien de Manosque, p. 17, pl. 1, figs. 2, 3; pl. 4, figs. 1, 2, 1891.

[3] Berry, E. W., Maryland Geol. Survey, Lower Cretaceous, p. 462, 1911.

[4] Saporta, G. de, Nouveaux détails concernant les Nymphéinées: Compt. Rend., vol. 119, pp. 835–837, 1894.

[5] Hollick, Arthur, The Cretaceous flora of southern New York and New England: U. S. Geol. Survey Mon. 50, p. 61, pl. 13, figs. 1–4; pl. 14, figs. 1, 2; pl. 15; pl. 16, figs. 1–6, 1906.

the logical ancestor of *Nelumbo protolutea* of the Wilcox, thus paralleling *Nelumbium provinciale* Saporta,[1] of the Aturian of southern France, which seems to be the ancestor of *Nelumbo protospeciosum* Saporta, in turn leading to the existing Indian lotus. Other Upper Cretaceous species are *Nelumbium schweinfurthi* Couyat and Fritel,[2] from the Aturian of Assouan, Egypt; *Nelumbium arcticum* Heer,[3] from the Atane beds of western Greenland; *Nelumbo intermedia* Knowlton,[4] from the Montana group of the West; and *Nelumbo dawsoni* Hollick,[5] from the Belly River beds of Canada. The two latter are small-leafed forms, possibly referable to *Nelumbites*.

Besides several poorly characterized forms, the following more definite species may be mentioned from the Tertiary: *Nelumbo lakesianum* Lesquereux[6] and *N. tenuifolium* Lesquereux,[7] from the early Tertiary of Colorado; *N. palaeocenicum* Fritel,[8] from the Sparnacian, or lower Eocene, of the Paris Basin; *N. microcarpum* Ettingshausen,[9] from the Ypresian, or lower Eocene, of England; *N. buchii* Ettingshausen,[10] which is found at a number of localities in the Oligocene and Miocene of Europe; *N. nymphaeoides* Ettingshausen,[11] from the Oligocene of Europe; and *N. casparianum* Heer,[12] *N. ettingshauseni* Sieber,[13] and *N. hungarica* Tuzson,[14] from the Miocene of Europe. One species, *N. minima* Clement and E. M. Reid,[15] is recorded from the Pliocene of northern Europe, and the genus is also represented by rhizomes in the late Tertiary of Japan.

The remains referred to these several species comprise leaves, flower parts, rhizomes, rootlets, characteristic fruits, and seeds, and they clearly establish the once cosmopolitan range of the genus, at least in the Northern Hemisphere, and its former abundance in Europe and residence there as late as the upper Pliocene. The existing *Nelumbo nelumbo*, therefore, appears to be a species whose extinction in Europe was brought about by the unfavorable conditions that existed during the Pleistocene epoch but which survived in eastern and southern Asia, as did its only existing ally, *Nelumbo lutea*, in eastern North America, by the opportunities afforded it to withdraw southward beyond the reach of adverse conditions—opportunities which Europe, with its high east-west mountain ranges and interior seas, failed to furnish.

In order to visualize the facts set forth in the preceding discussion I have assembled them on the accompanying sketch map (fig. 18), which shows the approximate range of the two existing species of *Nelumbo* by the obliquely lined areas and such Cretaceous and Tertiary records as occur outside these areas by solid black circles.

[1] Saporta, Gaston de, Le *Nelumbium provinciale:* Soc. géol. France Pal. mém. 5, 1890.

[2] Couyat, J., and Fritel, P. H., Sur la présence d'empreintes végétales dans le grès nubien des environs d'Assouan: Compt. Rend., vol. 151, p. 963, 1910.

[3] Heer, Oswald, Flora fossilis arctica, vol. 6, Abt. 2, p. 92, pl. 40, fig. 6, 1882.

[4] Knowlton, F. H., Flora of the Montana formation: U. S. Geol. Survey Bull. 163, p. 53, pl. 13, figs. 3–5, 1900.

[5] Hollick, Arthur, A new fossil *Nelumbo* from the Laramie group at Florence, Colo.: Torrey Bot. Club Bull., vol. 21, p. 309, 1894.

[6] Lesquereux, Léo, The Tertiary flora: U. S. Geol. Survey Terr. Rept., vol. 7, p. 252, pl. 46, figs. 1, 2, 1878.

[7] Idem, p. 253, pl. 46, fig. 3.

[8] Fritel, P. H., Note sur trois nymphéacées nouvelles du Sparnacien des environs de Paris: Soc. géol. France Bull., 4th ser., vol. 8, p. 472, pl. 10, fig. 3, 1908.

[9] Ettingshausen, Constantin von, Report on phyto-palaeontological investigations of the fossil flora of Sheppey: Roy. Soc. London Proc., vol. 29, p. 395, 1879.

[10] Ettingshausen, Constantin von, Die eocene Flora des Monte Promina in Dalmatien: K. Akad. Wiss. Wien Denkschr., Band 8, p. 36, pl. 10, figs. 2, 3; pl. 11, fig. 1; pl. 12, 1855.

[11] Idem, p. 37, pl. 10, fig. 1; pl. 11, fig. 2.

[12] Heer, Oswald, Flora tertiaria Helvetiae, vol. 3, p. 299, 1859.

[13] Sieber, Johann, Zur Kenntniss der nordböhmischen Braunkohlenflora: Akad. Wiss. Wien Sitzungsber., Band 82, p. 83, pl. 2, figs. 15, 16, 1880.

[14] Tuzson, Janos, A. Zsilvölgy egy új Harmadkori növénye: Magyar tud. Akad. Math. Természettud., Ert. 29, pp. 827–829, 1911; Beiträge zur fossilen Flora Ungarns: K. ung. geol. Reichsanstalt Jahrb., vol. 21, p. 257, pl. 17, fig. 3; pl. 19, figs. 2, 3; pl. 20; pl. 21, figs. 1, 2, 1914.

[15] Reid, Clement and E. M., The Pliocene floras of the Dutch-Prussian border, p. 85, pl. 6, fig. 20 a, b, 1915.

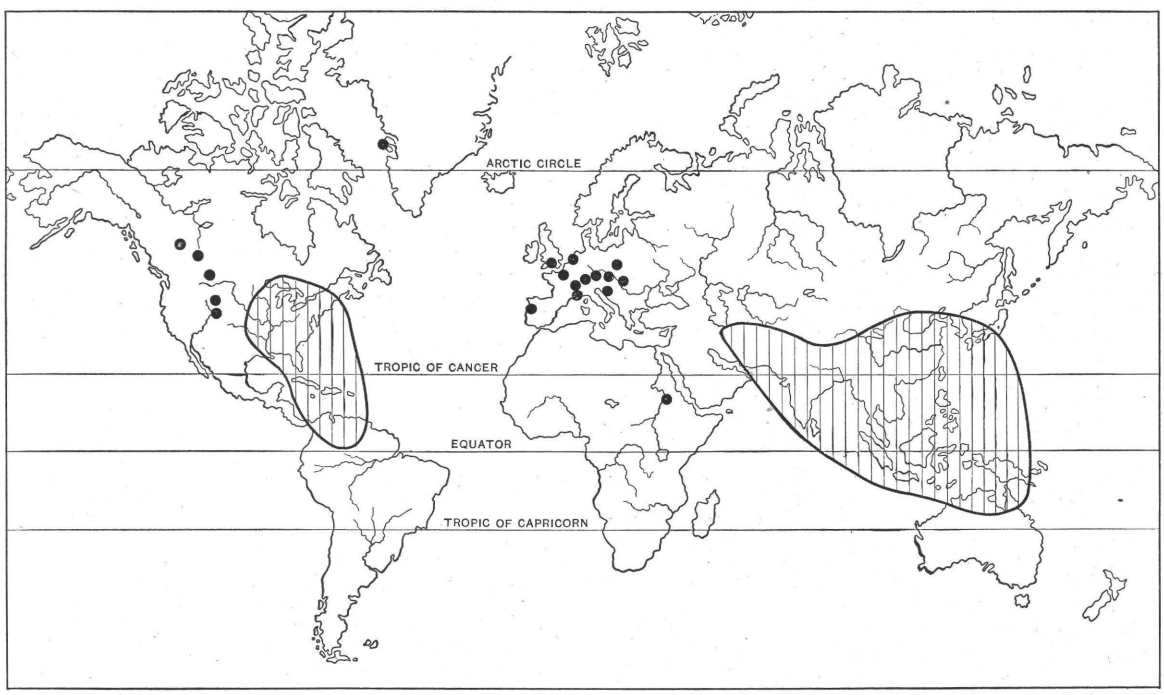


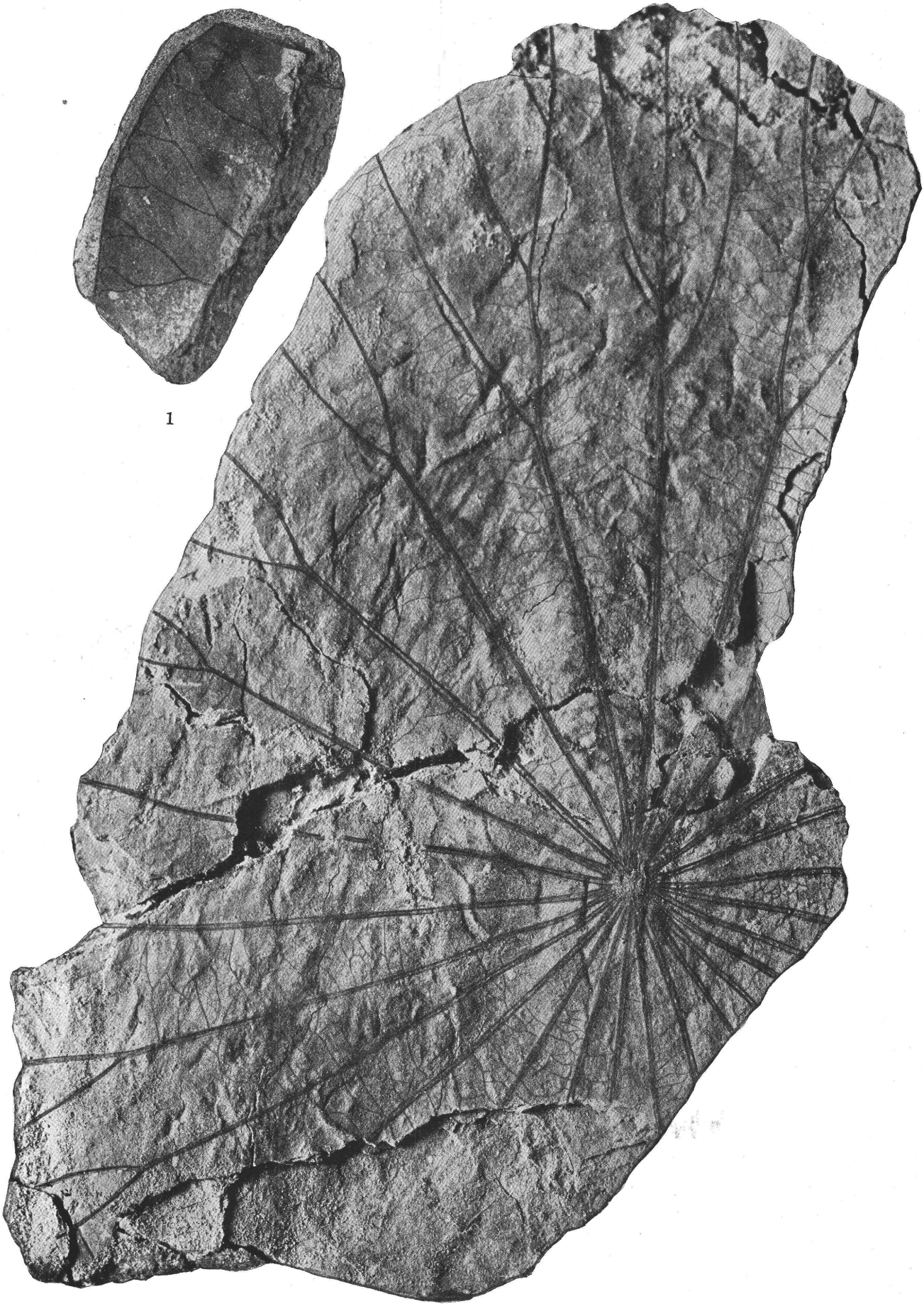
FIGURE 18.—Sketch map showing the existing and geologic distribution of *Nelumbo*.

PLATES XXIV-XXVI.

PLATE XXIV.

FIGURES 1, 2. *Nelumbo protolutea* Berry, n. sp., from the Grenada formation at Meridian, Miss.

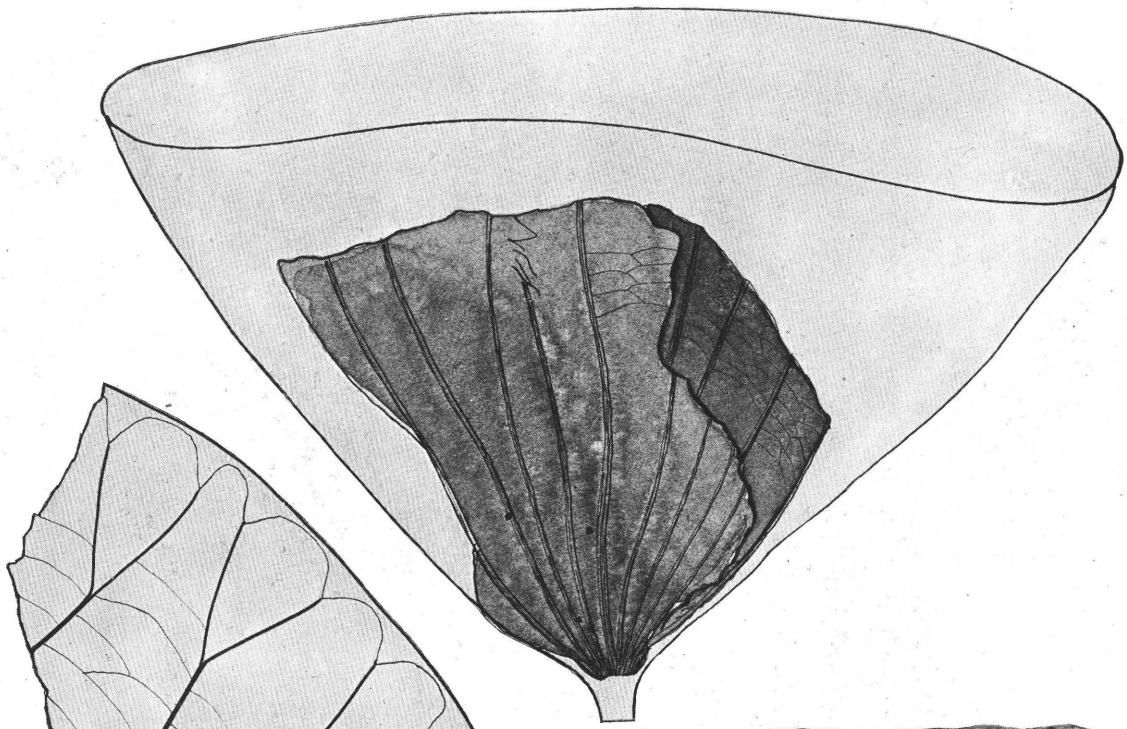
1. Specimen showing margin and marginal venation of a small leaf.
2. Specimen showing the central part of a large leaf.



1

2

NELUMBO PROTOLUTEA BERRY.



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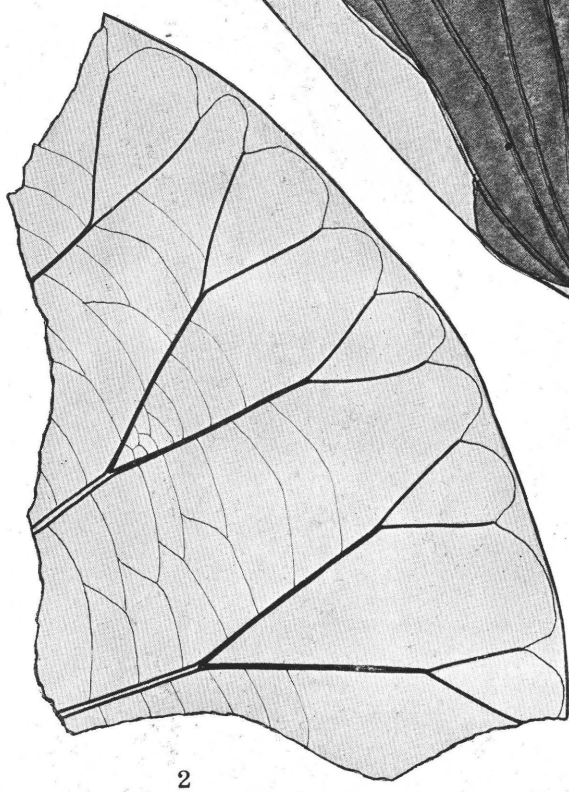
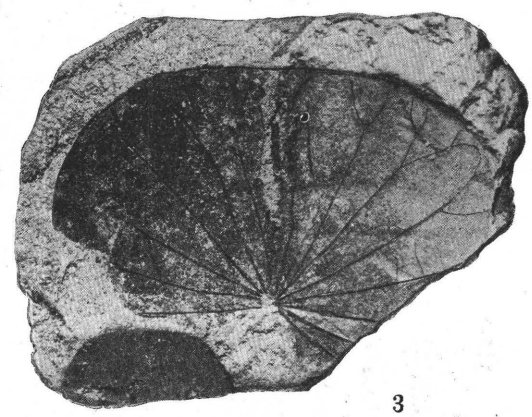
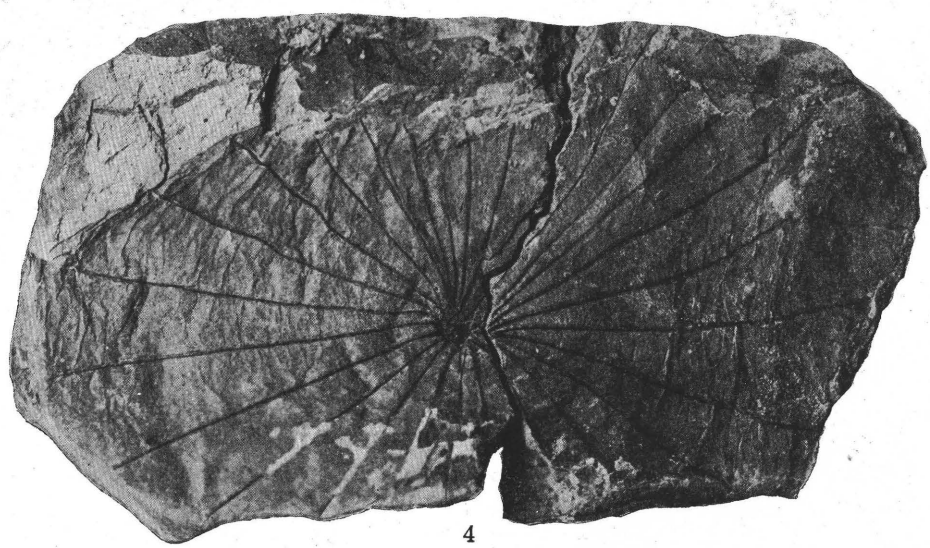


2



3



4

NELUMBO PROTOLUTEA BERRY.

PLATE XXV.

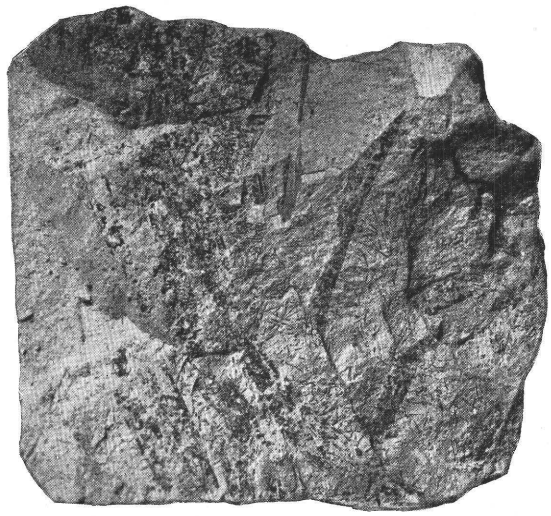
FIGURES 1–4. *Nelumbo protolutea* Berry, n. sp., from the Grenada formation at Meridian, Miss.

1. Specimen showing part of the under and upper surfaces of a small funnel-shaped leaf.
2. Specimen showing margin and marginal venation of a large leaf.
3. Specimen showing part of a very small leaf.
4. Specimen showing the central part of a medium-sized leaf.

PLATE XXVI.

FIGURES 1–3. *Nelumbo protolutea* Berry, n. sp., from the Grenada formation at Meridian, Miss.

1. Specimen showing rootlets and root hairs.
2. Specimen showing rootlets radiating from the node of a crushed rootstock.
3. Fragment of a large leaf, enlarged 2 diameters, to show the well-marked hexagonal areolation and other details of the venation.



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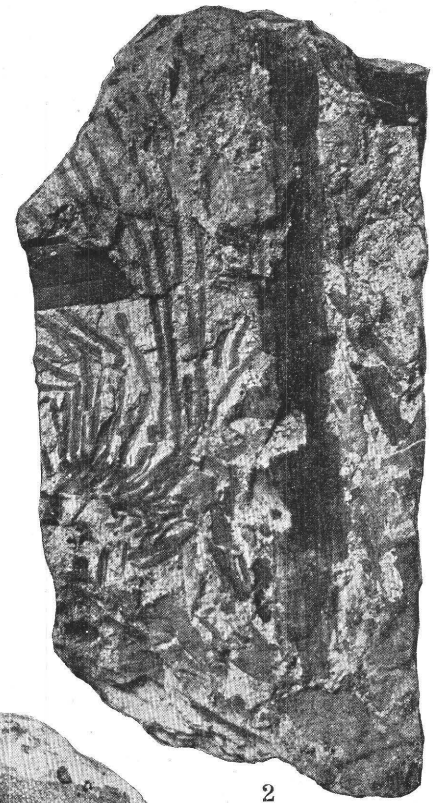

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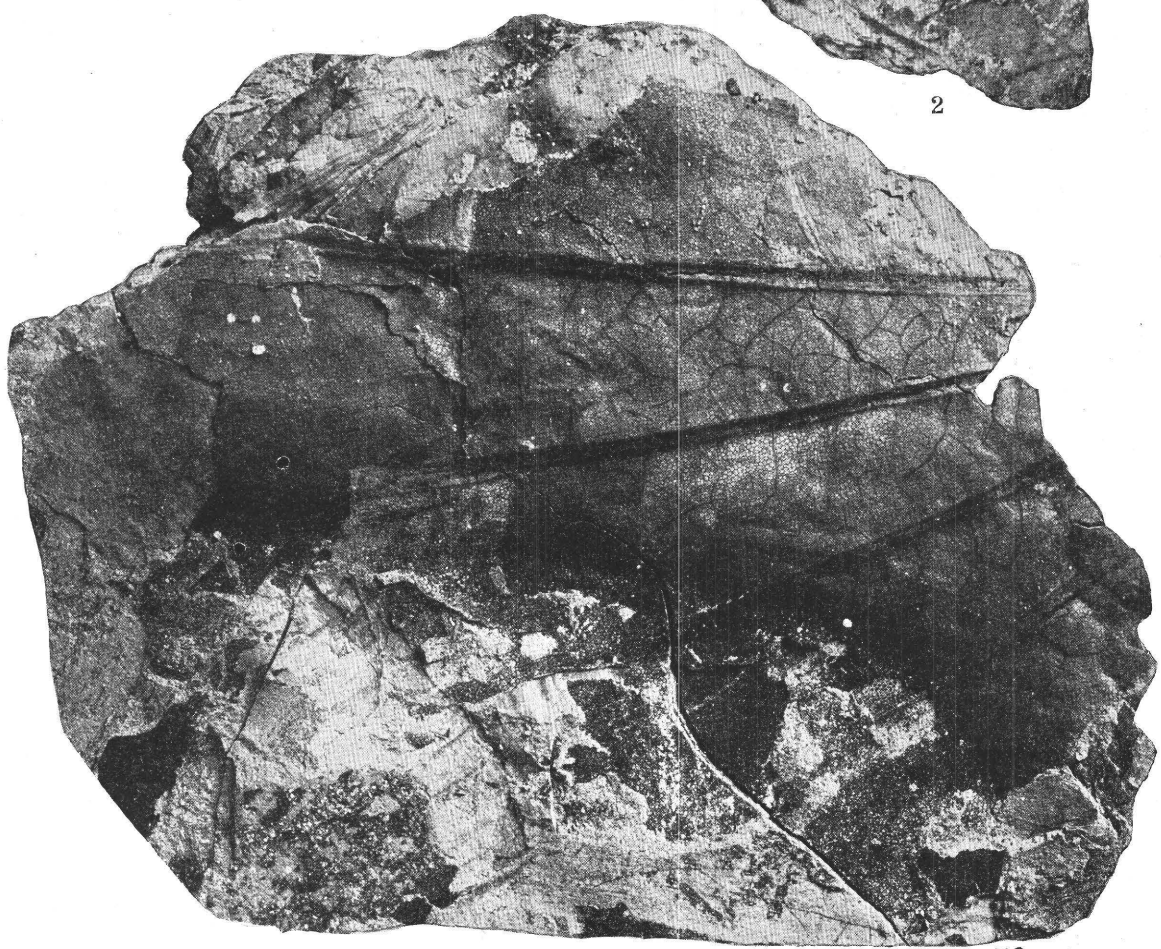

3 X2

NELUMBO PROTOLUTEA BERRY.